

INDO-PACIFIC RESOURCE GUIDE





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The U.S. Trade and Development Agency helps companies create U.S. jobs through the export of U.S. goods and services for priority development projects in emerging economies. USTDA links U.S. businesses to export opportunities by funding project planning activities, pilot projects, and reverse trade missions while creating sustainable infrastructure and economic growth in partner countries.

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1 INTRODUCTION

The U.S. Trade and Development Agency helps companies create U.S. jobs through the export of U.S. goods and services for priority development projects in emerging economies. USTDA links U.S. businesses to export opportunities by funding project preparation and partnership building activities that develop sustainable infrastructure and foster economic growth in partner countries.

This guide was prepared to provide U.S. companies and exporters an overview of infrastructure projects across the information and communications, transportation, energy, public health, agribusiness and water sectors in the Indo-Pacific region primarily over the next three years.

Currency amounts converted from local currencies to United States Dollars (USD) have been done using the current exchange rate at the time of preparation of this guide. Due to fluctuations in currency values, different levels of engineering and cost estimation completion for different projects, and different timing of cost information publication, the monetary values within this report should be considered as approximate. Unless explicitly indicated otherwise, all currency values are listed in United States Dollars (USD).

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INTRODUCTION

USTDA has sponsored the preparation of this Multi-Sector Resource Guide for the Indo-Pacific Region in an effort to assist U.S. companies in learning more about potential commercial opportunities within the region's Information and Communications, Transportation, Energy, and Public Health, Agribusiness and Water sectors. This guide presents a profile for each sector, with 60 project profiles distributed across these sectors from the six countries.

The Profiles contained in this report are mainly updates of projects that were included in the USTDA 2019 Indo-Pacific Resource Guide. Several new projects are also profiled here.

METHODOLOGY

This Resource Guide was prepared during a period when international travel was either banned or significantly curtailed and therefore all of the research and discussion meetings were held via video conference. The effort included reaching out to prior contacts, interviewing them or a replacement project executive and detailing project advances over the last fifteen months. In most cases, the project executives were available and interested in providing the information needed for completion of the effort. In addition, we reviewed public materials describing the project advances during the period.

In a few cases, the projects have stalled or been canceled and they are not profiled in this report. In addition, several project teams declined to respond to our requests and those projects are not included in this Resource Guide.

The **U.S. Trade and Development Agency** connects America's private sector to priority infrastructure projects in developing and middle-income countries. USTDA achieves its mission by funding feasibility studies, technical assistance and pilot projects that integrate the innovation and expertise of U.S. companies.

The Agency also connects project sponsors with U.S. partners through its reverse trade missions, industry conferences and expert workshops.

USTDA'S IMPACT



700+

Project activities
supported in Indo-
Pacific since 1992



156M

More passengers
served through
Indo-Pacific airports



139

Emerging markets
supported



11.7M

People with
improved digital
connectivity across
the Indo-Pacific

Supporting Infrastructure Development

USTDA is unique among federal agencies: it is mandated by Congress to promote U.S. industry participation in infrastructure projects at the critical early stages when design choices and technology options are being determined and defined.

The Agency also places particular emphasis on vital economic sectors: transportation, energy, information and communication technology, healthcare and agribusiness.

FEASIBILITY STUDIES AND TECHNICAL ASSISTANCE

USTDA funds feasibility studies and technical assistance to provide the comprehensive analysis that infrastructure projects need to move from concept to financing and implementation.

PILOT PROJECTS

USTDA tests U.S. equipment and technology in overseas settings to promote cutting-edge U.S. solutions and identify opportunities for scalability and replicability across the Indo-Pacific.

REVERSE TRADE MISSIONS

USTDA brings foreign project sponsors to the United States to observe the innovative design, manufacture and operation of American products and services to support their infrastructure development goals.

Since 1992, USTDA has funded **more than 700 activities** supporting infrastructure development in **23 Indo-Pacific countries**

Vietnam

USTDA has creatively invested in Vietnam's aviation sector, strengthening airport infrastructure, enhancing aviation safety and implementing modern air traffic control technologies. USTDA has also advanced Vietnam's energy security by supporting power generation, transmission and distribution activities. Vietnam is also one of USTDA's partners in promoting value-based procurement through the Global Procurement Initiative.

Indonesia

USTDA has worked across numerous sectors of the Indonesian economy to develop cleaner energy resources, strengthen disaster response capabilities, modernize aviation systems, expand rail sector capacity and modernize refineries.

Thailand

USTDA has completed more than 80 activities that have advanced Thailand's infrastructure priorities and built technical capacity through activities spanning disaster warning and management, airport design, new power generation and rail sector modernization.

India

USTDA has funded nearly 200 activities across key sectors of the Indian economy, linking U.S. expertise to projects that support smart, sustainable cities and expand the country's energy mix through investments in smart grid, energy storage, refineries and power plants. The Agency's aviation activities are led through the U.S.-India Aviation Cooperation Program, a unique public-private partnership that strategically supports India's rapidly growing civil aviation market.

The Philippines

USTDA activities in the Philippines have focused on the introduction of 5G telecommunications technologies, modernizing transportation networks, adopting best-value procurement policies and expanding electricity access and reliability. A series of these initiatives have also implemented smart grid solutions to more efficiently manage, monitor and distribute electricity throughout the country.

2 INFORMATION AND COMMUNICATIONS TECHNOLOGY

Sector Overview: Information and Communications Technology (ICT)

The Information and Communications Technology (ICT) sector's current relative importance in the countries of interest in this Resource Guide (India, Indonesia, Malaysia, Philippines, Thailand, and Vietnam) varies widely. Still, all have aggressive programs to expand both at home and in export markets. Malaysia, Vietnam, and the Philippines have established ICT-heavy trade positions for goods substantially larger than world averages (Figure 1). India and the Philippines have established strong services export positions due to the combination of low labor costs and the availability of educated sectors of their populations (Figure 2), a category Vietnam does not yet report.

Figure 1: ICT Goods Exports and Imports, 2019¹

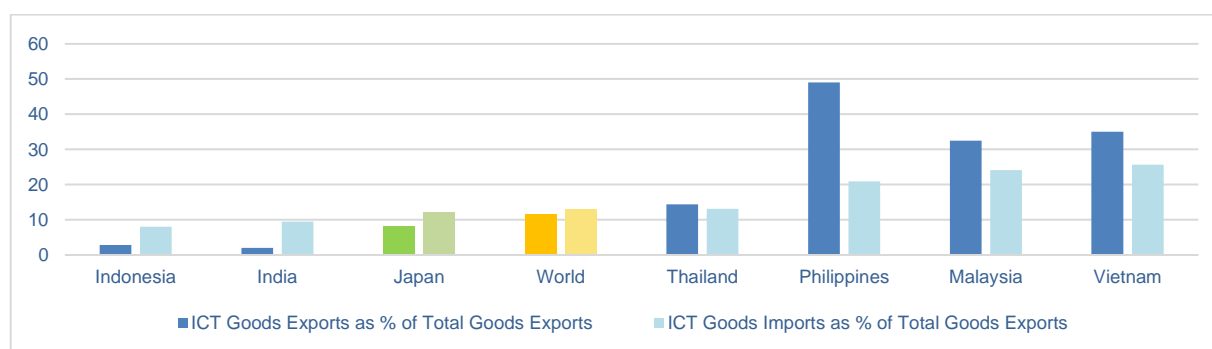
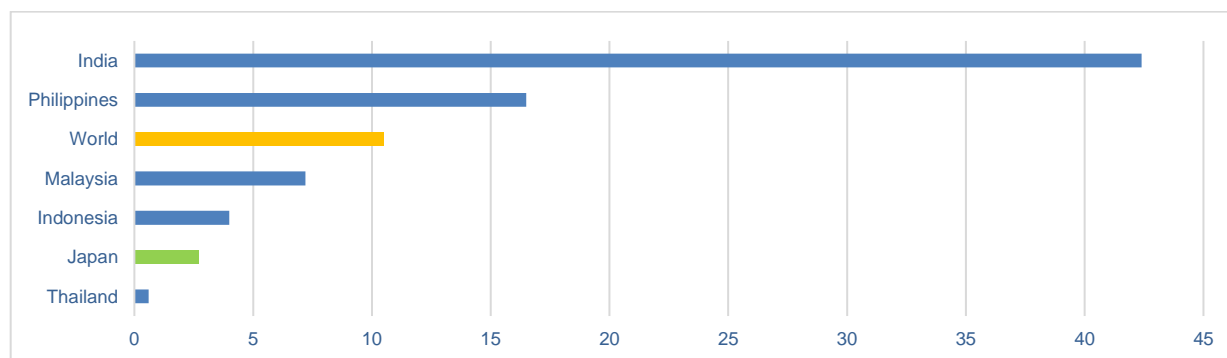


Figure 2: ICT Services Exports as Share of Total Services Exports, 2017²



¹ World Bank, <https://data.worldbank.org/indicator/TX.VAL.ICTG.ZS.UN>

² Ibid

Developing digital economies offers numerous benefits for Asian countries:³

- Government: infrastructure development with fewer hurdles and less capital.
- Business: encourage trade, ease access to global markets.
- Consumer: connectivity, mobility and social networks (e.g., in 2020, India, the U.S., and Indonesia were numbers one, two and three globally in terms of Facebook users, with India and Indonesia holding third and sixth places globally for Twitter users).

The COVID-19 global pandemic has reinforced the benefits of broad and reliable citizen, business and government access to ICT technologies, allowing remote access to critical public health information, access to medical care and providing contactless shopping. The region has generally struggled with preparedness for ICT-facilitated remote learning, though all the Resource Guide Countries have implemented to some degree, with most having plans to address their capabilities moving forward.

Five high-growth ICT segments for the Resource Guide countries are reviewed following.

Communications Networks

Communications Networks span the transfer of personal, enterprise, media, and government information using the internet, telephone lines, mobile telephone networks, TV and radio broadcasting, and satellites. The sector is vast and varied in terms of technology, users, infrastructure, software and hardware (Table 1).

Communications networks can be wired, wireless, or a combination of the two and can be as simple as the connection of devices within a home or as complex as serving millions of subscribers globally. Component products and services of communications networks include:

- Hardware: cable – both copper and fiber optic, routers, switches, wireless access points, communication devices, power hardware including batteries.
- Software: network protocols, device operating systems and firmware, security/encryption, and various application software.
- Services: design, programming, installation, operation, security, and maintenance/technical service.

Given the broad scope of the Communication Networks segment, it is difficult to get a precise estimate of its size. International Data Corporation expected global ICT spending to reach \$4.3 trillion in 2020, an increase of 3.6 percent versus the 2019 level. Technology changes rapidly in this segment – e.g., the current transition from 4G to 5G cellular communications, the decline of pay-tv with the advent of e-Sports, the rise of Software as a Service (SaaS) and related business models (Business Process (BPaaS), Platform (PaaS) and Infrastructure (IaaS)), adoption of cloud, edge and serverless computing versus traditional data centers, et al.

³ <https://www2.deloitte.com/us/en/insights/economy/voice-of-asia/may-2017/digital-role-economic-growth.html>

Table 1: Communication Network Infrastructure Segments

Segment	Focus
Internet (backbone)	Principal data routes to connect continents, countries, and regions – wireless and wired
Fixed Broadband/Last Mile	Wired connections for regions, cities and last mile to homes, businesses and data centers
Mobile Telecommunications	Cellular networks providing wireless broadband internet and communications services
Communications Satellites	Space-based network and information services
Network Infrastructure	Other infrastructure such as WiFi networks, VoIP (voice over internet protocol), et al
Data Centers	Facilities managing data storage, retrieval, processing, and networking
Cloud Computing	Virtual data center services with typically less security
Software: Systems and Application	Automation software for computers/devices and tools for users, including mobile apps
Application Programming Interface (API)/Integration	Allow various platforms, systems, applications to connect, work together and share information
User Devices	Phones, tablets, computers and communications devices
Internet of Things (IoT)	Physical items such as machines, sensors, robots, consumer products, vehicles, environments, et al., operated using an internet connection

In the Indo-Pacific region, growth has been faster than world averages by at least two-fold. The individual countries covered in this Resource Guide (India, Indonesia, Malaysia, Philippines, Thailand, and Vietnam) are currently at different technology and adoption levels. All but India have mobile telephone penetration above world levels, with all but India and the Philippines exceeding earlier-developed economy (EU as a proxy) levels (Figure 3). Similarly, the Resource Guide countries, with the exception of Indonesia and India, exceed world levels of population share using the internet (Figure 4). The only area in which the Indo-Pacific region lags earlier-developed economies (although Thailand and Vietnam are close) is in the use of fixed broadband (Figure 5), whose advantages include reliability/less latency (lagging) and lower cost for similar download limits; however, this situation is mostly an artifact of historic infrastructure development timing, with technology advances rapidly eroding cost and performance differentials.

Figure 3: Fixed and Mobile Telephone Subscriptions per 100 People, 2019⁴

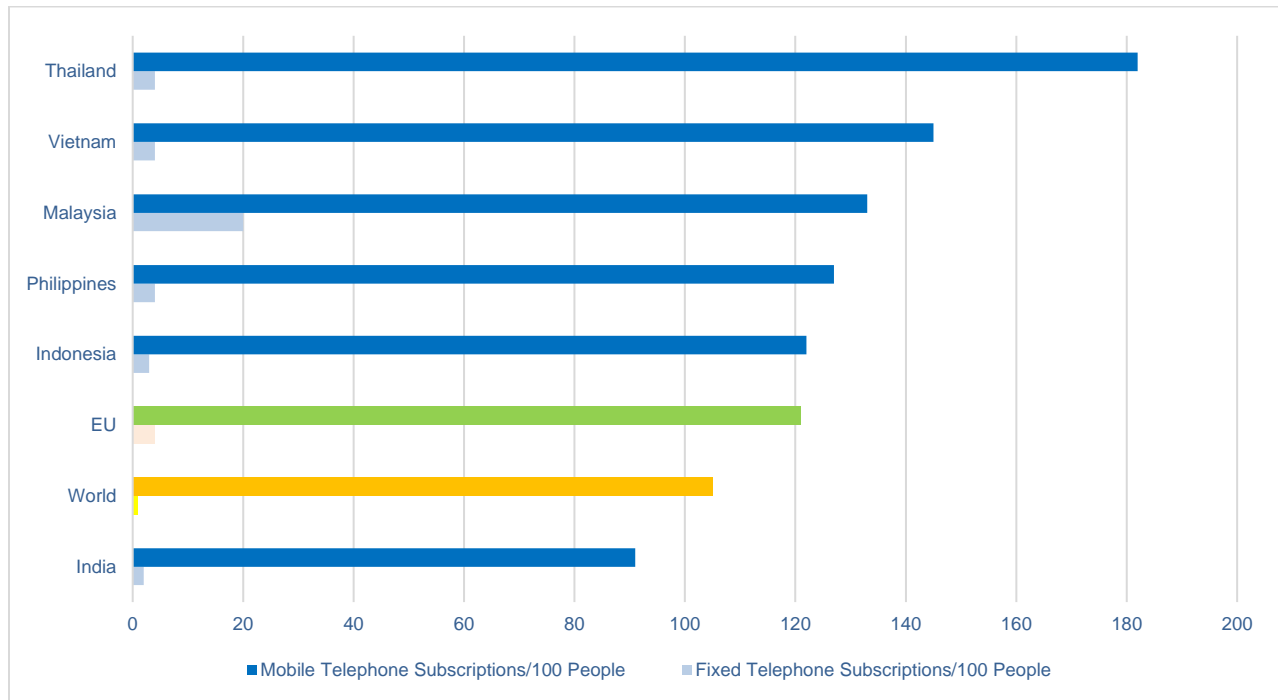
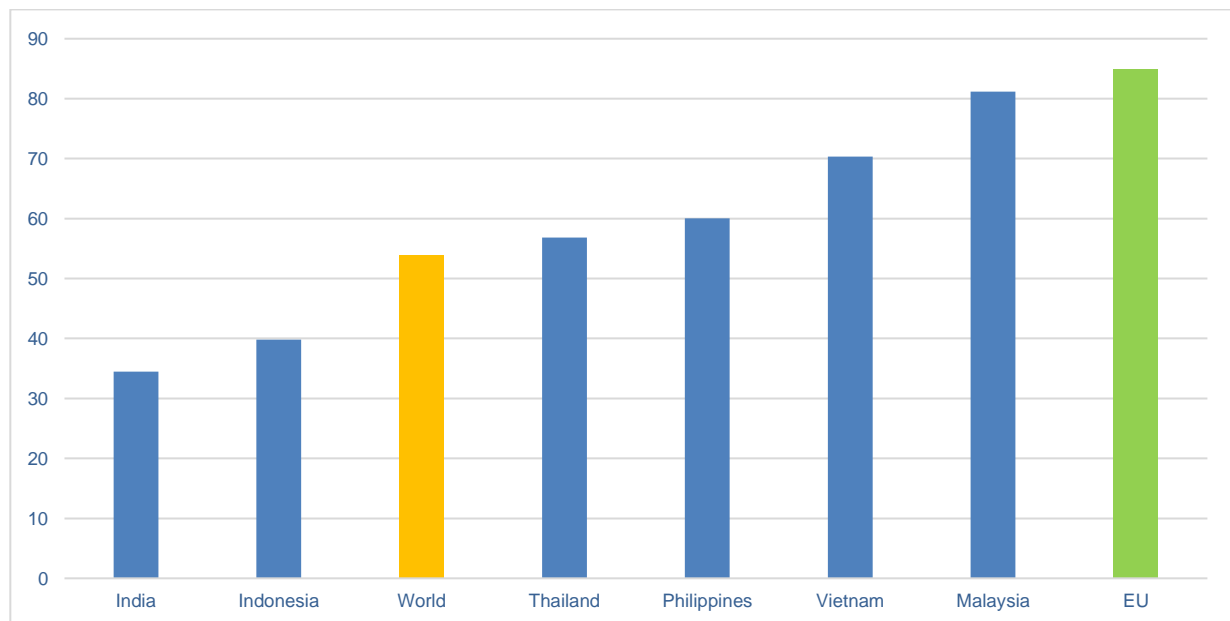


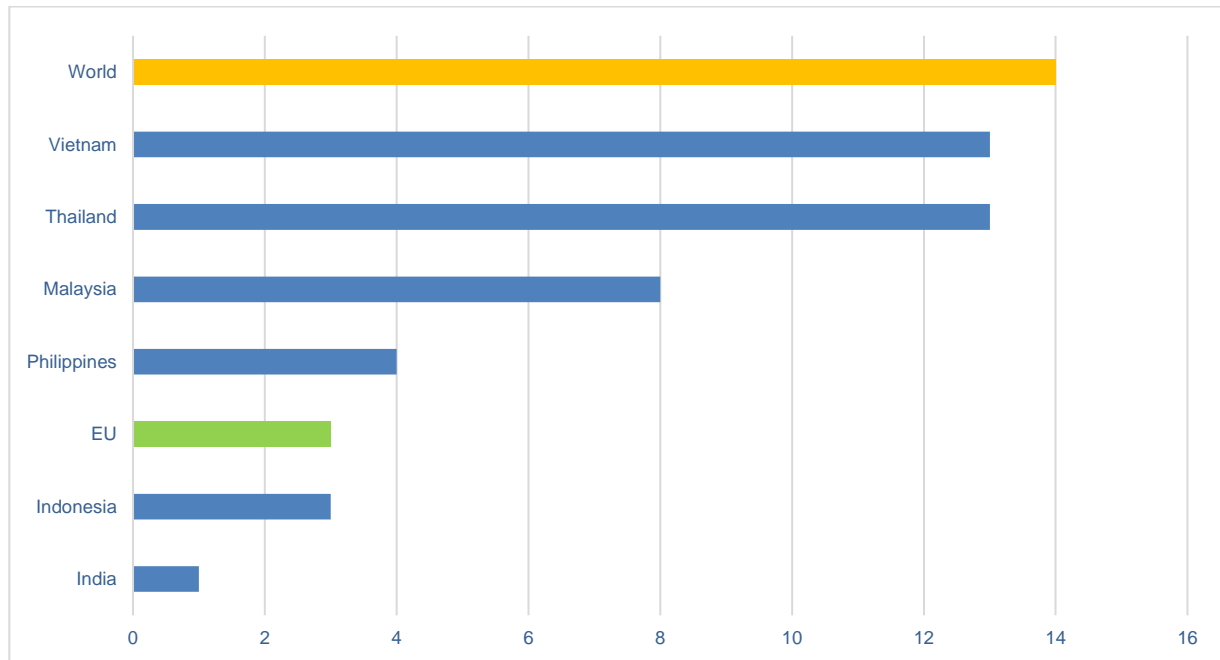
Figure 4: Percent of Population Using the Internet, 2019⁵



⁴ CIA Factbook

⁵ Ibid

Figure 5: Fixed Broadband Users per 100 People, 2019⁶



Data Centers

Data centers store and assist in the retrieval and processing of large amounts of critical data. In 2019, the global data center business was approximately \$245B globally⁷ with a projected CAGR of 9.9 percent through 2025, although the COVID-19 global pandemic slowed growth somewhat during 2020. Demand for new data centers in the Resource Guide region is driven by government initiatives toward modernization/infrastructure development and employment and the growth of private enterprise. The Indo-Pacific region will enjoy a projected Data Center CAGR of 14 percent through 2025. The Resource Guide countries currently host over 300 data centers, with India home to 123, or just over 40 percent (Figure 6).

Data centers segment by:

- Type - enterprise, managed services/outsourcing, colocation, wholesale, and cloud.
- Density - low, medium, high, and extreme.
- Vertical served - government, telecom and IT, banking and finance, healthcare, et al.
- Nature of infrastructure –nature of electrical, mechanical and IT systems incorporated.
- Tier (I-IV) - uptime/downtime/redundancy.

Technology is changing rapidly in this sector with the development of artificial intelligence (AI), edge and serverless computing, and SaaS (software-as-a-service/online subscription models),

⁶ Ibid

⁷ Research and Markets

which move away from historic data centralization. Data center participation opportunities include design, construction/infrastructure, power, cooling, and other environmental control.

Figure 6: Data Centers in the Indo-Pacific Region, 2020⁸



Smart Cities

A smart city is a highly digitally connected municipality using ICT to increase operational efficiency, share information with the public, and improve government services and associated citizen welfare. Initiatives typically focus first on infrastructure development, such as reliable electric supply, robust IT connectivity, and efficient public transportation. Efforts surrounding citizen safety and security, public housing, water management, healthcare, and education, may be added.

The ASEAN Smart Cities Network (ASCN), a cooperative effort begun in 2018, has a list of twenty-six pilots for regional development. India is developing its smart cities outside ASCN. Indonesia, Malaysia, the Philippines, and Thailand are developing projects both within and beyond the ASCN pilots (Table 2).

Smart cities can begin by installing smart street lighting and building toward high levels of interconnectedness for nearly every city function. Because of the large capital requirements to make a city “smart,” many initiatives are undertaken by public/private partnerships. In the Resource Guide countries, foreign governments and businesses (e.g., the United States, Japan, and South Korea) have been partners/supporters.

⁸ Cloudscene.com

Table 2: Indo-Pacific Smart City Initiatives

Country	ASCN Pilot Cities	Other Smart Cities	Government Initiative
India	N/A	Funding in tranches – 98 total over five years: Capital cities Business and industrial centers Culture and tourism sites Port cities Education and healthcare hubs	<i>Smart Cities</i> Ministry of Housing and Urban Affairs
Indonesia	Jakarta Makassar (South Sulawesi) Banyuwangi (Java)	Surabaya Bandung	<i>100 Smart Cities Initiative</i> Ministry of Communications and Informatics
Malaysia	Kuala Lumpur Kota Kinabalu (Sabah) Kuching (Sarawak) Johor Baharu (Johor)	Selangor Cyberjaya & Putrajaya Iskandar Melaka Penang	<i>Smart Cities</i> Communications & Multimedia Commission (MCMC)
Philippines	Manila Cebu Davao	Clark City	<i>Smarter Philippines</i> Department of Science and Technology
Thailand	Bangkok Chonburi Phuket	Chiang Mai Khon Kaen Rayong Chachoengsao	<i>Thailand 4.0</i> <i>(100 Smart Cities in Two Decades)</i> Ministry of Digital Economy and Science
Vietnam	Danang Hanoi (Nhat Tan-Noi Bai) Ho Chi Minh City		Ministry of Information and Communication

Smart Street Lighting

Demand for smart street lighting is driven primarily by the building and expansion of smart cities, where smart street lighting is often the first step. Various sources estimate the global smart street lighting market at approximately US\$8B in 2019, with a CAGR of 15-20 percent from 2021-2025. The Asia Pacific Region is roughly 25 percent of the global market and is expected to experience the fastest growing demand for smart street lighting, with a CAGR of 28 percent, over the same period.⁹

⁹ Technavio

The Indo-Pacific region has been a leader in adopting wireless street lighting (Figure 7). However, both wired and wireless are likely to co-exist. Wired street lighting uses programmable logic controllers, which are more secure than the Bluetooth used for wireless. Yet, the systems are more costly and time-consuming to install, as they require greater available infrastructure. Wireless requires less supporting infrastructure, uses less energy, and decreases both cost and carbon emissions. Also, wireless can offer added-value lighting and surveillance applications. The market includes the following segments: network components, connectivity, and lamps.

Figure 7: Wireless Street Lighting in Action in India¹⁰



Electric Vehicle (EV) Charging Networks

The 2019 global Electric Vehicle Charging Infrastructure (EVCI) market is estimated at \$2-8B by various sources, with a projected CAGR of greater than 30 percent over the period 2021-2025. Government intervention to support the adoption of electric vehicles, primarily through tax credits and subsidies, is largely driving growth. Due to regulatory requirements, growth is expected to be fastest in Western Europe, while Asia offers the largest prospective market longer term.

In the Resource Guide countries, the adoption of electric vehicles spans:

¹⁰ Smart Energy International

- Malaysia's limited government EV incentives to date.
- The Indonesian government's current road-mapping effort aimed at having 20 percent electric vehicles by 2025.
- India, where the government began an aggressive program to ensure 100 percent of vehicles were electric by 2030 but is now targeting 30 percent electric vehicles by that date.

To that end, the Delhi government recently (Feb. 2021) issued a tender for 100 charging stations with 500 charging points to be operational within twelve months. Recently, only 8,000 of India's 150MM drivers indicated interest in owning electric vehicles, according to Bloomberg.


There are three types of EV charging infrastructure (Table 3). While focused most heavily on developing EV infrastructure in Western Europe, Western vehicle producers are beginning to establish EV charging in Asia, primarily China. Even the oil company, BP, has entered a joint venture with Chinese rideshare company Didi Chuxing to build a charging network in China. Activity by Western interests in the Resource Guide countries, to date, has been less pronounced.

Table 3: Electric Vehicle Formats and Charging Protocols

EV/Charging	Advantages	Disadvantages
Vehicle Types		
Plug-In Hybrid Electric Vehicles (PHEVs)	Gasoline and electric hybrid Range flexibility	Less range than AEV solely on battery
All Electric Vehicles (AEVs)	Solely powered by electricity	Short-range Even shorter in cold climate
Charging Protocols		
Level 1 – Slow Charging (120 V)	Low-cost installation Low impact on electric utility peak demand surcharges	Slow charging 3-5 miles of range/hour
Level 2 – Fast Charging (240V)	Faster charge time (10-20 miles range/hour) More efficient than Level 1 for charges, one hour	Installation costs higher than Level 1 Higher impact on electric utility peak demand surcharges
Level 3 – DC Fast Charging/ CHAdeMO and SAE CCS (480V)	Charge time much reduced (similar to gasoline refueling)	Costly infrastructure Competing standards High impact on electric utility peak demand surcharges Cold weather operation challenges

Summary

The ICT sector in the Indo-Pacific region is one of robust business opportunity and continuing technological change. Communications networks, data centers, including cloud regions/farms, smart cities, and smart street lighting, all offer future prospects for U.S. technology, products, and services. The rate of adoption of electric vehicles (EV) and their charging stations (EV Charging) is less certain. Early success will be largely dependent on government initiatives and the assertiveness with which vehicle and gasoline providers support changes and entice consumers away from conventional passenger cars.

New Indonesian Capital – Smart City Development		
	SECTOR	ICT
	SUBSECTOR	Smart Cities
	LOCATION	Kalimantan, Indonesia
	PROJECT VALUE	Up to \$34 Billion, ICT \$2 to 3 Billion

PROJECT SUMMARY

Indonesia is in the planning stages for moving its capital city from Jakarta, on the island of Java, to East Kalimantan, on the island of Borneo. While Indonesia has not yet announced a name for the new capital, the city will be constructed from the ground up, using smart city technology, taking advantage of advances in information and communications technologies, and emphasizing efficiency and environmental responsibility. The first phase of the capital's relocation is scheduled for completion in 2024.

PROJECT DESCRIPTION

In August 2019, Indonesia's President, Joko Widodo, announced the country would move its capital from Jakarta, located on Java, to an as-yet-unnamed city in East Kalimantan, on the island of Borneo. The new city will be located on 180,000 hectares of government-owned land, between the cities of Balikpapan and Samarinda (Figure 8). The government projects an overall Phase One cost of moving the capital of approximately \$34 billion. The city plan specifies the accommodation of a population of 1.5 million people.

The city's core will occupy 6,000 to 10,000 hectares and serve as the seat of the national government. The new capital city will include housing for many of the federal employees and their families. Phase One will develop a core city center to accommodate 150,000 to 200,000 inhabitants initially. After completing the core, the rest of the metropolitan area will be developed, spanning 40,000 hectares.

The rationale for moving the capital includes overcrowding in Jakarta, its subsidence, and the frequency of natural disasters, including floods, earthquakes, and tsunamis. The new capital location is an area with limited seismic activity, reducing the risk of devastating earthquakes. Additionally, by moving the capital to another island, the proponents expect that some economic development and population expansion will shift away from Java to another island, contributing to the population's overall well-being and offering more opportunities in Central Indonesia.

Figure 8: Location of the New Indonesian Capital¹¹



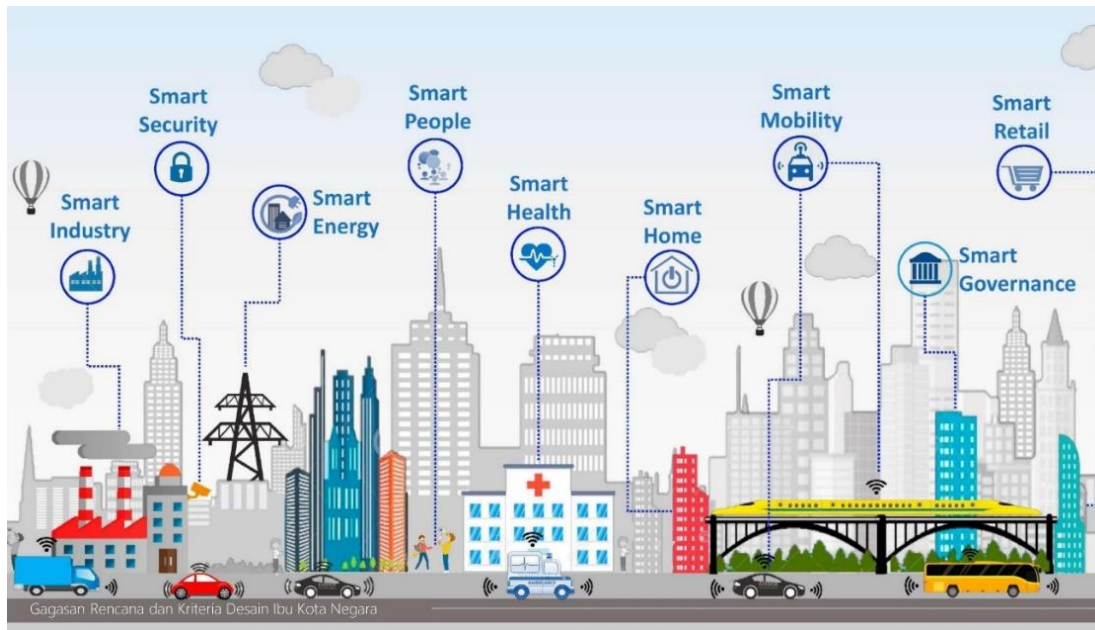
Indonesia's national government is committed to making its new capital a smart city, using international standards for information and communications technology. Critical areas of smart technology integration (Figure 9) include energy, healthcare, mobility, personal homes, industry, and government. Indonesia intends to develop a highly integrated, interconnected capital, calling on modern, technologically advanced solutions across all sectors, which will serve as a model for future city development efforts.

At present, the country's Ministry of National Development Planning (Bappenas) is the lead organization for the new capital's planning and development. Bappenas is working in coordination with all line ministries, particularly the Ministry of Public Works, to ensure the city is effectively planned, functional, and environmentally focused. Ultimately, Indonesia will establish a new Agency or Board, at the national level, to be the primary decision-maker for new capital advancements.

As there is little or no infrastructure at the new capital's planned location, the logistics for getting equipment and materials to the site will pose a challenge. To facilitate the city's overall construction and expansion, new roads and access points must be constructed. The existing airport in Balikpapan will be expanded from its current capacity to accommodate the planned increase in passenger and cargo traffic.

¹¹ Source: BBC

Figure 9: Planned Smart Cities Technologies for the New Capital¹²



PROJECT STATUS AND IMPLEMENTATION TIMELINE

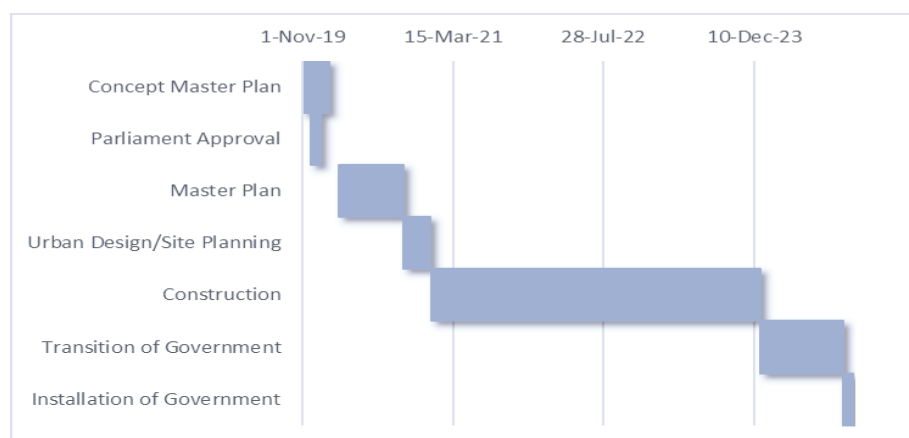
A consortium of international firms completed the master plan for the central government zone in December 2020. These firms include engineering company AECOM, consulting firm McKinsey & Company, and architecture and engineering firm Nikken Sekkei. In December 2020, the Minister of National Development Planning approved the project to assist in economic recovery.

Phase One of the project has begun, with a projected end date of 2024. However, the project has been delayed due to COVID-19. The government postponed a "soft" groundbreaking planned for Aug. 2020 to focus on the pandemic and recovery. The pandemic has delayed work on new laws required to allow for the project's execution and the government's transition to the new capital.

The first phase of construction will focus on the central core area of the capital, including government offices and supporting facilities. The government expects to complete Phase One within three years. Construction is now scheduled to begin in 2021, but start-timing will depend upon whether the government must divert further resources to pandemic recovery efforts. The 5,000 ha of land required for the first phase is wholly government-owned. The government plans to move to the new capital city and begin operations in 2024 (Figure 10), coinciding with the conclusion of President Jokowi's term in office.

¹² Source: Bappenas

Figure 10: New Indonesia Capital City Project Timeline¹³



PROJECT COST AND FINANCING

Indonesia projects the Phase One costs, for the construction and government move, to be approximately \$34 billion. The ICT investment is between five and ten percent of the total.

A variety of mechanisms will support project financing, including government resources, private investment, and public-private-partnerships (PPP). The state will provide a fifth of the budget amount. The United Arab Emirates (UAE) government and the United States International Development Finance Corporation (DFC) will provide \$22 billion for infrastructure development, including in the new capital city, through a sovereign wealth fund.¹⁴

U.S. EXPORT OPPORTUNITIES

Significant opportunities exist for U.S. firms offering smart city solutions. Planning for the integration of smart city technologies has already begun and will continue through all phases of the city's development. These smart city technologies can be incorporated into all public buildings, new residences and commercial structures. Already, there has been significant interest from firms and governments based outside of the United States, including Korea, China, India, Russia, Australia, and multiple European countries.

Possible opportunities for U.S. firms operating in this space include:

- Internet backbone.
- Data centers, management, and analysis.
- Smart meters.
- Wireless telecommunications equipment.


¹³ Source: Bappenas

¹⁴ <https://www.archpaper.com/2020/03/capital-city-indonesia-master-plan-aecom-mckinsey-company-nikken-sekkei/>

- Cellular network.
- Intelligent transportation solutions.
- Traffic management systems.
- Public safety communications.
- Smart street lights.
- Cybersecurity solutions.
- Building controls.
- HVAC systems.
- Water and air monitoring systems.
- Distributed energy resources.
- Smart grid solutions.
- Smart water meters.
- Smart elevators.
- Battery storage solutions.
- Healthcare solutions.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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National Digital Infrastructure Plan – JENDELA 4G & 5G		
	SECTOR	ICT
	SUBSECTOR	Communications Networks
	LOCATION	Malaysia
	PROJECT VALUE	\$5+ Billion

PROJECT SUMMARY

The National Digital Infrastructure Plan (NDIP) is the Malaysian government’s plan to provide its citizens with robust, pervasive, high quality and affordable digital connectivity. The project is 50/50 government and private industry-financed. The NDIP’s goals are to expand the existing Malaysian fiber optics communications network, improve internet connectivity and speed, and reduce user costs across Malaysia. During the 2020-2022 period, the Jalinan Digital Negara Plan (JENDELA) focuses on six “quick win” and two mid-term projects to achieve the country’s telecommunications and broadband goals.

PROJECT DESCRIPTION

Malaysia intends to enhance the speed and reliability of communications for all citizens based on three National Aspirations set by the National Digital Infrastructure Lab (NDIL):

1. Gigabit access fixed broadband.
2. Greater than 100 Mbps mobile broadband.
3. 100 percent 4G coverage.

The Plan has three associated focal efforts:

1. Creation of a digital infrastructure and coverage map.
2. An improvement plan for coverage and quality.
3. Resource optimization to achieve the JENDELA National Aspirations.




As of 2018, 81.2 percent of the Malaysian population was using the internet. The number of mobile telephone subscriptions per 100 persons is 133, suggesting many Malaysians already use multiple devices. However, Malaysia lags global levels for fixed broadband access.¹⁵ While Malaysia has rapidly digitized, some segments of the population have limited internet and cellular

¹⁵ CIA Factbook

communications access. Specific industries and areas of the country are also in need of better service.

The NDIL has formulated the Jalinan Digital Negara Plan (JENDELA) to improve coverage and quality of service and set the foundation for 5G (Table 3). JENDELA will span the years 2020 to 2022.

Table 3: Evolution of Malaysian Digital Infrastructure Planning¹⁶

	RMK-11, RMK-12 Focus (2016 – 2020)	Current State (2020)	RMK 12 Aspirations (2021-2025)	JENDELA National Aspirations
 Wireless Broadband	<ul style="list-style-type: none"> Nationwide 3G coverage Rapid 4G expansion 	<ul style="list-style-type: none"> 96.7% of 2G *coverage in populated areas 95.3% of 3G coverage in populated areas 91.8% of 4G coverage in populated areas 25Mbps Speed 	<ul style="list-style-type: none"> Nationwide 4G coverage 5G planning and rollout 	<ul style="list-style-type: none"> 100% of 4G coverage in populated areas 100Mbps speed by adopting 5G
 Fixed Broadband	<ul style="list-style-type: none"> Expand from High Speed Broadband (HSBB) to HSBB 2 and Sub-Urban Broadband (SUBB) 	<ul style="list-style-type: none"> 4.95 mil premises passed** 	<ul style="list-style-type: none"> Expand fibre to sub-urban and rural areas Alternative technologies to connect premises 	<ul style="list-style-type: none"> Gigabit access to 9 million premises passed
 Delivery Ecosystem	<ul style="list-style-type: none"> Strengthen digital infrastructure planning across States 		<ul style="list-style-type: none"> Integrating digital infrastructure across Government, Businesses and Rakyat 	<ul style="list-style-type: none"> A readily accessible Digital Infrastructure map
<p>Note: JENDELA will prioritise populated areas and areas having economic activities</p> <p>* Coverage in populated areas covers at least 20 people per square km</p> <p>Source: **Consolidated data by the fixed operators in NDIL</p>				

The NDIP has defined JENDELA to address currently high citizen usage of electronic communications and media during the COVID-19 global pandemic. For example, during 2020:

- Internet traffic has increased across the country by levels of 30-70 percent.
- Internet usage has migrated to residential areas by 50-70 percent.
- As a result of increased usage, internet speeds have declined by 30-40 percent.
- Citizen complaints regarding internet speed, as well as the ability to effect new coverage and reliably use the internet indoors, have risen substantially.

JENDELA focuses on the development of communications infrastructure to meet the national objectives through a series of six quick-win fixed and mobile communications and two mid-term subprojects:

¹⁶ National Digital Infrastructure Lab Report, Sept. 3, 2020

Quick Win

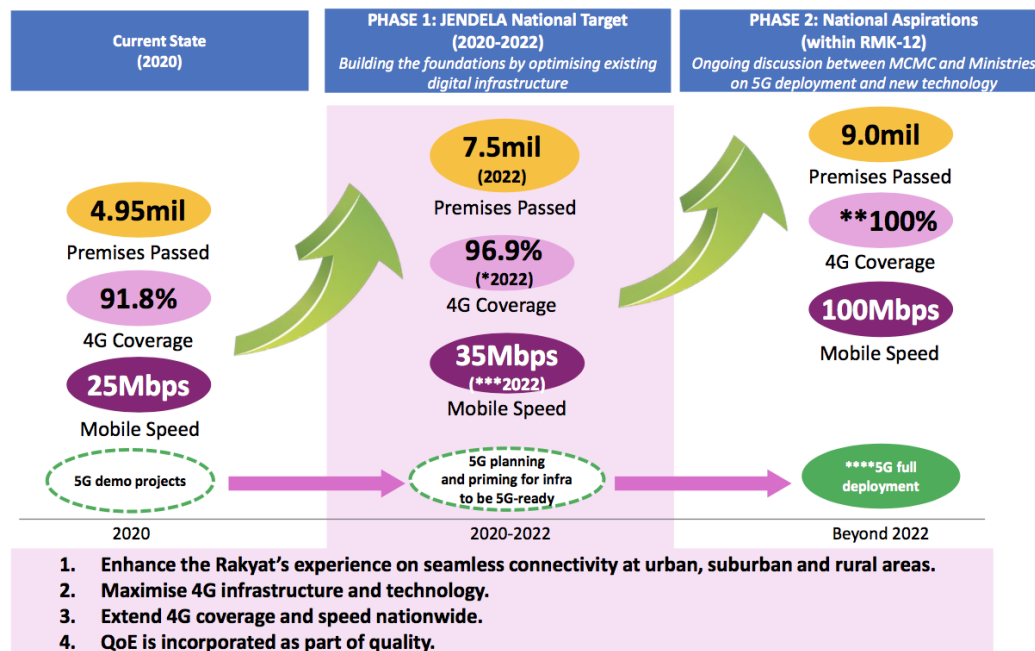
1. Construct 940 new 4G base stations in urban and suburban areas for quality and indoor coverage improvement.
2. Upgrade 4,589 existing 2G/3G base stations to 4G to expand 4G coverage and increase speed.
3. Upgrade 16,214 existing base stations in urban and suburban areas.
4. Sunset 3G network and migrate the spectrum for 4G technology use to further improve communications speed.
5. Fiberize 352,101 premises (i.e., homes and businesses) during 2020.
6. Fiberize 1,245,452 premises during 2021.

Mid-Term

1. Construct 1,661 new 4G sites across Malaysia to extend mobile 4G coverage in rural and remote areas.
2. Fiberize 929,631 premises by year-end 2022.

Overall, the JENDELA agenda is to establish a modern, reliable and fast 4G communications network across Malaysia first, with targets of 96.9 percent 4G coverage and 35Mbps mobile speed (Table 4). Once sufficient returns are realized on 4G investments, Malaysia intends to build a competitive presence as a leader in 5G technology and its applications to Industry 4.0/IoT.

Table 4: JENDELA National Targets, 2020-2022



Major Malaysian participants in JENDELA are Malaysia's electric utility company, Tenaga Nasional Berhad (TNB) and Telekom Malaysia (TM), where:

- TNB provides access to the fiber cable backbone already laid in many areas in Peninsular Malaysia for SCADA (supervisory control and data acquisition) systems, which allow remote electric utility metering. This existing infrastructure will support coincident communications fiberization along the electric grid where feasible. TNB does not service the Borneo-island-located states of Sabah and Sarawak.
- TM offers integrated telecommunications services, including fixed telephony, mobility, content, Wi-Fi and smart services. It is the country's incumbent fixed-line broadband operator operating under the Unifi brand. TM operates under three key business segments: unifi (broadband), TM One (business-to-business services for the enterprise and public sectors), and TM Global (domestic wholesale connectivity for local service providers).

A key challenge to achieving the base infrastructure goals of JENDELA is “last mile” connectivity, i.e., delivering service from main trunk lines to individual user sites. The TNB lines well serve areas near transmission lines and main substations, but connectivity to homes and businesses in rural areas is limited.

While the development of 5G communications capability in Malaysia is part of the government’s plan, delays due to the COVID-19 global pandemic and lower-than-expected returns on 4G investments will protract somewhat (versus prior plans) the country’s adoption of 5G. Malaysia will initially focus 5G development on high-impact areas to address its simultaneous objectives to improve internet connectivity while reducing access costs. Also, 5G will enable broad use of the Internet of Things (IoT).

PROJECT STATUS AND IMPLEMENTATION TIMELINE

Despite the COVID-19 global pandemic delaying some elements and the government diverting some of the associated infrastructure funds to meet human needs, three of the JENDELA subprojects began in 2020:

1. 940 new 4G base stations in urban and suburban areas.
2. Upgrade 16,214 existing base stations in urban and suburban areas to 35 Mbps speed.
3. Fiberize 352,101 residential and business premises.







The JENDELA projects span 2020-2022 (Table 5).

PROJECT COST AND FINANCING

The full JENDELA implementation cost is just over \$5 billion (RM21B). The Malaysian Communications and Multimedia Commission (MCMC) expects to invest \$1.8B (RM7.4B) to build and upgrade broadband services during 2021 and 2022.

The Malaysian 2021 budget, announced on Nov. 6, 2020, supports JENDELA and additional, related ICT projects (Table 6). The portfolio of projects will accelerate Malaysia's transition to a digital economy. Infrastructure projects are typically 50/50 public-private partnerships.

Table 5: JENDELA Projects Timeline¹⁷

National Aspirations	Targeted Project Sites*	Year End	Impact
 4G Coverage in populated areas	1 Construct 940 new sites in urban and suburban areas for quality and indoor coverage improvement	2020	 96.9% Nationwide Coverage
	2 Upgrade 4,589 existing 2G/3G base stations to 4G to expand 4G coverage and increase the speed	2021	
	1 Construct 1,661 new sites across Malaysia to extend the mobile 4G coverage in rural and remote areas	2022	
 Wireless Broadband Speed	3 Upgrade 16,214 existing base stations at urban and suburban areas	2020	 35 Mbps
	4 Sunset 3G network and migrate the spectrum for 4G technology use, hence, further improve the speed	2021	
 Fibre Connectivity (Gigabit Access) in Premises/ Homes	5 Fiberise 352,101 premises	2020	 83%
	6 Fiberise 1,245,452 premises	2021	
	2 Fiberise 929,631 premises	2022	



 Quick win initiatives
  Mid-term initiatives

Table 6: JENDELA Budget Items – Malaysia 2021 Budget

Amount, \$ (million)	Amount, RM (million)	Task
1,792	7,400	For MCMC to upgrade broadband services, 2021-2022
363	1,500	Jaringan PRIHATIN Program to alleviate the financial burden of the B40 societal group in accessing the internet. Telecommunications companies will match the value with free data.
121	500	To implement JENDELA to ensure the connectivity of 430 schools across Malaysia
10	42	Under JENDELA, to improve connectivity in 25 industrial areas

¹⁷ National Digital Infrastructure Lab Report, Sept. 3, 2020

U.S. EXPORT OPPORTUNITIES

U.S. export opportunities for JENDELA include (Table 7):


Table 7: U.S. Export Opportunities -- JENDELA

Network	Last Mile/User	Software/Services
Antennae	DOCSIS	Data centers/cloud farms
Core infrastructure	Componentry	Convergence software
Chips/arrays	GPON	Security support services
Componentry – switches, hubs, attenuators, repeaters, amplifiers, filters, phase shifters, bridges	Devices – handsets, modems, routers, servers	Infrastructure support services/MANO systems
Satellites	Drones/Robots	Analytics/machine learning

U.S. companies with technological leadership advantages have fared well in Malaysia. The country regularly assesses technologies from foreign sources and actively seeks disruptive technologies.

CONTACTS

Project Sponsor	U. S. Trade and Development Agency	U.S. Commercial Service
Ministry of Communications and Multimedia Malaysia Lot 4G9, Persiaran Perdana Presint 4, 62100 Putrajaya, Malaysia Phone: 603-8000-8000 webmaster@kkmm.gov.my MCMC MCMC Tower 1 Jalan Impact, Cyber 6 63000 Cyberjaya, Selangor, Malaysia Dr. Fadhlullah Suhaimi Abdul Malek MCMC Chairman Nfcp.sec@mcmc.gov.my	Indo-Pacific Region 1101 Wilson Blvd., Suite 1100 Arlington, VA 22209 USA Mr. Jeff Phillips Country Manager jphillips@ustda.gov U.S. Trade and Development Agency GPF Witthayu Tower A, Suite 302 93/1 Wireless Road Bangkok, 10330 Thailand Mr. Brandon Megorden Regional Manager for Asia bmegorden@ustda.gov IndoPacific@ustda.gov www.ustda.gov	U.S. Embassy Kuala Lumpur 376 Jalan Tun Razak 50400 Kuala Lumpur Malaysia Mr. Dennis Simmons Senior Commercial Officer Phone: 60-3-2168-5000 dennis.simmons@trade.gov www.trade.gov

Negeri Sembilan MVV 2.0 High Tech Park Development		
	SECTOR	ICT
	SUBSECTOR	High Technology
	LOCATION	Negeri Sembilan, Malaysia
	PROJECT VALUE	\$70 Billion

PROJECT SUMMARY

Malaysian Vision Valley 2.0 (MVV 2.0) is a \$70 billion mega-project encompassing Port Dickson and Seremban in Negeri Sembilan, MY. The state-led, private-sector-driven development envisions a world-class metropolis that is competitive, inclusive, clean and green and attracts international and local investors. The master developer is Sime Darby Property Bhd. MVV 2.0 focuses on four pillars: 1) high tech industry, 2) services and tourism, 3) education and skills-based research, and 4) logistics, aviation and maritime hub-related activities.

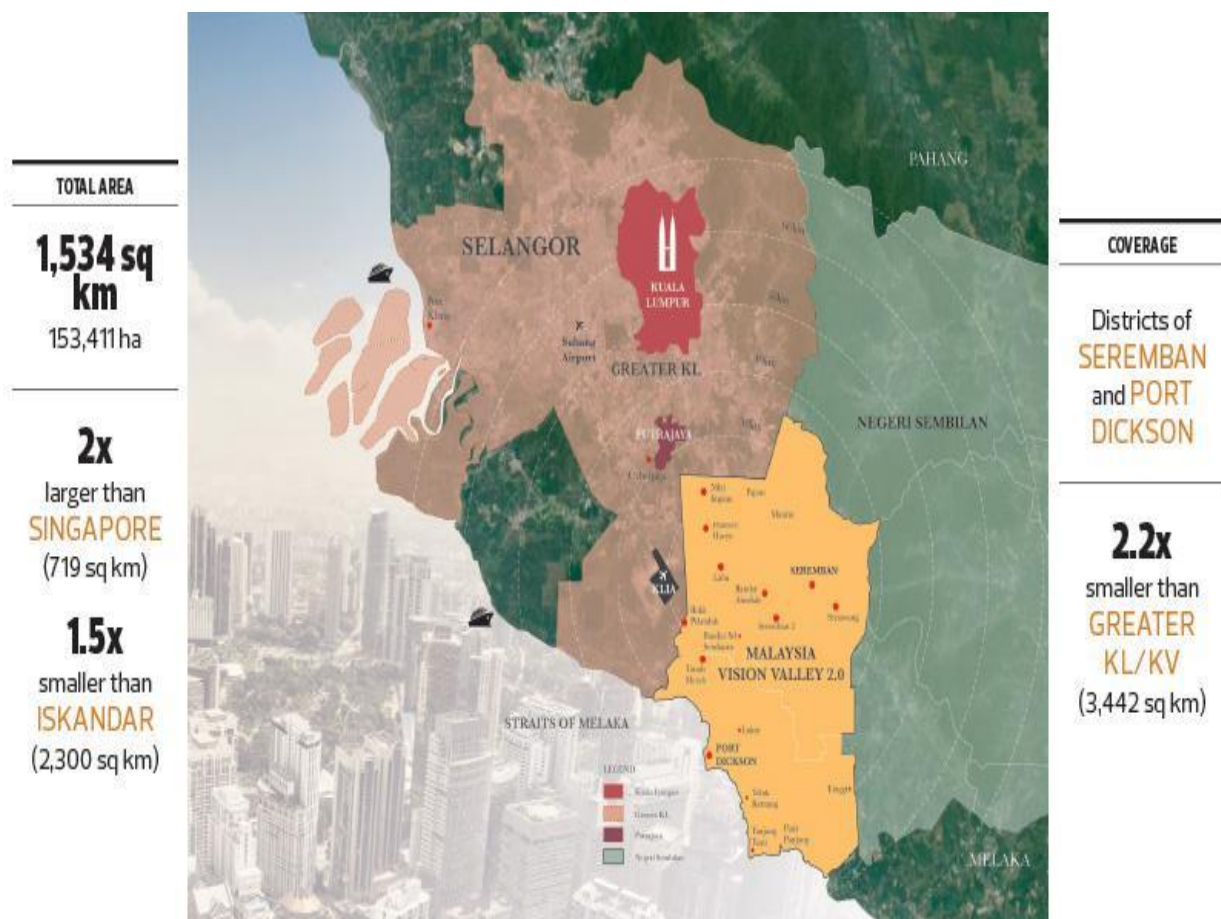
PROJECT DESCRIPTION

MVV 2.0 envisions a world-class metropolis in Negeri Sembilan, driven by public-private partnerships. Phase One (Figure 11) includes six projects, with the high-tech industrial park being developed first. The projects are:

- High-Tech Industrial Park.
- Integrated Transport District.
- Specialized and Integrated Logistics Services.
- World Knowledge City.
- Biopolis and Wellness City.
- Tourism District and Bird/River Sanctuary.

Negeri Sembilan is near Kuala Lumpur, MY and Petaling Jaya (Figure 12), where the project's master developer, Sime Darby Property Bhd., is headquartered. The real estate businesses of Golden Hope Plantations, Kumpulan Guthrie and Sime Darby, a global leader in trading and logistics, were integrated to create Sime Darby Property.

Figure 11: MVV2.0¹⁸



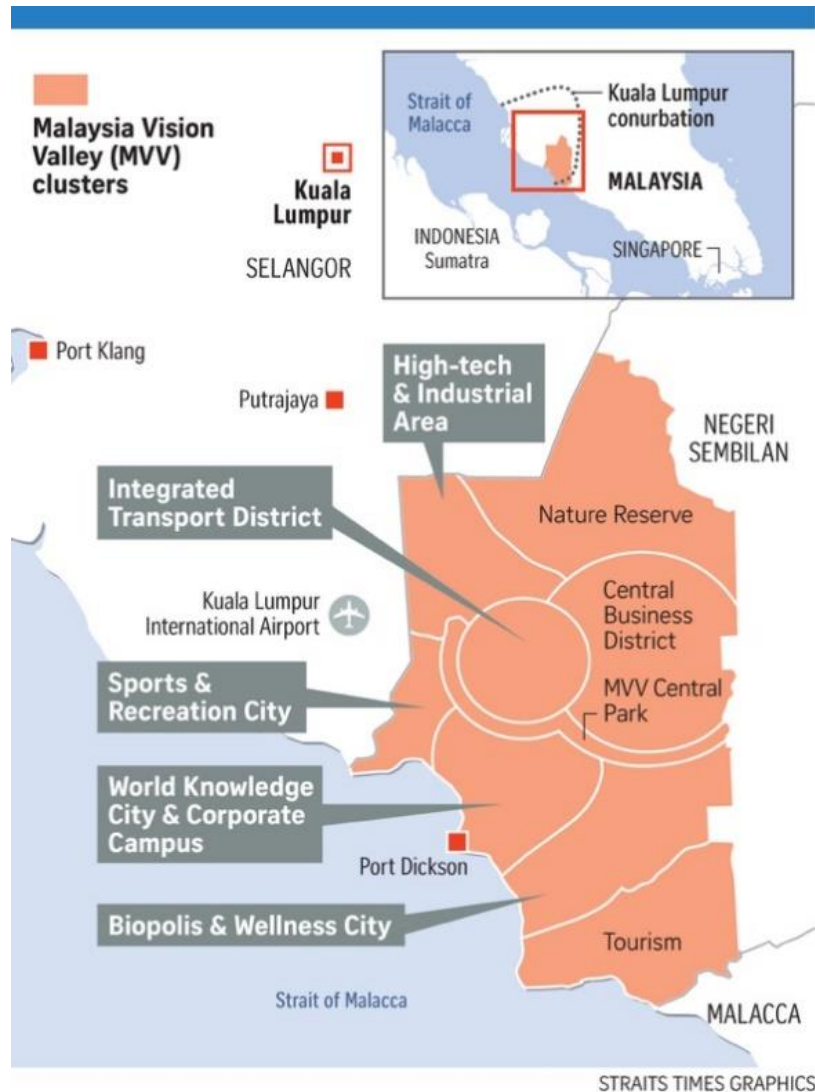
The project focuses on the creation and growth of four pillars:

- High tech industry.
- Services and tourism.
- Education and skills-based research.
- Logistics, aviation, and maritime hub-related activities.

A Comprehensive Development Plan (CDP), publicly available and promoted as MVV 2045, lays out land zoning and development for environmental enhancement, accessibility, infrastructure, liveability and industries within MVV 2.0. The Malaysian Green Technology Corporation has signed a Memorandum of Understanding for collaboration on the adoption and implementation of green concepts and green technology enablers. The governing body for this initiative is a state agency, MVV Secretariat (MVVS).

¹⁸ The Edge

Figure 12: MVV2.0 Clusters and Surrounding Area¹⁹



MVV 2.0 is part of the Malaysian government's National Physical Plan for 17 Promoted Development Zones. In particular, MVV 2.0 aims to position the Seremban and Port Dickson districts as extensions to greater Kuala Lumpur, MY. Malaysia specifically seeks to create job opportunities and attract more investors for the high tech, clean and green sectors.

The Physical Plan Development Zone dovetails with the Digital Free Trade Zone (DFTZ). Digital free trade zones are a strategic initiative promoted by the Malaysia External Trade Development Corporation (MATRADE) and driven by the Malaysia Digital Economy Corporation (MDEC). Their objectives are to intensify Malaysia's ability to participate in cross-border e-commerce and establish Malaysia as a regional e-commerce fulfilment hub to drive exports from Malaysian small-medium enterprises. Current partners in DFTZ are:

¹⁹ Straits Times

- EBay: B2C -- targeting the U.S., Europe, Australia.
- Alibaba: B2B -- targeting globally.
- eRomman: B2C -- targeting the Middle East.

MVV 2.0 and DFTZs are similar to other Malaysia Free Trades Zones in terms of growth opportunities and foreign company collaboration. In the early years of Malaysia free trade zones, pioneering multinational corporations (MNCs), for example Intel, National Semiconductor, HP, Clarion, AMD, Bosch and Litronix, turned a previously largely agrarian landscape into a high-value product hub. The pioneering MNCs' presence also stimulated the development of local supporting companies for example Pentamaster, Globetronics and Vitrox. These win-win relationships have endured in the country.

Malaysia further supported these objectives with a new initiative in its 2020 budget, released on Oct. 11, 2019, providing incentives for Fortune 500 companies and Tech Unicorns (earlier-stage tech companies with market values greater than \$1 billion). For five years, a total of \$1 billion (split into annual tranches over the period 2020-2024) will be available in customized packages for large foreign companies investing at least \$1.2 billion in Malaysia. Target investment areas for these funds include high technology, manufacturing, creative and economic sectors.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

The MVV 2.0 initiative is a 30-year project with six projects comprising Phase 1. A Master Plan is complete, and Sime Darby has begun to attract private investors and tenants for the high-tech park. Nestle launched its MILO (chocolate and malt mix) factory as a global Center of Excellence in the district in Nov. 2019 with an investment of \$ 21.5 million (RM 90 million).

Sime Darby Property Bhd is setting the benchmark for future industrial and commercial projects for MVV 2.0 by developing the XME Business Park in Nilai Impian. The location is strategic, sitting next to the North-South Expressway, one of Malaysia's busiest highways. The expected development value for the XME Business Park is \$60 million (RM520 million). The initial plan is for 149 industrial factories in two phases, spread across an allotted 28.21 hectares.

Sime Darby undertook a soft launch of the XME Business Park in Dec. 2019 and indicates more than half of the first phase was subscribed within a month of launch. Prospective tenant indications of interest have spanned logistics and warehousing, food and beverage (central kitchens), engineering, food processing and packaging and metal fabrication.

Given development take-up exceeding 50 percent for Phase One, earthwork for Phase Two is slated to begin during the first quarter of 2021.

PROJECT COST AND FINANCING

MVV2.0 has an expected cost of \$70 billion over thirty years. Most Malaysian infrastructure projects are financed at 30 percent equity and 70 percent debt. Major local and global banks have been active in infrastructure financing.

This project will attract primarily private investors for whom numerous incentives exist. The State has indicated flexibility to accommodate investor needs. In 2021, the Negeri Sembilan Secretariat will launch “Invest Negeri Sembilan” for foreign investors, with a celebratory ceremony planned at the end of 2020. The program will include investment incentives related to land ownership and conversion of premiums.

U.S. EXPORT OPPORTUNITIES

U.S. export opportunities for MVV2.0 will take two forms:


1. Site development-related products and services for :
 - a. Building and construction:
 - Civil engineering and project management.
 - Architectural design.
 - Advanced building materials and componentry.
 - Data center componentry including racks, HVAC and security.
 - Building systems management hardware.
 - Security systems hardware.
 - Environmental management and monitoring systems.
 - b. Information and communications technology systems and services, including:
 - Data center hardware, software, and training.
 - Cybersecurity software and training.
 - Network hardware, software and training.
 - c. Transportation, including:
 - Traffic management systems.
 - Smart street and traffic lighting.
 - Select vehicles.
 - d. Specialized industrial equipment suitable to business tenants of the site, including:
 - Factory automation hardware, software and systems.
 - Inventory management systems.
 - Cold chain management systems.
2. Participation in the operation of the site as a supplier or tenant.

U.S. companies with advantages in high tech, green and clean technologies will be suited to this project, with a choice of business model options. Malaysia regularly assesses key technologies from global players from the U.S., Europe, Japan, Korea and China, seeking platform and disruptive technologies. Malaysia’s technology search opens opportunities for licensing, joint ventures, and other business approaches.

Specific procurement announcements and requests will accompany or shortly follow MVV2.0 promotional activities in 2021.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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Advanced Metering Infrastructure (Smart Meters)		
	SECTOR	ICT
	SUBSECTOR	Advanced Metering Infrastructure (AMI)
	LOCATION	Malaysia
	PROJECT VALUE	\$290 Million

PROJECT SUMMARY

The Advanced Metering Infrastructure (AMI) project aims to install smart electric meters to permit monitoring and management of power usage in all Malaysian homes. The current goal is to install 9 million smart meters by 2026. The initiative is nationwide and endorsed by Suruhanjaya Tenaga (the nation's energy commission). AMI is being implemented in peninsular Malaysia by Tenaga Nasional Berhad (TNB), the electric power utility and in Sabah and Sarawak, MY by their state electric utilities.

PROJECT DESCRIPTION

Malaysia has a well-developed electric grid network with relatively low distribution losses in Peninsular Malaysia through electric utility Tenaga Nasional Berhad (TNB). With continued economic growth, the Malaysian government is concerned with potential electricity shortages. The Advanced Metering Infrastructure (AMI) project does two things:

1. Enables efficient usage and distribution of electricity.
2. Strengthens stakeholder coordination and collaboration within the Malaysian energy sector.

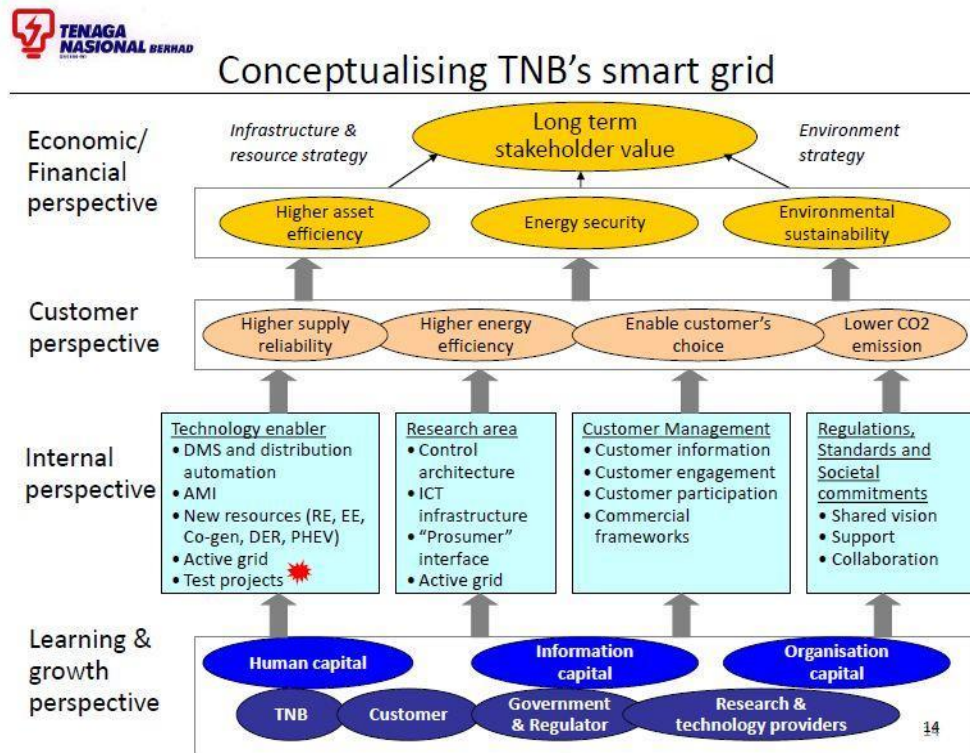
The 11th Malaysian Plan (2016-2020) features AMI among strategies for encouraging sustainable energy usage to support economic growth. The 12th Malaysia Plan is delayed and will issue in 2021.

TNB is the largest electricity utility in Malaysia, with a customer base of nine million customers and assets totaling \$20 billion. The utility plans to evolve to a future-forward grid (i.e., automated and fully digitized). Elements of TNB's strategy (Figure 13) to achieve this include:

- Investments in advanced metering infrastructure (AMI) and grid automation for advancement in network reliability and efficiency.
- National grid growth to position the Malaysian grid as one of the smartest and most automated/digitally-enabled grids globally.

- Ensuring maximum efficiency and reliability of the grid.
- Transforming customer experience and offerings through embedding innovations, especially digital ones, into the grid (Figure 14).

Figure 13: TNB Smart Grid Strategy²⁰



The TNB AMI program implementation is incentive-based regulation, with each tranche called a Regulated Period (RP). Currently, TNB is implementing RP2 (2018 to the end-of-the-year 2020). The original RP2 goal was the installation of 1.5 million meters by the end of 2020. With delays due to the COVID-19 global pandemic, 600,000 meters have been installed in RP2, with 800,000 installations projected by the end of 2020. TNB expects to complete Klang Valley by 2022, covering Putrajaya, Kuala Lumpur and Selangor, MY. The Melaka project is almost complete. Following those tranches, TNB will begin installations in Penang and Johor.

Originally, TNB targeted RP3 to start in 2021 and run for three years. RP4 was to follow in 2024 with an endpoint of 2026, with an overall goal of the complete installation of 9 million meters. Recently, the RP3 2026 end date was extended to 2027. With the RP tranches, TNB will continue to roll out apps for consumption data and energy budgeting.

²⁰ Tenaga Nasional Berhad via Geospatial Blog,
<https://geospatial.blogs.com/.a/6a00d83476d35153ef0153922879d0970b-320wi>

Figure 14: Grid System in Malaysia²¹



After installations slowed in early 2020 due to the COVID-19 global pandemic, smart meter usage now has increased urgency as citizens realize the meters help to reduce energy usage and costs, thereby accelerating consumer acceptance. As a result, the Malaysian government has indicated an interest in faster implementation of the second Regulated Period (RP2). TNB has gone from installing a few hundred meters/day during the early months of the pandemic up to 5000/day. The Federal Government has been supporting the initiative by investing in rapid training of new installers, which has had the companion benefit of job creation during the pandemic. TNB now sees an ability to concurrently install smart metering in multiple states while also managing and expanding country development and technology adoption, with energy cost benefits for citizens.

Malaysian energy and ICT regulators involved in oversight of AMI include:

²¹ Ibid

- Suruhanjaya Tenaga Energy Commission (<https://www.st.gov.my>).
- Tenaga Nasional Berhad (<https://www.tnb.com.my>).
- Malaysia Communications and Multimedia Commission (<https://www.mcmc.gov.my>).
- Sirim (<http://www.sirim.my>) (meter testing and certification).

Smart meters are also considered important to Malaysia's climate change goals, so the Ministry of Energy, Science, Technology, Environment and Climate Change (MESTECC) (<https://www.mestecc.gov.my>) has advisory responsibilities.

Electric service is not as developed in the states of Sabah and Sarawak, MY, on the island of Borneo, as in Peninsular Malaysia. Nonetheless, Sabah and Sarawak are implementing numerous power availability and reliability projects. With the increase in economic activities and the development of new industrial areas, power demand and smart metering will increase in tandem here. TNB is not present in Sabah or Sarawak, where Sabah Electricity Sdn Bhd and Sarawak Energy, respectively, are the electric utilities.

PROJECT COST AND FINANCING

The AMI project, as a whole, has a budget of \$290 million. TNB funds smaller projects internally and has a formal tender system for AMI suppliers. For larger projects, debt financing is available and typically arranged through local banks. Last year, TNB was successful in raising \$2.4 billion of Sukuk (Islamic bonds). With Malaysia's continued focus on renewable energy sources (e.g., moving from fossil fuels to solar, other renewables and smart energy), TNB's Financial & Corporate Strategy Group may elect to raise additional funds.

U.S. EXPORT OPPORTUNITIES

U.S. export opportunities for AMI IT infrastructure include project management and:

- Software and Systems Integration.
 - AMI Head End.
 - Application Servers and Database Servers.
 - Meter Data Management System.
 - Data Analytics Software.
 - Big data management.
 - Licensing and Maintenance Contracts.
- Hardware.
 - Servers for Enterprise Service Bus (ESB).
 - Network Operations Hardware.
 - Meters.


The AMI tender process is streamlined and automated as an e-Tender Process. TNB and Suruhanjaya Tenaga both publicly request tenders online and may also advertise in newspapers.

All foreign AMI participants are required to align with a local company. Foreign AMI participants have included companies from the U.S., Europe, India and China. Foreign companies often employ a local agent to stay current on upcoming projects.

U.S. company, Trilliant, will deploy its smart communications platform as part of TNB's multi-year upgrade to its smart meters and AMI infrastructure. Trilliant is a leader in RFMesh technology, which offers flexibility for connections in dense urban areas, suiting Malaysian needs.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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Davao Smart City Program		
	SECTOR	ICT
	SUBSECTOR	Smart Cities
	LOCATION	Davao City, Philippines
	PROJECT VALUE	\$60 Million (estimate)

PROJECT SUMMARY

Davao's smart city program has two initial priority areas:

- Enhanced Emergency Operations capability: particularly a Converged Command and Control Center, adopting technological solutions to enable efficient collaboration among agencies to ensure near, if not real-time, information critical to handling the overall safety and security of the city.
- Intelligent Transport Management Systems: using technology to address the growing challenges of transportation and traffic in the city while ensuring the general public's security and safety.

PROJECT DESCRIPTION

Davao is the third most populous city in the Philippines. Davao was selected to be part of the ASEAN Smart Cities Network, catalyzing a long-term, smart city, digital planning program. City planners recognize modern information infrastructure is essential to maintaining public safety, improving emergency response times, and addressing urban traffic challenges.

Davao City envisions creating a community harnessing digital connectivity and technological advancement to provide high-quality living and a safe and secure environment for its residents. Specific goals of the smart city program include:

- Strengthen safety and security measures.
- Enhance public service delivery.
- Bolster domestic and international linkages and relations.

Davao's smart city program is a key element of broader municipal objectives to drive economic growth and achieve sustainable development.

Davao City's initial smart city program has two specific project areas:

1. Improving emergency response capability.
2. Intelligent transport and traffic systems with security.

Improving Emergency Response Capability

Davao City was the first municipality in the Philippines to establish a Public Safety and Security Command Center (PSSCC). The PSSCC was founded in 2010 with the following functions:

- Orchestrate all undertakings relative to safety and security.
- Provide security, safety, and risk management.
- Ensure efficient people, information, technology, and intelligent solutions utilization.
- Act as the center for all coordination efforts.
- Lead a multi-agency mechanism.

The PSSCC sits at the center of three organizational clusters within the Davao City administration:

- Emergency Response Cluster (including 911 and medical and fire first responder dispatch).
- Safety Cluster (including traffic and transportation management and urban video surveillance).
- Security Cluster (including police and security forces).

The PSSCC is not a police or internal security organization but coordinates with those departments through the regular performance of its duties.

The PSSCC is the focal point of emergency response for both natural disasters and man-made threats:

- Terrorist activity in Davao City accelerated markedly following a September 2016 bombing at the Roxas Night Market, which killed 15 people and wounded 70.
- The Philippines experiences an average of 20 tropical cyclones per year, often accompanied by tidal surges, major river flooding, mudslides, and collapsed structures. The toll on life and property can be considerable.
- Earthquakes are common, as the country sits on the Pacific Rings of Fire at the meeting point of three tectonic plates.

Specific elements of the PSSCC upgrade smart city project include:

- Converged Command and Control: develop a unified, multi-agency technology and operational management framework to coordinate data, procedures, and communications to improve real-time situational awareness and ensure public safety and security.
- Unified Digital Communication Systems: integrate all analog and digital radios, smartphones, messaging systems, data and text sharing, and shared document and video management to ensure interoperability among local and national safety and security agencies.

- **Intelligent Surveillance Systems:** install additional intelligent Internet Protocol-based CCTV cameras and introduce advanced video analytics.
- **Data Analytics and Solution Integration:** improve knowledge sharing among safety and security agencies. Integrate databases with analytical capability and government and non-government systems (e.g., fire alarm, panic button, digital signage sirens), including improved mapping.
- **ICT Network Infrastructure:** rehabilitate and expand fixed broadband and radio networks to ensure maximum communications capacity and radio coverage.
- **Cybersecurity:** comprehensively upgrade the cybersecurity platforms and mechanisms to ensure data protection and integrity at all phases in emergency operations, data management, and communications.
- **Sensors and Internet of Things:** following the global trend toward a "sensing city," allow Davao to progressively introduce smart sensors to monitor potential environmental hazards and incorporate received remote data into its overall situational awareness.

Intelligent Transport and Traffic Systems with Security

Davao's second smart city project aims to efficiently address current traffic conditions in the city with modern technology. The goal, by 2025, is travel time reduction by 50 percent within city limits.

Among the greatest transportation and traffic management challenges facing the city are:

- **Weak Traffic Signal System:** Davao City's traffic signalization system was implemented from 2004 to 2010. Many traffic lights are not in working order, raising the public's ire and impairing safe traffic flow. The original system was never fully configured. Data generated by the system is retained by the solution contractor but is not accessible to city planners. A more dynamic system is required for improved congestion control.
- **Limited integration of traffic signalization with emergency operations:** the PSSCC and the city's traffic management unit cannot control traffic signals to coordinate emergency response, for example, by opening traffic signals to accommodate ambulances or fire trucks during emergencies.
- **Aging camera and traffic surveillance system:** the camera network coverage requires expansion and capabilities upgrade to accommodate license plate readers for contact-less violation management and fare collection. Additionally, cameras need to accommodate intelligent analytic functions for public safety operations performed by other departments utilizing the traffic camera video feeds.
- **Limited parking management:** Davao has no paid parking program or violation protocol on city streets and has essentially no revenue source from parking fees. The absence of parking fines also negatively impacts traffic street traffic flow. The city seeks to introduce a paid parking regime, including smart or meter-less parking, with video or remote sensors to manage parking spots.

Specific elements of Davao's smart city traffic management project include:

- **Transport & Traffic Management Monitoring Center:** new and upgraded ICT systems to monitor and manage all transport and traffic issues and concerns in the City.

- Intelligent Traffic Signal System: more advanced traffic management system to augment the current 67 traffic lights and signals at key intersections, as well as address the growing challenges in the traffic situation in the city.
- Intelligent Transportation System: leverage artificial intelligence and big data to manage and administer city traffic as well as the high-priority bus system.
- Secured Transport Terminals: video surveillance for commuter safety.
- Integration with National Government Transportation Projects: interconnection and coordination with the interprovincial train system.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

Davao City and USTDA signed a grant agreement to fund a technical assistance project to initiate Davao's smart city program. A U.S. contractor was selected to execute the study. The project is expected to begin in the spring of 2021. The expected duration is four months. Implementation of the smart city program will require approximately five years.

PROJECT COST AND FINANCING

Implementation of the first two smart city projects is expected to require approximately \$60 million. The technical assistance funded by USTDA will result in a more reliable estimate. Davao City will examine multiple sources of implementation financing for the anticipated smart city projects.

U.S. EXPORT OPPORTUNITIES


Potential U.S. exports for this smart city program include:

- Hardware:
 - Sensors.
 - Field devices.
 - Digital cameras.
 - Cabling.
 - Routers.
 - Switches.
 - Servers.
 - Workstations.
- Software:
 - Video management/analytics.
 - Data integration.
 - Traffic management
- Services:
 - Enterprise architecture design.
 - Functional and technical design.

- Implementation and deployment services.
- Smart city strategy

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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Philippine Cloud Computing Center of Excellence		
	SECTOR	ICT
	SUBSECTOR	Data Center
	LOCATION	Quezon City, Philippines
	PROJECT VALUE	To be determined

PROJECT SUMMARY

The Philippine Department of Information and Communications Technology (DICT) is committed to moving many of the government's computing needs to the cloud, albeit with numerous migration challenges. DICT will establish a Cloud Computing Center of Excellence (CCOE) to resolve barriers and facilitate cloud computing adoption. USTDA is providing a technical assistance grant to help DICT design and implement the CCOE.

PROJECT DESCRIPTION

The Philippines adopted a Cloud-First strategy in early 2017 to accelerate the migration to shared computing facilities and cloud-based delivery of software and information technology (IT) services. The policy clearly states that government agencies shall adopt cloud computing as the preferred ICT deployment strategy for their use in government administration and online government services delivery. The uptake of cloud services by the Philippines government departments, however, has been slow.

Recent amendments to the Cloud-First strategy, published in 2020, clarify which institutions shall be covered by the policy and which institutions will only be encouraged to adopt it. This distinction is absent in the prior version. As amended, the Cloud First Policy covers:

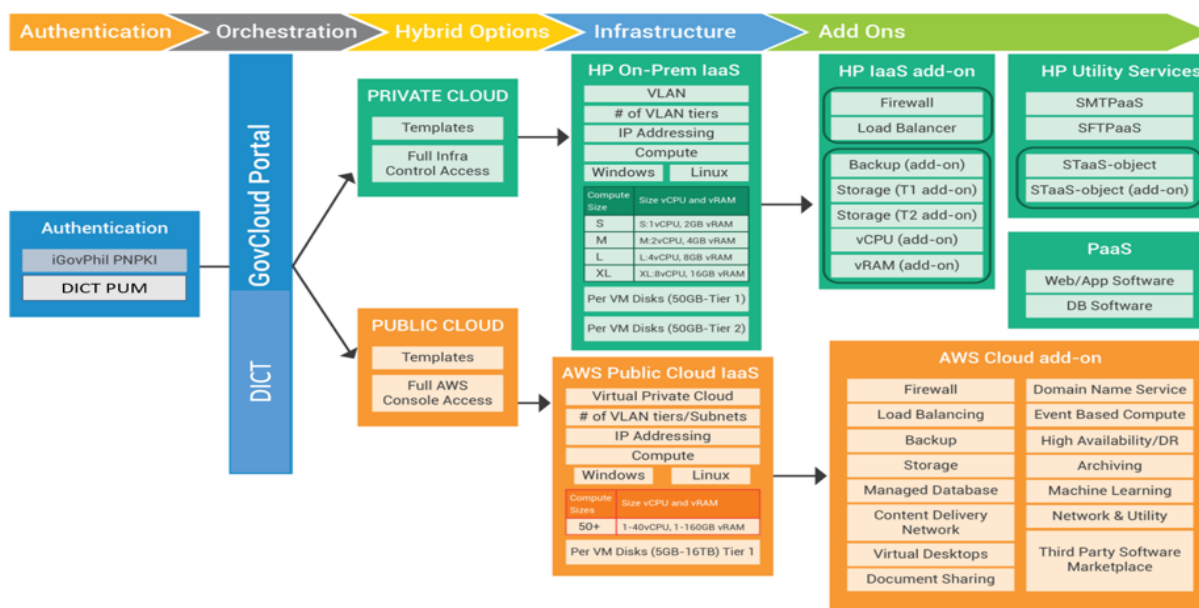
- All departments, bureaus, offices, and agencies of the Executive Branch.
- Government-Owned and/or Controlled Corporations (GOCCs).
- State Universities and Colleges (SUCs).
- Local Government Units (LGUs).
- All cloud service providers and private entities rendering services to the government.

Meanwhile, Congress, the Judiciary, the Independent Constitutional Commissions, and the Office of the Ombudsman are encouraged to adopt the Cloud First Policy.

The amendments also clarify the government’s policy on data sovereignty, which was confused with the concept of data residency in the previous version. In this policy, the application of Philippine laws over its foreign counterparts is asserted, specifically over data ownership and data processing by any entity with linkage to the Philippines.

DICT currently uses cloud computing at two government data centers (Figure 15).

Figure 15: DICT Cloud Computing Architecture²²



The benefits of cloud computing for public sector transformation are many and well-documented:

- Increased On-Demand Access – unilaterally provisioned computing capabilities, such as server time and network storage, as needed.
- Resource Pooling – computing resources served and shared across multiple consumers with dynamic reassignment according to demand.
- Flexibility and Elasticity – the ability to add and subtract capacity as needed in IT departments.
- Cost Savings – elimination of initial upfront expenditures for hardware, software, and development tools; monitoring and managing resource usage; customers pay only for the computer resources they use.
- Increased Effectiveness –higher service and reliability levels, reduced the threat of network outages, and more immediate response to emergencies.
- Greater Resilience – better risk management and reduced single event impacts.

²² DICT

- Rapid Implementation – projects launched more quickly as a result of more flexible procurement and certification processes, greater selection of services, tools, and features.
- Energy Efficiency – resources pooled to allow departments to maintain their own dedicated IT infrastructure, leading to fewer servers and less energy consumption.

Cloud computing introduces a significant shift in how technology is obtained, used, and managed, including a new procurement process that trades capital expenses for variable expenses. In this respect, the cloud is not merely a new technology; it also involves fundamental changes in business processes, budgeting, and solution innovation.

Migrating workloads to the cloud is a challenge for any organization. Migration requires extensive planning and structured methodologies to redesign and shift workloads from private servers onto managed clouds while implementing best practices and monitoring performance over time.

To assist in the cloud adoption process, governments often establish a Cloud Center of Excellence (CCOE) to provide advisory services to help departments with their planning and migration:

- A Cloud Center of Excellence is a cross-functional team of people responsible for developing and managing the cloud strategy, governance, and best practices, allowing the rest of the organization to transform the business using the cloud.
- The CCOE leads the organization as a whole in cloud adoption, migration, and operations. It may also be called a Cloud Competency Center, Cloud Capability Center, or Cloud Knowledge Center.²³

Functions of the Philippine CCOE include:

- Institute governance measures for the cloud.
- Simplify procedures and remove blockages to procurement.
- Remove restrictions on the use of offshore services and data storage.
- Provide advisory services to assist all departments in adopting the cloud faster.
- Work with security agencies to address critical security concerns.
- Negotiate commercial agreements with cloud providers to enable agencies to access their services with a single price book and standard terms and conditions.
- Raise awareness on cloud best practices and showcase examples of early adopters to drive transformation.
- Develop technical competency at DICT.
- Network agency practitioners and encourage sharing and reuse of good practices.

USTDA and DICT have signed a grant agreement to fund the design and implementation of the Philippine CCOE. The DICT has selected U.S. contractor Astro Systems to execute the project.

²³ Cloud Management Report 2017

http://click.cloudcheckr.com/rs/222-ENM-584/images/OEoE_whitepaper%20%282%29.pdf

PROJECT STATUS AND IMPLEMENTATION TIMELINE

A CCOE is not a permanent agency but rather a team that facilitates migration to cloud computing solutions. The CCOE's functions will likely require the team to be in place for three to five years.

The technical assistance to design the CCOE, funded by USTDA, will begin in Feb. 2021. The technical assistance will require about four months to complete. Staff changes and the COVID-19 global pandemic have resulted in the delay of the project start. After completion of the implementation plan, DICT will oversee the implementation of cloud computing migration.

PROJECT COST AND FINANCING

The anticipated costs of setting up and running the CCOE are modest compared to the computing costs. The Philippine government spends approximately \$750 million to \$1 billion per annum on ICT equipment and services. Cloud computing will eliminate a sizeable percentage of this budget, with variable costs for cloud access, processing, and services replacing portions thereof.

U.S. EXPORT OPPORTUNITIES


U.S. export opportunities exist for large, integrated cloud service providers. Cloud services are available according to different business models, including:

- Infrastructure as a service.
- Platform as a service.
- Software as a service.

Additional U.S. export opportunities exist from specialized applications for government agencies and functions, often marketed as software as a service.

CONTACTS

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PEA Smart Grid Implementation		
	SECTOR	ICT
	SUBSECTOR	Smart Grid/Cities
	LOCATION	Chonburi, Thailand; Nationwide
	PROJECT VALUE	\$110 Million +

PROJECT SUMMARY

The Provincial Electricity Authority (PEA) of Thailand is moving forward with its plan for the wide-scale implementation of smart grid technologies following numerous pilot studies' successful implementation. PEA will employ smart grid technologies both in the field and at PEA headquarters to ensure higher quality and consistent and reliable electrical service. The implementation will take place in stages, continuing through 2036.

PROJECT DESCRIPTION

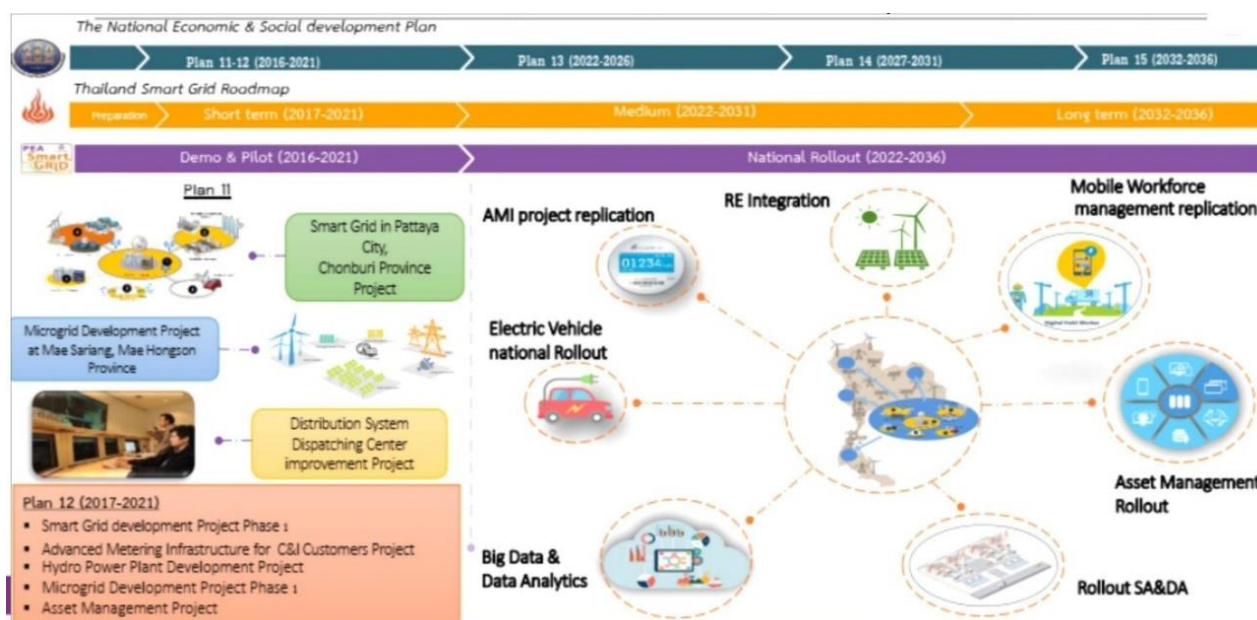
PEA is in the process of implementing its Digital Roadmap (2018-2022), aiming to become a Digital Utility by 2022, in line with the country's overall "Thailand 4.0" policy. Thailand 4.0, an economic model aiming to unlock the country from several economic challenges, emphasizes agriculture, light industry, and advanced industry, all of which are electric power consumers. The objectives of Thailand 4.0 are²⁴

- Economic Prosperity: to create a value-based economy driven by innovation, technology and creativity.
- Social Well-Being: to create a society moving forward without leaving anyone behind.
- Raising Human Values: to raise the Thailand Human Development Index metric.
- Environmental Protection: to become a livable society capable of adjusting to climate change and become a low-carbon culture.

Within the framework of Thailand 4.0, PEA has taken steps to pilot smart grid activities to achieve a more extensive, countrywide implementation by 2036. The utility is currently engaged in tackling immediate steps to improve its ability to manage the overall system (Figure 16), including serving approximately 20 million customers nationwide.

²⁴ Royal Thai Embassy, Washington, D.C. <https://thaiembdc.org/thailand-4-0-2/>

Figure 16: PEA Smart Grid Roadmap²⁵



PEA is replacing and upgrading its SCADA system under its Dispatching Center Improvement Project (DCIP). A local firm, Precise Group, is serving as the engineering, procurement, and construction (EPC) contractor. Under the current system, PEA has 12 control centers spread across the country, all reporting to headquarters. The new system will transition from this decentralized model of operations to a centralized structure by creating a data center at PEA's headquarters in Bangkok to handle all of the 12 control centers' nodes. Precise Group has recommended the use of Schneider Electric's Ecostruxure™ ADMS (advanced distribution management system) technology.

Recognizing the importance of cybersecurity, PEA plans to augment its new, centralized SCADA system with tools to protect the network and ensure against unauthorized access. ESTA, a U.S. company, has served as the consultant to PEA on this effort and developed a technical specification compliant with North American Electric Reliability Corporation (NERC) critical infrastructure protection (CIP) requirements. The security tools will not only protect communications and data between headquarters and the control centers but also between headquarters and the substations. The new ADMS SCADA system meets these CIP requirements.

PEA is moving toward non-staffed substations requiring a robust monitoring and security system. To date, 340 of 600 substations have been outfitted with remote capabilities.

PEA is also studying and undertaking proof of concept activities for a smart meter pilot project in the Eastern Economic Corridor (EEC). The initial goal is to replace a sample of 1.3 million

²⁵ Source: PEA

conventional meters with smart meters in Chachoengsao, Chonburi, and Rayong. This program will follow the completion of an ongoing meter replacement effort involving 116,308 meters in Pattaya City. The Pattaya City meter changeovers will be completed by 2021, after which the broader EEC effort will commence. The EEC, smart meter effort, will include meter replacement, meter maintenance and software upgrades. PEA is currently studying both public-private partnership (PPP) and service models, assessing both legal and logistical considerations thereunder. Completing the broader EEC program was expected by 2024 but as PEA has not yet designed the EEC area's final solution, PEA has not set a completion date.

The advanced metering infrastructure (AMI) pilot will be expanded on a turnkey basis under Phase II to target 700,000 residential customers and 70,000 commercial and industrial customers. The 700,000 customers will focus on the larger cities that PEA serves, including Chiang Mai, Hat Yai, Korat, and Khon Kaen. The commercial and industrial metering is at the stage of bidding document preparation. PEA expects to use a similar model to that for the EEC effort (once decided) for residential meters.

Phase III of the AMI rollout will bring the total number of residential users to 3 million, with a complete phase-out of electro-mechanical meters. Initially, PEA expects the AMI infrastructure to be installed on a turnkey basis. Smart meters improve energy consumption efficiency, allow for more accurate billing and reduce consumer electricity costs.

PEA also plans two pilot studies for remote communities to test microgrid applications. In Mae Hong Son, in the Northwest portion of the country, and the southern area of Betong District, Yala Province, similar projects will be installed. Each project will include:

- In Mae Hong Son:
 - A three-megawatt (MW) battery.
 - A five-by-one-MW diesel generator.
 - Four-MW solar PV panels.
 - A microgrid controller.
 - A communications package.
 - A grid interface.
- In the Betong District:
 - A four-MW battery.
 - A seven-by-one-MW diesel generator.
 - A seven-MW biomass power plant, including static synchronous compensator/static var generator (STATCOM/SVG) technology.
 - A microgrid controller.
 - A communications package.
 - A grid interface.

The grids will help ensure the continued supply of quality electricity to select remote areas, which will support the development of large-scale infrastructure, including in the Betong District of Yala province. Following the completion of these pilots, PEA anticipates a broader rollout.

Finally, grid improvements are planned for the overall PEA network, to be implemented following the SCADA system installation. PEA plans a study to determine which elements need upgrading to support the smart grid system. The study follows the finalization of the latest PEA Digital Roadmap and provides a specific timeline for plan implementation. Key study areas will include:

- Overall IT system upgrading.
- Solutions to better integrate renewable energy technologies into the grid.
- Conductor upgrading.
- Burying select transmission lines, particularly in cities classified as smart cities.

For renewable energy integration to the grid, PEA has undertaken a study and proof of concept which must be structured to deal with an obstacle in the Thai regulatory landscape. For power system planning, PEA is shifting its focus from the high-voltage (HV) and medium-voltage (MV) levels to focus on electric vehicles (EV) and EV charging. Finally, PEA is planning to develop more underground distribution in cities.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

PEA is currently conducting pilot programs and larger-scale implementation of smart grid technologies and solutions. Following the final Board of Directors' approval, the SCADA system's upgrade at headquarters began in late 2019. Precise Group, the DDIP project's EPC, was awarded the project in July 2020. The project is currently in the implementation phase and will be complete by 2022.

The large-scale replacement of analog meters with smart meters is likely to begin in 2021. After completing the pilot program in Pattaya City, Phase II will target 700,000 residential customers and 70,000 commercial and industrial facilities. A public hearing will be scheduled ahead of the commercial and industrial rollout.

The pilot studies for microgrids in Mae Hong Son and Betong occurred in 2020. The Mae Hong Son project completed site acceptance tests (SAT) and will put its microgrid into action in 2021. The Betong project is in the evaluation phase, with PEA expecting to make a contractor announcement during the first quarter of 2021. For wider scale implementation, PEA may not be the sole microgrid implementer. PEA's goals for these two projects are creating use cases and reference projects for future interested investors and learning how to control and regulate the microgrid in the future.

PROJECT COST AND FINANCING

Budgets for the various elements of the PEA Smart Grid project are summarized below (Table 8):

Table 8: PEA Budget

PEA Sub-Project	Budget (\$ Million)	Budget (Million Baht)
Smart Grid – EEC (1.3 million meters)	300	9,000
SCADA System Upgrade	40	1,200
Betong Microgrid	13	390
Mae Hong Son Microgrid	9	265
AMI (3 million residential)	TBD	TBD
AMI (70,000 commercial and industrial)	TBD	TBD

PEA intends that customers not see an increase in their down payments to PEA for a smart meter's costs as AMI is installed. The overall cost for PEA's smart grid implementation will be passed through to customers as part of the overall tariff structure.

US EXPORT OPPORTUNITIES

PEA's smart grid implementation activities will take many forms, including installing a SCADA server, replacing meters with AMI, cybersecurity upgrades, non-staffed substations, grid upgrades, and community microgrid solutions. Itron, a U.S. company, is the prime supplier of the Meter Data Management System (MDMS), smart meters, and network interface cards (NIC) for use in the AMI pilot project in Pattaya City.

In addition to PEA's existing plans reviewed here, PEA expects to add future elements, including electric vehicles and the architecture and infrastructure to support them, over the next several years. However, these improvements will not be undertaken until the majority of the Pattaya City project is complete.


Specific opportunities for U.S. suppliers under PEA's smart grid activities include:

- Batteries and Inverters.
- AMI and associated infrastructure.
- Communications equipment.
- Cybersecurity solutions.
- Racking for solar panels.
- Servers.
- Remote cameras and sensors.
- Data integration technologies.

- Data exchange technologies compliant with standards including CIM (Common Information Model).
- Substation automation technology, especially Intelligent Electronic Devices (IED).

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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SRT Central Rail Station Smart City		
	SECTOR	ICT
	SUBSECTOR	Smart Cities
	LOCATION	Bangkok, Thailand
	PROJECT VALUE	\$5 Billion

PROJECT SUMMARY

As Thailand continues its massive rail network improvement plan, it is constructing a new central rail station with a budget of \$366 million (THB 11 billion) to serve as the hub for rail movements throughout the country. The area surrounding the station has been planned as a smart city and will be developed using integrated technologies to enhance commercial and residential activities. The station itself will open in 2021, with areas of the smart city development targeted for completion at the same time and overall completion by 2031. In total, the smart city is expected to require an investment of approximately \$5 billion (THB 150 billion).

PROJECT DESCRIPTION

Thailand is in the process of building a new central rail hub in Bangkok, the Bang Sue Grand Station (Figures 17 and 18), as part of its overall rail network expansion and modernization effort. The new hub will be more centrally located and offer easier access to areas both within and outside Bangkok. Bang Sue will offer connections with existing and planned urban rail transport systems. The new rail hub will offer connections to 10 rail lines, three high-speed rail routes, and the urban transport lines.

To support this new station, the State Railway of Thailand (SRT) will develop the 372 hectares surrounding it into a smart city community based on smart growth planning principles (Figure 19). The area will be divided into seven zones, providing areas for a smart business complex, MICE and sports complexes, government offices, commercial areas, residences, and green spaces.

Figure 17: New Bangkok Central Station²⁶

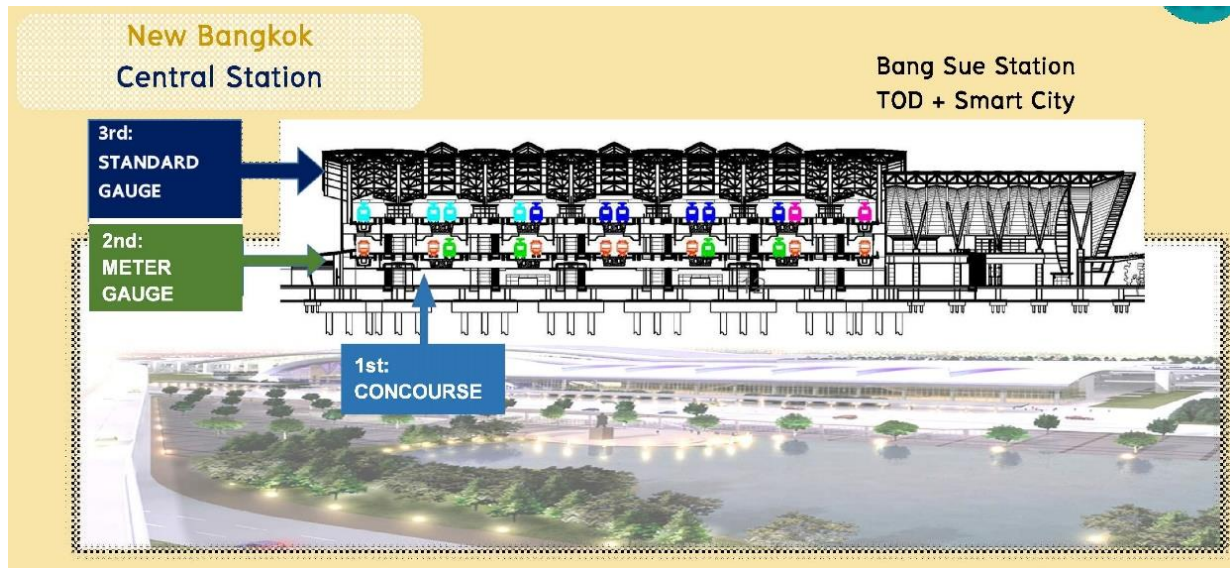
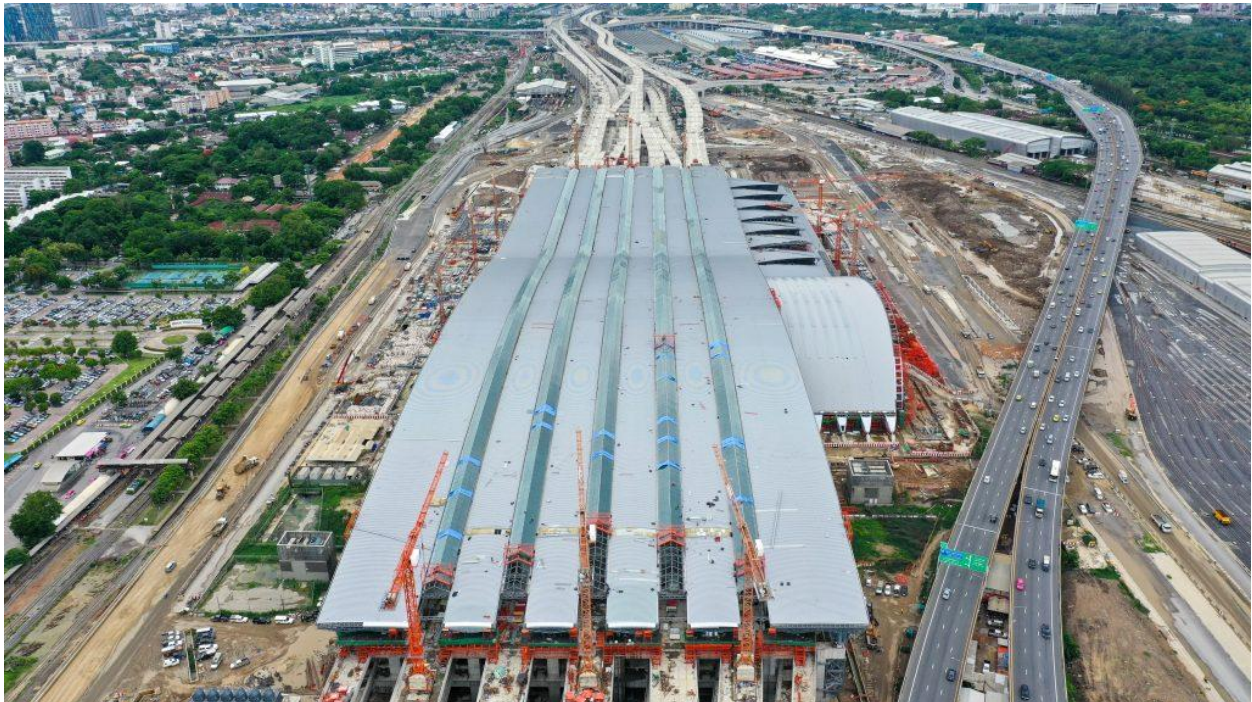


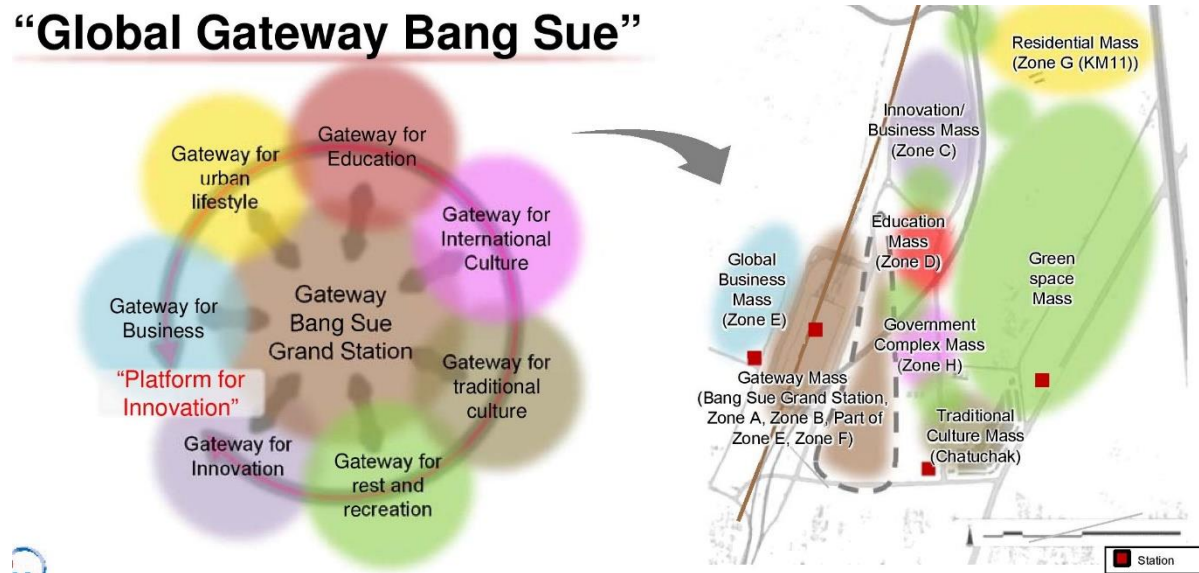
Figure 18: Bang Sue Central Station Construction²⁷



²⁶ Source: Ministry of Transportation

²⁷ Source: Unique Engineering and Construction

Figure 19: Global Gateway Bang Sue Construct²⁸



The smart city will be developed in line with a master plan currently being finalized. The Master Plan targets seven different “smart” elements to be incorporated in the design and construction of the area:

- 1) Smart environment.
- 2) Smart economy.
- 3) Smart energy.
- 4) Smart governance.
- 5) Smart living.
- 6) Smart mobility.
- 7) Smart people.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

The master plan was presented to SRT in November 2019 after being funded and undertaken by Japanese planning firms. SRT and the Japanese team are devising a smart city implementation plan based on the Master Plan’s contents.

SRT expects the first phase of development to be the commercial and office buildings directly associated with the transportation facility. Phase One is targeted for completion in 2024. Phase Two, extending through 2029, will develop the following:

- Location for the meetings, incentives, conferences and exhibition (MICE) center.

²⁸ JICA

- Sports complex.
- Retail facilities.
- Additional residential and office space.

Finally, Phase Three will add further housing units until the smart city's completion in 2031.

The Bang Sue Grand Station will open in November 2021 for red line operations, with testing scheduled for the second half of 2021. Once the rail station is operational, significant effort will be made to finish the smart city development quickly. A fully-developed smart city across all 372 hectares is planned for the three phases, extending from 2020 through 2031.

PROJECT COST AND FINANCING

SRT will work with a financial advisor to develop an Access Management Company (AMC) under a Public Private Partnership (PPP) structure that will form a joint venture tasked with managing and operating the smart city. The joint venture company will include the AMC and the private sector member, who will develop and operate the city for minimum of 30 years under a build-operate-transfer (BOT) contract. At the conclusion of the contract, the ownership of the property development will revert to SRT ownership. As this will be the first time that an AMC will be used by SRT, the railroad is seeking guidance from advisors regarding its establishment. Once the AMC has been established, implementation will begin in detail in line with the 2019 Master Plan.

The overall cost of developing the Bang Sue Grand Station is \$366 million (THB 11 billion), while the development of the surrounding smart city is anticipated to require a total investment of five billion dollars (THB 150 billion) through 2031.

US EXPORT OPPORTUNITIES

Significant opportunities exist supporting the development of Thailand's new central rail station for U.S. firms offering smart city solutions. The area around the new station is being built from the ground up, with no existing framework, and planning for the integration of smart technologies and processes has already begun through the Master Plan. Numerous opportunities to participate in the project are available to U.S. firms with appropriate technologies and requisite experience. Initially, firms with experience in providing financial advisory services will be greatly in need.


Possible opportunities for U.S. firms operating in this space include:

- Financial services.
- Internet backbone.
- Data centers and open data platform.
- Smart meters/AMI.
- Energy management system.
- Wireless telecommunications equipment.
- Cellular network.

- Intelligent transportation solutions.
- Smart street lights.
- Smart home and building systems.
- Renewable energy technologies.
- Traffic management systems.
- Cybersecurity solutions.
- Building controls.
- HVAC systems.
- Water, wastewater and air monitoring systems.
- Smart grid solutions.
- Smart elevators.
- Battery storage solutions.
- Healthcare solutions.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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Eco-Park Smart City ²⁹		
	SECTOR	ICT
	SUBSECTOR	Smart City
	LOCATION	Hung Yen Province, Vietnam
	PROJECT VALUE	\$1 Billion

PROJECT SUMMARY

Eco-Park (Figure 20) is a market-leading township located in Hung Yen Province, Vietnam. The township currently includes over 8,000 homes and about 15,000 citizens, with projected growth to more than 40,000 homes and 180,000 residents. Eco-Park expects job creation of 30,000 positions by 2030. The development encompasses over 500 hectares of land, with more than 100 hectares dedicated to parks, lakes and canals to create an eco-friendly living environment. Eco-Park residents enjoy a wide variety of services, including retail merchants, food & beverage establishments, clubhouses, and sporting complexes. The township will also contain education provisions and modern health clinics. Eco-Park has a planned investment of \$10 billion. Construction started in 2009. In 2013, the first citizens began residing in the township.

Figure 20: Views of the Eco-Park Development



During 2018, the Eco-Park Township’s strategy was changed from “GREEN” to “GREEN & SMART,” entailing a specific smart city development plan. Eco-Park’s ambition is to build a

²⁹ USTDA Definitional Mission Report Eco-Park Smart City ICT Infrastructure Technical Assistance Project, Pythia International Inc. Sept. 2020.

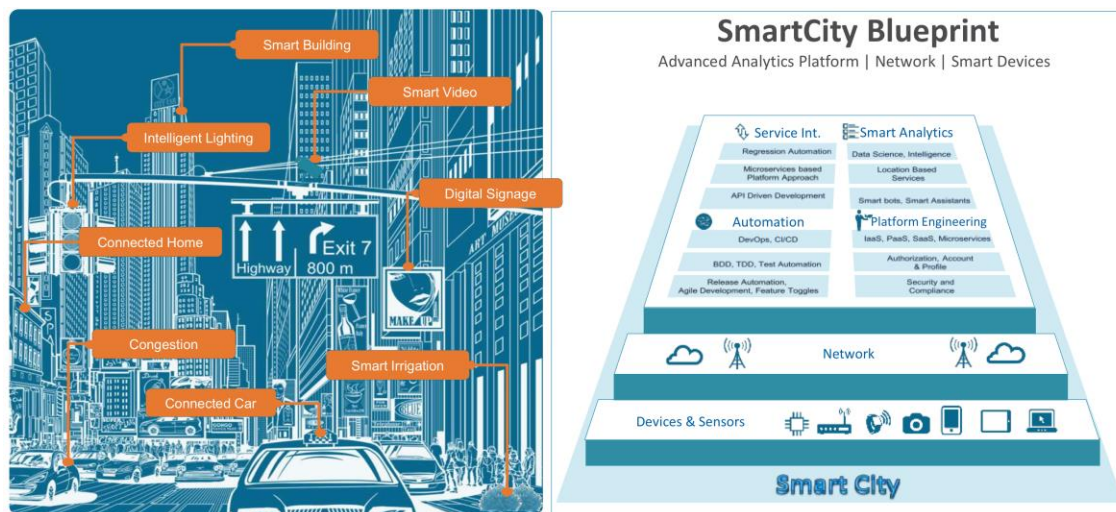
sustainable, connected community, offering a modern suburban lifestyle with smart services enabled by a planned set of solutions and supporting infrastructure. The planned “smart services” include township management/e-government, transportation, facial recognition, watering, street life, safe city, and energy.

PROJECT DESCRIPTION

Eco-Park Corporation is developing a Smart City ICT Infrastructure Masterplan (2020-2030). Information Services Group (ISG) will execute the Smart City Infrastructure Plan under a USTDA grant. The effort will focus on transitioning Eco-Park into a Smart City by building an ICT infrastructure transformation plan, developing a business case and assisting Eco-Park in deploying critical technologies. Eco-Park expects the Smart City ICT Infrastructure transformation to achieve global standards for a smart city by 2030.

To address the multiple ICT challenges faced by Eco-Park, including developing and optimizing the required enterprise architecture, network, platform, and applications, Eco-Park requires the services of an established ICT project planning/smart city advisory firm. The proposed USTDA-funded Eco-Park Smart City Infrastructure Technical Assistance (TA) project will define Eco-Park’s Smart City Vision. The proposed TA includes preparing a Smart City Blueprint (Figure 21).

Figure 21: Typical Smart City Blueprint



Smart City Blueprints typically include systems to manage communications, utilities traffic flow, government services, operations, and maintenance. The TA scope:

- Situational assessment/evaluation of Eco-Park’s ICT infrastructure.
- Elaborating an overall network infrastructure plan for smart city development.
- Establishing an enterprise architecture roadmap.

- Creating the ICT infrastructure framework and Operating Model.
- Developing detailed technical requirements and specifications for network infrastructure equipment and services.
- Developing a project implementation plan and cost estimate.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

The overall timeline for development and implementation of Eco-Park’s core smart city ICT infrastructure extends from 2020 to 2025 over three phases:

- Phase I: 2020-2021. Project definition & creating the organization and partner network. The three main deliverables, which are nearing completion, are the Business Plan, Network Review and Smart City ICT Infrastructure Management Policy.
- Phase II: 2022-2023. Development and implementation of the Eco-Park smart city network and cloud, data platforms, network security, services operations centers.
- Phase III: 2024-2025. Full implementation and network/cloud refinement, including enhanced data center capabilities and platform enhancements.

The USTDA expects to award the grant for the Smart City ICT Network Infrastructure TA during 2021.

PROJECT COST AND FINANCING

The ICT Smart City Roadmap is estimated to require \$1 billion to implement. Eco-Park will incorporate financing in the development budget for the Project with funding through a variety of sources. Eco-Park has been working in partnership with Vietcombank, the second-largest joint-stock commercial bank in Vietnam. In subsequent phases, Eco-Park Corporation will continue working with Vietcombank and will also offer additional equity. The township is projected to have a total investment of \$10 billion and is due to be completed by 2030. Over the past 15 years, \$3 billion has been invested. During the next ten years, Eco-Park will invest heavily in IoT infrastructure and data centers to provide Smart City solutions.

U.S. EXPORT OPPORTUNITIES

The Project requires a wide range of ICT systems, software, and services to support the Smart Cities Infrastructure implementation. These include:

- Wireless communications infrastructure:
 - Cellular access network infrastructure for 3G/4G/5G.
 - Private 5G infrastructure for City Network.
 - City Wi-Fi.
 - City LPWAN technology network for IoT services.
- Metro network infrastructure:

- High-speed backbone (400Gbps) for multiple services.
 - High-speed Edge Rings for multiple services (40Gbps).
 - Fiber backhaul for Cellular operators.
 - Fiber access for business & enterprise customers in CBD.
 - FTTH for residential.
- Data Center:
 - For Municipal Data Platform.
 - For Business Services Data Platform.
 - For Cellular Network Edge Computing.
 - For other services.
- Municipal Data Platform:
 - Residential-related data (e.g., identity, demographic, health, education, security).
 - City management data.
 - City infrastructure data (e.g., utilities, traffic system, energy, safety, helpdesk).
- Business Services Data Platforms:
 - IoT platform for multiple services & connectivity technology.
 - Data analytics application programming interface (API).
 - E-commerce data platform.
- Network Security:
 - Security for City Network.
 - Security services for business and enterprise customers.
- Smart City Applications:
 - Smart Parking.
 - Transit.
 - Video surveillance.
 - Waste management.
 - Lighting.
 - Energy.
 - Resident security & safety.
 - Personal healthcare.
- Smart Home & Applications:
 - Various applications and supporting infrastructure for Smart Home Ecosystems.
- Advanced Traffic Management System (ATMS):
 - Smart traffic management.
 - Autonomous vehicle management.
 - Drone management.
- City Service Operation Centre
 - Facilities for SOC.
 - Service Integration.
- SOC Operations Management:
 - Smart City ICT Infrastructure Planning and Execution
 - Overall Smart City Infrastructure Planning.
 - Workstream execution and platform/service implementation.
 - Program governance for overall Smart City ICT Infrastructure Transformation.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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3 TRANSPORTATION INFRASTRUCTURE

Sector Overview: Transportation Infrastructure

To meet the infrastructure needs, maintain growth momentum, and respond to climate change, infrastructure in developing Asian countries will require \$26 trillion of investment between 2016 and 2030. This amount translates to infrastructure investments of approximately \$1.7 trillion annually (Table 9). More than 30 percent of that amount will be to support transportation infrastructure (Table 10). Investments in transportation infrastructure have already been significant to date but far below levels necessary for the Indo-Pacific region's continued economic growth and population demands.

Table 9: Infrastructure Investment Needs in the Asia Pacific Region, 2016-2030 (\$B in 2015 Prices) ³⁰

	Baseline Total	Percent of GDP	Climate Adjusted Total	Percent of GDP
Central Asia	33	6.8	38	7.8
East Asia	919	4.5	1,071	5.2
South Asia	365	7.6	423	8.8
Southeast Asia	184	5.0	210	5.7
The Pacific	3	8.2	3	9.1
Asia & Pacific	1,503	5.1	1,745	5.9

Table 10: Infrastructure Investment Needs by Sector, 2016-2030 (\$B in 2015 Prices) ³¹

	\$ Billion	Percent of Total
Power	995	57
Transportation	558	32
Telecommunications	157	9
Water & Sanitation	35	2
Total	1,745	100

³⁰ Asian Development Bank, <https://dx.doi.org/10.22617/FLS168388-2>

³¹ Ibid.

Technology Adoption in Transportation

The use of and planning to incorporate new technologies and solutions to improve efficiency and minimize transportation's environmental impact is vital in the Indo-Pacific region. Increased use of biofuels (for both aviation and road transport), electric vehicles and supporting infrastructure, expanded options for urban transport, port automation, and intelligent transportation systems (ITS) integrated with city planning contribute to more sustainable transportation. Ride-sharing applications have become increasingly popular as an effective method to reduce the number of vehicles on the often-congested regional roads. While these trends are gaining interest in the region, adopting advanced e-mobility and IoT technologies is slower than in other regions.

India tends to be more advanced in implementing technology-based solutions than the other countries profiled. For example, 49 public electric vehicle (EV) charging stations are identified in India, while in the other countries, the numbers are in single digits. These low numbers will continue to prevent the adoption of EVs in the region. EV sales in the region are also small, with new sales measured in the hundreds of vehicles per year in many of the countries.

The prior Resource Guide profiled several advanced transportation technologies. Some of those have been canceled or significantly delayed. One was the Pune-Mumbai Hyperloop project, a transport system that will reduce the traveling time between the two cities to 25 minutes from 2.5 to 3 hours, which the state government may scrap. We suspect other advanced transportation technologies will be slowly adopted in the region, with the countries as thoughtful followers rather than taking on technology leadership in this sector.

Financing Transportation Infrastructure

As countries look to finance transportation infrastructure investments, increasingly, they are looking to the private sector to supply a portion of the necessary capital. Many of the projects highlighted in this Resource Guide will be developed under Public-Private-Partnership (PPP) models. The PPP model is increasing in popularity as it spreads capital requirements and risk across the parties. Frequently, the public partner provides land access, regulatory supports, and some investment, while the private partner provides additional capital and builds and operates the project on a multi-decade concession. In this Resource Guide, eleven transportation projects that are organized as PPP are profiled:

India:

- Jewar (Greater Noida) Greenfield Airport
- Outer Harbor Development Project at V.O. Chidambaranar Port (Tuticorin Port)
- Paradip Port (Phase 1) – Western Dock Development
- Visakhapatnam Light Metro Rail Project

Indonesia:

- Hang Nadim International Airport
- Indonesia New Capital City

- Patimban Port

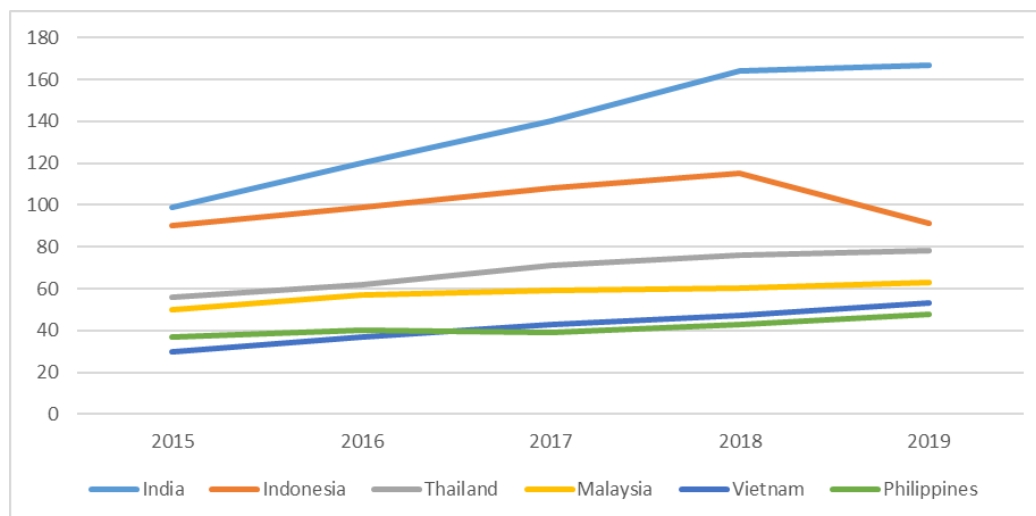
Thailand:

- Laem Chabang Port - Phase III Expansion
- Map Ta Phut Port - Phase III Expansion
- SRT Central Rail Station Smart City
- U-Tapao International Airport

Aviation

As GDP rises across the region and tourism continues to grow after the disruption of the COVID-19 global pandemic, each of the countries represented in this Resource Guide is developing and enhancing its aviation infrastructure to support both domestic and international revenue sources. The Indo-Pacific countries are expanding existing airports, constructing new airports, and implementing new technologies to utilize current capacity more efficiently. Sector growth represents a substantial opportunity for U.S. exporters to target aircraft sales, design services, communications and navigation technologies, and safety and security solutions. While historical growth in air passengers across the region from 2015 to 2019 was substantial (Figure 22), not unexpectedly, all have experienced significant declines in 2020.

Figure 22: Air Passenger Growth 2015 to 2019 (millions of passengers)³²

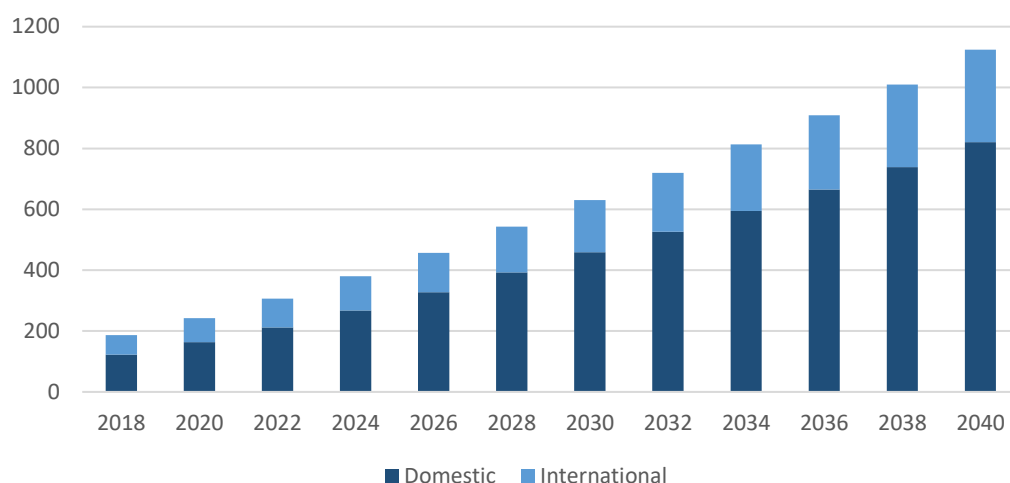


In India, which recently became the third-largest aviation market for passenger throughput, behind the United States and China, the government is embarking on a large-scale plan to bring aviation “to the masses.” The Indian government has developed a regional connectivity plan allowing

³² <https://knoema.com/atlas/ranks/Number-of-air-passengers-carried?action=export&gadget=tracking-container>

greater access to air travel for a market that has already shown recent double-digit growth (Figure 23).

Figure 23: Projected Total Air Passengers to/from/within India (Millions)³³



Although air traffic was off nearly 40 percent in 2020 due to the COVID-19 global pandemic, India expects air travel growth to continue along the previous trajectory once public health concerns abate. The Directorate General of Civil Aviation reported that Indian domestic air passengers decreased by 56 percent to 63 million in 2020.

In Southeast Asia, pandemic-related declines in airline passenger traffic were similarly stark:

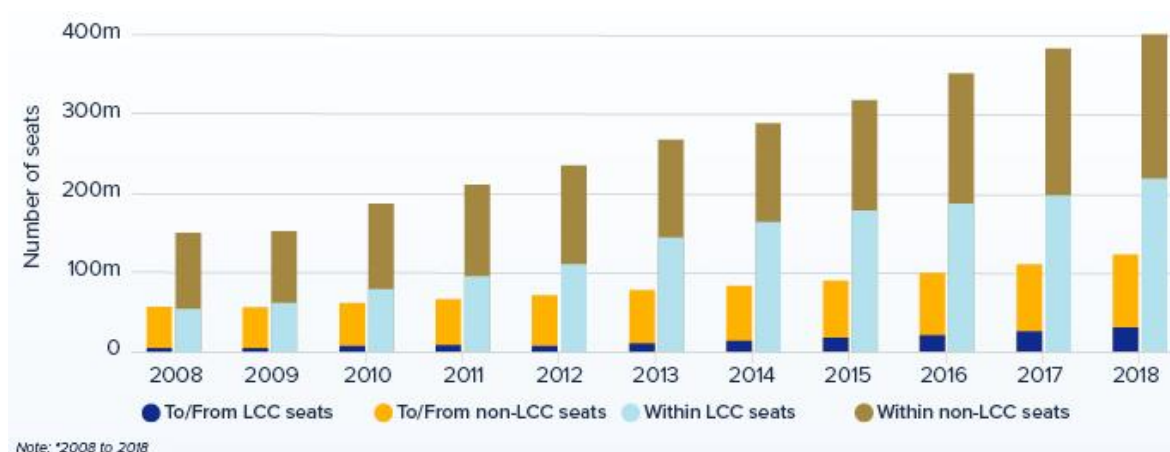
- In November 2020, the Indonesian National Air Carrier Association (INACA) projected the number of air passengers to only reach around 45.8 million by the end of 2020, a 40 percent drop over 2019.
- According to the CAAV, Vietnamese airlines carried out around 340,000 flights in 2020, a decrease of more than 31.9% compared to 2019. The volume of air passengers this year (2021) is estimated to reach only 66 million, 43.5% less than in 2019.
- Passenger numbers at Malaysia's airports fell by -75.5% in 2020, to 25.8 million. The international and domestic sectors recorded 9.5 million and 16.3 million passengers, posting declines of -82.2% and -68.7%, respectively.
- In the Philippines, data from the Civil Aeronautics Board showed total passenger traffic carried by domestic and international airlines reached only 13.12 million in 2020, down from over 60 million in 2019.
- In Thailand, Airports of Thailand reported 47 million domestic and international passengers in 2020, down 67% from 2019 levels.

All of the regional air authorities are projecting returns to pre-pandemic levels no sooner than 2023. Consolidation in the sector is likely, with some airlines being absorbed, which suggests air traffic may continue to be depressed for a longer period. This may slow the development and expansion projects planned for some of the region's airports.

³³ Vision 2040 Civil Aviation Industry in India; FICCI and KPMG

In Southeast Asia, the availability of low-cost carriers (LCC) and increasing passenger and cargo traffic with China have driven growth and are likely to be significant contributors to the future recovery. Seat capacity in the region grew from 200 million in 2008 to nearly 530 million in 2018, with LCCs representing approximately 200 million seats of that growth (Figure 24). LCCs accounted for at least 50 percent of regional traffic in the domestic markets and 30 to 40 percent of the international market. While the Indo-Pacific region countries suffered significant air traffic declines in 2020 due to the COVID-19 global pandemic, most, if not all, airport and air travel projects are moving forward, albeit with some delays. We expect the LCC carriers to continue to capture market share going forward once air travel is considered safe.

Figure 24: Southeast Asia Low-Cost and Full-Service Carrier Annual Seat Capacity³⁴



With recent traffic volumes increasing for international and domestic passenger sources (but for the 2020 COVID-19 global pandemic disruption), all civil aviation authorities in the region are expanding capacity through efficiency gains. Using collaborative decision-making (CDM) and enhancements to air traffic management capability, each country will better manage its airspace with the growing number of aircraft.

Surface Transportation

In total, Asia has a rail network of more than 79,000 kilometers, either planned or under construction. More than half of this amount is in the Indo-Pacific region (Table 11). The Resource Guide countries are making substantial investments in developing new high-speed rail, urban transport, traditional freight rail, and associated infrastructure such as signaling and rolling stock purchases. We profile several rail projects in India and Thailand in this Resource Guide.

³⁴ CAPA – Centre for Aviation; OAG

Table 11: Indo-Pacific Region Upcoming Rail Projects and Investments³⁵

Country	Upcoming Rail Projects, km	Upcoming Project Cost, \$ billion
India	37,882	284.2
Indonesia	2,200	25.0
Malaysia	1,180	28.4
Philippines	1,800	17.1
Thailand	4,308	50.0
Vietnam	550	19.0
TOTAL	47,920	423.7

For road transport, between 2005 and 2015 (where data was available), motor vehicle use increased significantly, with the Indo-Pacific region overall seeing a 13 percent per year average expansion.³⁶ Motor vehicle fleets are doubling every five to seven years across cities in Asia. With this growth comes increased traffic congestion and the greater possibility for accidents, both of which harm economic growth. Estimates suggest road congestion results in a two to five percent reduction in GDP for Asian economies annually due to lost time and higher transport costs.³⁷ Further, up to 80 percent of the air pollution in the region's cities is attributable to transport.

The countries in the region (and others supporting their economic development) are exploring various solutions to manage surface transportation challenges. Opportunities include expanding public transportation systems, using non-motorized transport, integrating urban transport planning, applying demand management to limit congestion, and utilizing traffic engineering/management systems. Combining the expanding network of rail, roads, highways, and toll-roads under construction and planned across the region provides numerous opportunities for U.S. companies to support further surface transportation development. While we have touched on several road system-oriented projects, this is not the focus of this Resource Guide.

Maritime Transportation

Globally, in 2019, there were nearly 800 million twenty-foot equivalent units (TEUs) of containers handled by ports³⁸, the overwhelming percentage (65 percent³⁹) of which were in Asia and Oceania (including China). The six Resource Guide countries represent over 11 percent of global container traffic, and each grew its port traffic materially from 2015 to 2019 (Figure 25). Even with the COVID-19 global pandemic, growth has continued, albeit at a slower rate.

Because of the increased demand for containerized cargo, shipping lines are using larger and larger vessels. Larger vessels require the expansion of ports to accommodate their size and draft. At the

³⁵ Asia Pacific Rail 2020: The Future of Rail in Asia

³⁶ OECD

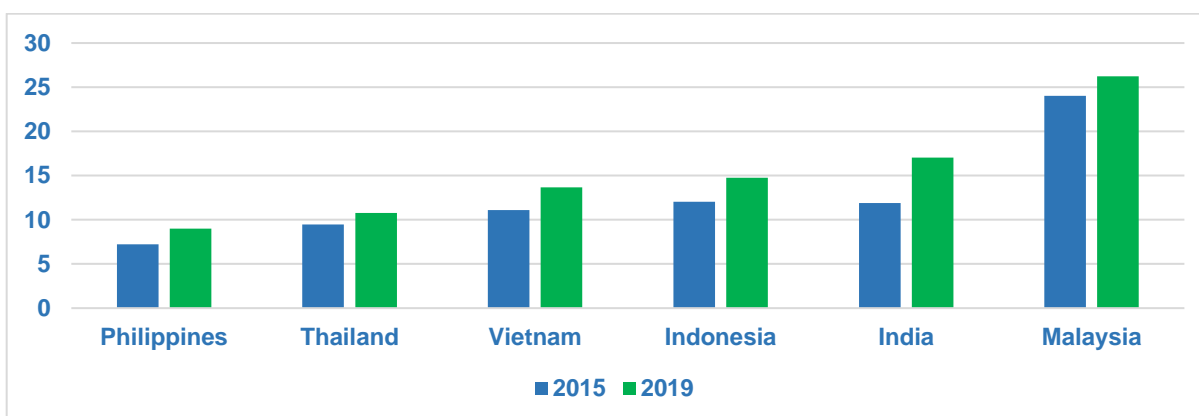
³⁷ ADB, <https://dx.doi.org/10.22617/FLS168388-2>

³⁸ World Bank

³⁹ Hellenic Shipping News Worldwide

same time, archipelagic countries like the Philippines and Indonesia rely heavily on sea traffic as a cost-effective means for cargo and passenger domestic movements. These factors, along with increasing import volumes of gas and other fuel through maritime terminals, combine to require port operators to make significant infrastructure investments. This Resource Guide highlights multiple opportunities for U.S. firms to become involved with port sector development and expansion across the Indo-Pacific region. Several LNG terminal projects are also profiled in this Resource Guide in the Philippines, Thailand, and Vietnam.


Figure 25: Indo-Pacific Containerized Port Traffic, 2015-2019 (Million TEU) ⁴⁰



Summary

The Transportation sector in the Indo-Pacific region is an attractive opportunity for U.S. interests. Demographics and continued economic development favor continued strong growth in transportation for moving both people and cargo. The area is a leader in marine transport. Air and rail transport demand is growing rapidly with passenger incomes. Manufacturing and service industry development are creating additional cargo shipment demand. Road transport is growing, with many cities in the region plagued by insufficient roadway capacity for the rapidly expanding number of vehicles, with resulting traffic jams and pollution. U.S. technology capabilities fit well to support Indo-Pacific growth in transportation and ameliorate associated environmental and passenger convenience issues. Smart city technologies and e-mobility will become more important in the region in the near future.

⁴⁰ United Nations Conference on Trade and Development (UNCTAD)

Itanagar (Hollongi) Greenfield Airport		
	SECTOR	Transportation Infrastructure
	SUBSECTOR	Airports
	LOCATION	Itanagar (Hollongi), Arunachal Pradesh
	PROJECT VALUE	\$155 Million

PROJECT SUMMARY

The greenfield Hollongi Airport, near Itanagar, in the Papum Pare district of Arunachal Pradesh will be developed in two phases at an expected cost of \$155 million. When Phase One is complete, the airport will permit the operation of ATR-type aircraft. Phase Two will support larger aircraft (e.g., Boeing 737s).

PROJECT DESCRIPTION

India is the third-largest civil aviation market globally, after the United States and China. It is the fastest-growing domestic aviation market in terms of tickets sold and passengers carried. At \$30 billion, civil aviation represents 1.5 percent of the Indian economy and supports 7.5 million jobs. From 2016-2020, domestic aircraft traffic reached 2.2 million, increasing at a compounded annual growth rate (CAGR) of 9.8 percent, while international aircraft traffic reached 4.3 million, growing at a CAGR of 3.6 percent. In 2020, due to the COVID-19 global pandemic, there was a significant drop-off in air traffic. Comparing Aug. 2020 to Aug. 2019, aircraft traffic, total passengers and freight decreased by 65.5, 78.6 and 29.4 percent, respectively. Given the nature of the economy, India expects post-pandemic air traffic to normalize without a structural change in the Indian aviation market.

India has 137 airports, including 24 international airports, 10 customs airports, 80 domestic airports and 23 domestic civil enclaves at military airfields. In Jan. 2019, India unveiled its “Vision 2040” for the aviation sector with the objective of handling 1.1 billion passengers annually by 2040. The Vision will require the construction of approximately 200 new airports and a financial commitment of \$40-50 billion.

Recent initiatives to support the growth of the Civil Aviation sector include:

- Regional Connectivity Scheme – ‘Ude Desh ka Aam Naagrik’ (RCS-UDAN).
- A provision of \$600 million, with budgetary support of the Indian Government, for the revival of 50 unserved and underserved airports and airstrips.

RCS-UDAN is a regional airport development plan of the Government of India, with the objectives of "letting the common citizen of the country fly." The Plan intends to ensure the provision of affordable air travel, while simultaneously spurring national economic development and job growth through air transport infrastructure development. The Plan's objective is to build new airports, as well as to expedite the development of India's nearly 425 unserved, underserved and most underdeveloped regional airports.

Under the RCS-UDAN program, the Airports Authority of India (AAI) proposed to build a greenfield airport at Hollongi village, Yupia Tehsil, in the Papum Pare district, near Itanagar in the State of Arunachal Pradesh (Figure 26). The site lies between the Kokila (eastern side) and Hollongi (southwest side) rivers and is approachable from National Highway 52A. The latitude and longitude reference points for the proposed airport are 26°58'12"N and 93°39'53"E. The site has no protected areas (e.g., under international conventions or national or local legislation for ecological, landscape, cultural or other related issues) within a 10 km radius of the site that might prevent the project. There is a stream passing through the project site. Drupong Reserve Forest is located 0.5 km to the north of the planned project.

Figure 26: Artist Rendering of Hollongi Airport



The project's Phase One scope of work includes the following:

- New runway construction (2300m x 45m, 08/26 magnetic).
- Construction of apron, taxiway and ramp area.
- Terminal building (capability of handling 200,000 passengers concurrently at peak hours (100,000 inbound/100,000 outbound)).
- Cargo complex and hangar.
- Fire station.
- Doppler very-high-frequency, omni-range (DVOR) navigation system.
- NDB (non-directional beacon) building.
- Pumphouse building.

- Electrical substation.
- Ground lighting, including runway edge lights.
- Passenger side amenities, including a hotel/convention center, 150-vehicle car park, and approach road.
- Airside infrastructure, including baggage-handling and hangar.
- Operation and Maintenance (O&M) of electrical installations for seven years, including a defect liability period (DLP) of two years.

The airport project had faced roadblocks in its implementation due to delays in finalizing the project site. In June 2016, the state government suggested the Ministry of Civil Aviation (MoCA) convene a committee to re-assess (for the third time) the techno-economic feasibility of two potential targeted locations, Hollongi and Karsingsa. The MoCA Committee report identified Hollongi as the more suitable site for technical, environmental, and financial reasons. Hollongi has now received necessary clearances from the Ministry of Home Affairs (MoHA), Ministry of Defence (MoD), and Ministry of Finance (MoF).

PROJECT STATUS AND IMPLEMENTATION TIMELINE

The Ministries of Civil Aviation (MoCA) and Finance (MoF) granted environmental clearance (EC) and approvals in Dec. 2018 and Jan. 2019, respectively. In Feb. 2019, the laying of foundation stone began.

Dineshchandra R Agrawal Infracon Private Limited (DRAIPL) won the \$55 million civil works contract bid on Feb. 7, 2020. The scope of work includes the following:

- Detailed design.
- Engineering, procurement and construction of earthwork.
- Wall to wall grading.
- Pavements for runways.
- Runway strips, turning pads, taxiways, apron, shoulders.
- Runway-End-Safety-Area (RESA).
- Ground support equipment (GSE) area.
- Isolation bay.
- Operational boundary walls, perimeter and other roads.
- Drainage systems, related retaining structures (river training works), soil improvement works, fire pit, cooling pit.
- Airport reference points (ARP).
- Localizer platform, meteorological platform, security and watchtowers and associated approaches and supply.

- Installation, testing and commissioning of airfield ground lighting system, illuminated guidance signages, visual aids for navigation, perimeter road lighting and bird hazard reduction system, etc.
- Civil repair, maintenance and Operation and Maintenance (O&M) of electrical installations for seven years, including two years of defect liability period (DLP).

Phase I project construction work began almost immediately in Feb. 2020. However, delays occurred due to a countrywide lockdown caused by the COVID-19 global pandemic. Soil testing and survey works restarted in May 2020. In Oct. 2020, runway construction work, construction work on the four-lane airport approach road, water and electricity connections, and erection of boundary walls began, with an intended completion date of Nov. 2022. Following civil construction, AAI will contract for MRO, communications systems, security systems, and air and terminal operations.

On Aug. 11, 2020, bidding began for the Phase II selection of an EPC contractor who will focus on the construction of a complete city-side and balance airside infrastructure. The work includes the following:

- Detailed design.
- Construction of the terminal building, fire station, air traffic control (ATC) tower-cum-technical block, residential complex, electrical and mechanical (E&M) workshop, medical center, pump house building, substation, car park, etc. including all civil works.
- Navigational Aids including the provision of Doppler VHF (Very high frequency) Omni Directional Range (DVOR).
- Plumbing, firefighting, heating ventilation and air conditioning (HVAC).
- Airport system 7 information technology (IT).
- Furniture and furnishing.
- Landscape, roads/pavements, drainage, sewage treatment plant (STP) and ancillary works for city side and balance airside infrastructure.
- O&M of electrical installations for a period of seven years including, DLP.

The last date for bid submission was Oct. 12, 2020. Uttar Pradesh Rajkiya Nirman Nigam Limited has emerged as the lowest bidder (L1) for construction of complete city side and balance air side infrastructure under Phase II of the project. The contract is yet to be awarded. AAI expects the tendered work to be complete within 24 months of contract execution at an estimated cost of \$24 million.

PROJECT COST AND FINANCING

The estimated project cost is \$155.15 million. The Ministry of Development of North Eastern Region (MDoNER) and the North Eastern Council (NEC) are providing \$29 million, with the Central Government (via AAI) supplying the balance. On March 4, 2020, the state government allocated \$7 million in its 2020-21 budget for external infrastructure development.

U.S. EXPORT OPPORTUNITIES

U.S. export opportunities include:


- Terminal design services and equipment.
- ATC systems design, installation packages and equipment.
- Avionics packages.
- GPS Aided GEO Augmented Navigation (GAGAN) system.
- Navigation systems design and equipment.
- Jet bridges and baggage handling systems.

Subsequent to construction, additional export opportunities will be available for:

- Safety and security and ICT and digital systems.
- Maintenance Repair Operations (MRO) facilities and inventory.
- Airport rescue firefighting equipment.
- Engineering services.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
<p>Airports Authority of India Rajiv Gandhi Bhawan Safdarjung Airport New Delhi, India</p> <p>Mr. R. Radhika GM (Commercial) radhika@aai.aero</p> <p>www.aai.aero</p>	<p>Indo-Pacific Region 1101 Wilson Blvd., Suite 1100 Arlington, VA 22209 USA</p> <p>Ms. Alissa Lee Senior Country Manager alee@ustda.gov</p> <p>U.S. Embassy in Delhi Shantipath Chanakyapuri, New Delhi Delhi 110021 India</p> <p>Ms. Mehnaz Ansari Senior Regional Representative, South Asia mansari@ustda.gov IndoPacific@ustda.gov www.ustda.gov</p>	<p>U.S. Commercial Service The American Center 24 Kasturba Gandhi Marg New Delhi 100 001 91-11-2347-2000 India</p> <p>Ms. Nisha Wadhawan Senior Commercial Specialist nisha.wadhawan@trade.gov</p> <p>www.trade.gov</p>

Jewar (Greater Noida) Greenfield Airport Project		
	SECTOR	Transportation Infrastructure
	SUBSECTOR	Airports
	LOCATION	Jewar, Uttar Pradesh
	PROJECT VALUE	\$4.2 Billion

PROJECT SUMMARY

A new international airport is planned for Jewar, in Greater Noida, the National Capital Territory, in the Gautam Budh Nagar district of Uttar Pradesh. The Jewar Airport is a greenfield project located 72 km from the existing Delhi airport whose development includes four phases.

The plan is to build a two-runway airport by 2022 or 2023 and then at a future date extend it to a 7,200-acre, six-runway airport. The airport will have a passenger handling capacity of 70 million passengers per annum (mppa) and cargo handling capacity of three million metric tonnes per annum (mmtpa). Noida International Airport Limited (NIAL) will implement the project, with four governmental agencies holding the shares. The airport will be a public-private partnership (PPP) built on a Design, Build, Finance, Operate and Transfer (“DBFOT”) model, with a planned investment of \$4.2 billion.

PROJECT DESCRIPTION

India is the third-largest civil aviation market globally, after the United States and China. It is the fastest-growing domestic aviation market in terms of tickets sold and passengers carried. At \$30 billion, civil aviation represents 1.5 percent of the Indian economy and supports 7.5 million jobs. From 2016-2020, domestic aircraft traffic reached 2.2 million, increasing at a compounded annual growth rate (CAGR) of 9.8 percent, while international aircraft traffic reached 4.3 million, growing at a CAGR of 3.6 percent. In 2020, due to the COVID-19 global pandemic, there was a significant drop-off in air traffic. Comparing Aug. 2020 to Aug. 2019, aircraft traffic, total passengers and freight decreased by 65.5, 78.6 and 29.4 percent, respectively. Given the nature of the economy, India expects post-pandemic air traffic to normalize without a structural change in the Indian aviation market.

India has 137 airports, including 24 international airports, 10 customs airports, 80 domestic airports and 23 domestic civil enclaves at military airfields. In Jan. 2019, India unveiled its “Vision 2040” for the aviation sector with the objective of handling 1.1 billion passengers annually by

2040. The Vision requires the construction of approximately 200 new airports and a financial commitment of \$40-50 billion.

Recent initiatives to support the growth of the Civil Aviation sector include:

- Regional Connectivity Scheme – ‘Ude Desh ka Aam Naagrik’ (RCS-UDAN).
- Provision of \$600 million, with budgetary support of the Indian Government for revival of 50 unserved and underserved airports and airstrips.

Initiatives like Nabh Nirmaan (for airport capacity augmentation), Digi Yatra (for paperless travel) and AirSewa (for online passenger grievance redressal) will result in service upgrades, facility modernizations and enhanced passenger experiences. The government also unveiled a drone (UAS) policy to ensure civilian drones are manufactured in India, which will enhance local economic development. At the same time, the government is focused on leveraging technologies such as artificial intelligence to improve the flying ecosystem.

The expansion of airport capacity in the National Capital Region (NCR) is critical to this initiative. By creating a second international airport hub to ease Indira Gandhi International Airport (IGIA) traffic in the New Delhi area, the Jewar Airport, strategically located in the NCR, will provide this much-needed additional regional capacity. Given its proximity, the airport will operate systemically with IGIA. When IGIA experiences constraints during peak hours, spill-over traffic from IGIA will be diverted to Jewar to balance the system. Air Navigation Services (ANS), meteorological services, and other operational services will be harmonized with IGIA to maintain the optimum level of efficiency and capacity for both airports.

The Government of India first announced the Jewar Airport in 2001. For multiple reasons (political, land issues, cost, et al) the project was delayed. However, due to capacity constraints at IGIA, coupled with recent alignment between the Central Government and the Uttar Pradesh State Government, there is now a joint commitment to bring this project to fruition. The project (Figure 27) is being enabled by an aggressive civil aviation policy and the completion of a techno-economic feasibility report (TEFR) prepared by Price Waterhouse Coopers (PWC). Yamuna Expressway Industrial Development Authority (YEIDA) has been appointed as a nodal agency by the Government of Uttar Pradesh (GoUP).

The airport will be built in four phases (Table 12) and will eventually encompass an area of 5,000-hectares. Upon completion, passenger-handling capacity will grow from 12 mmpa to 70 mppa, and cargo-handling capacity will reach three mmtpa.

Figure 27: Jewar (Noida) Airport⁴¹

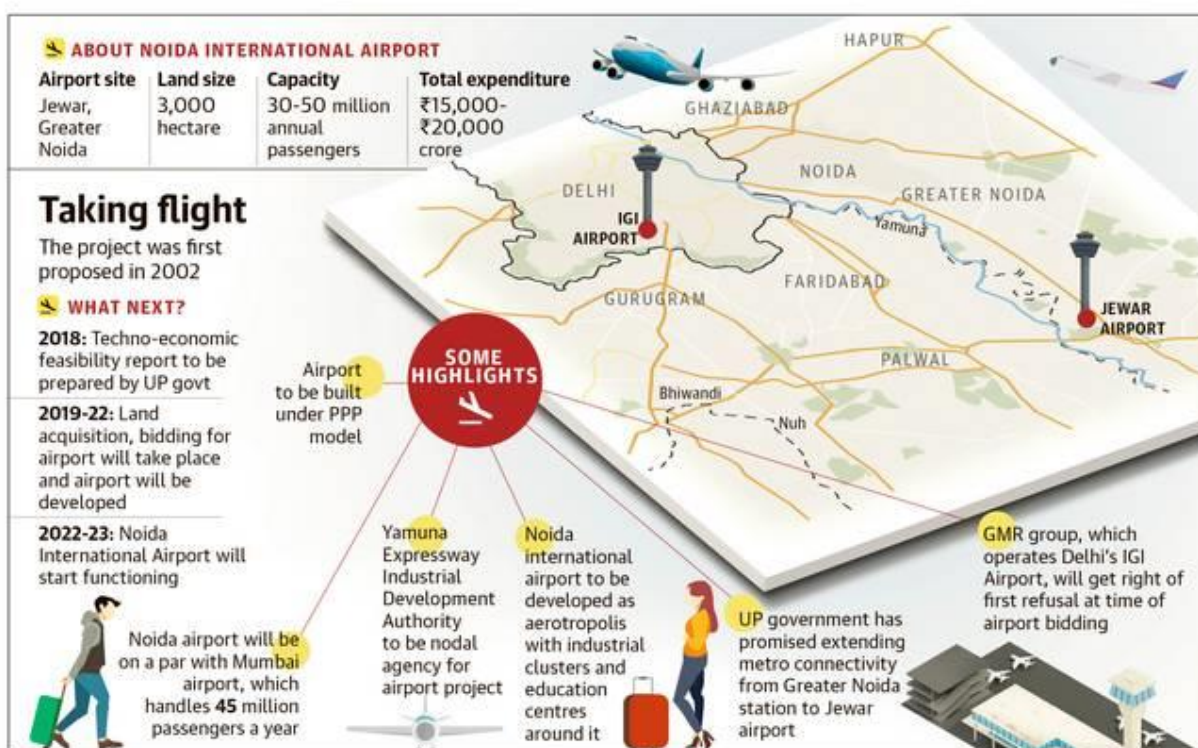


Table 12: Jewar Greenfield Airport Development Phases⁴²

Development Period	Phase	Period	Design Year		Passengers (MMTPA)	Cargo (MMT)	Gates
FY 2020-22	1	FY 2023-27	2028		12	0.75	24
FY 2028-30	2	FY 2031-32	2034		30	1.0	40
FY 2033-35	3	FY 2036-37	2039		50	1.5	68
FY 2037-39	4	FY 2040-50	2044		70	3	85

Key elements of the First Phase include (Table 13):

⁴¹ Thgim.com

⁴² NIAL

Table 13: Jewar Airport Phase One – Key Project Elements⁴³

Facilities (1st Phase)	
Sl. No.	Details of items
1	Runway 4150 x 60 for Code 'F'
2	Code F, precision approach, Runway 10/28- Cat III, fully supported by Cat III ILS and approach lighting and visual aids.
3	Parallel End to End Taxiway
4	Taxiway with two rapid exits conforming to Code F and Cat III requirements.
5	Apron for 4Code E/F and 21 Code C Aircraft with built in capacity to accommodate up to 5 Code E aircraft
6	Terminal Building for peak 2750 passenger capacity (Total Floor Area of 90,000 sq.m., Swing Gate operation)
7	Fire Station (Category 9)
8	Air Traffic Control Building
9	Isolation Bay
10	Operational Wall
11	Cargo Terminal Building (50,000 sq.m.)
12	Maintenance Building
13	Management Building
14	Security Staff Building
15	Energy Building
16	Property Boundary Wall
17	E & M Facilities
18	a Power House
19	b Electrical Substation
20	c Distribution Substation
21	d AGL and Visual Aids to support Cat III operations
22	e METFARM

Upon completion, Jewar Airport will have six runways and become India's largest airport and one of the world's largest. Only O'Hare International Airport (ORD) and Dallas/Fort Worth International Airport (DFW) will be larger, with eight and seven runways, respectively.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

The State Cabinet approved the bid document for the project in May 2018. In Jan. 2020, the Ministry of Environment, Forest and Climate Change (MoEFCC) granted Environmental Clearance for the development of Phases One and Two.

YEIDA has acquired a total of 923-hectares of land for this project. Each phase of construction will require about 36 months. NIAL will issue a Request for Proposal (RFP) during each project phase for the selection of a PPP partner. Each PPP will subcontract relevant services and supplies for its project components.

⁴³ Ibid.

In May 2019, NIAL invited Phase 1 Requests for Proposal (RFPs). Subsequently, the technical proposals of Adani Enterprises, Delhi International Airport Authority Ltd (DIAL), Anchorage Infrastructure Investments Holding Ltd. and Flughafen Zürich AG were shortlisted. Flughafen Zürich AG was recommended as the preferred bidder in Nov. 2019. On Oct. 7, 2020, NIAL and YIAPL signed a 40-year project concession agreement with Flughafen Zürich AG. The entity will be responsible for the design, engineering, financing, procurement, construction, operations, maintenance and transfer of the greenfield airport project as defined under the provisions of the concession agreement.

NIAL expected construction work to begin by early 2021, with the commencement of Phase One operations in 2024. The COVID-19 global pandemic is likely to create some delays.

PROJECT COST AND FINANCING

Based on the Master Plan, the full project's capital expenditure is estimated at \$4.2 billion:

- Phase 1: \$655 million.
- Phase 2: \$855 million.
- Phase 3: \$1,202 million.
- Phase 4: \$1,511 million.

Noida International Airport Limited (NIAL) is overseeing this greenfield airport project and its associated PPP. The State Government and Noida Authority will together have 75 percent equity in the project (37.5 percent each). The Greater Noida Industrial Development Authority (GNIDA) and YEIDA will hold the remaining 25 percent equity in the project (12.5 percent each). Each selected bidder will incorporate as a Special Purpose Vehicle (SPV), as defined under the Companies Act, 2013.

Haryana Urban Development Corporation (HUDCO) has agreed to provide a \$441 million loan at an interest rate of 10.5 percent. The National Capital Region Planning Board (NCRPB) agreed to provide loans worth \$74 million at an interest rate of 7.5 percent. The State has released to YIEDA a \$147 million fund to acquire land for Phase Two.

U.S. EXPORT OPPORTUNITIES

As a greenfield airport, this project presents many opportunities for U.S. companies offering design, engineering, and project management services, including:

- Air traffic control (ATC).
- Facilities and utilities.
- Engineering services.
- Lighting and electrical.
- Ground-side facilities.
- Air-side facilities.

- Communications network.
- Passenger services.

The Jewar Airport passenger terminal will be a state-of-the-art, unique, futuristic building creating a highly visible, iconic landmark. U.S. design and architecture firms, as well as other arts-related organizations, may have opportunities here.

Retail design and related operations opportunities will encompass shopping and duty-free areas concessionaires, designers, retail-management and maintenance providers and repair and overhaul (MRO) service providers.


Equipment and supplies opportunities will extend to aviation and airport-related equipment and systems, including the following:

- Advanced lighting systems.
- Jet bridges.
- Navigational aids and lighting systems.
- Distance measuring equipment (DME).
- VHF omnidirectional radio range (VOR).
- Instrument landing systems (ILS).
- Visual aids, including precision approach path indicators (PAPIs).
- Runway lights.
- Communications systems.
- Terminal security systems (metal detectors, body scanners).
- Closed-circuit television (CCTV)/cameras.
- Access control systems.
- Ground-handling equipment.
- Fire-fighting trucks and emergency vehicles.
- Baggage and cargo handling equipment.

Several U.S. companies have already expressed interest in participating in the Jewar Airport development and operations. For example, The Boeing Company has expressed interest in setting up a maintenance, repair, and overhaul (MRO) facility on the airport site. Similarly, VT Systems (now ST Engineering North America) has indicated an interest in developing an MRO unit nearby in Meerut city.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
<p>Noida International Airport Ltd. OFFICE NO. 1-15 BLOCK P-2-SECTOR, OMEGA -1, Greater Noida, Gautam Buddha Nagar 201308 Uttar Pradesh India</p> <p>Mr. Shailendra Kumar Bhatia, Chief Nodal Officer info@nialjewar.com www.nialjewar.com</p>	<p>Indo-Pacific Region 1101 Wilson Blvd., Suite 1100 Arlington, VA 22209 USA</p> <p>Ms. Alissa Lee Senior Country Manager alee@ustda.gov</p> <p>U.S. Embassy in Delhi Shantipath Chanakyapuri, New Delhi Delhi 110021 India</p> <p>Ms. Mehnaz Ansari Senior Regional Representative, South Asia mansari@ustda.gov IndoPacific@ustda.gov www.ustda.gov</p>	<p>U.S. Commercial Service The American Center 24 Kasturba Gandhi Marg New Delhi 100 001 91-11-2347-2000 India</p> <p>Ms. Aileen Crowe Nandi Minister Counselor for Commercial Affairs office.newdelhi@trade.gov www.trade.gov</p>

Kolkata Airport Expansion (Phase 2)		
	SECTOR	Transportation Infrastructure
	SUBSECTOR	Airports
	LOCATION	Kolkata, West Bengal
	PROJECT VALUE	\$147 Million

PROJECT SUMMARY

The Airports Authority of India (AAI) is planning to develop a new terminal building as part of the second-phase expansion of the Kolkata airport (located in the state of West Bengal), at a cost of approximately \$147.1 million. The old international terminal is planned for demolition, making way for a new 70,000-square meter building. Additionally, expansion of the security hold area (SHA) is intended, and with the addition of a new jet bridge, also a futuristic multi-modal transport hub. The new terminal will serve only domestic flights, while the existing integrated terminal will serve international flights.

PROJECT DESCRIPTION

The Indian aviation sector has been growing at a rate of 20 percent annually over the last four years, becoming the fastest-growing aviation sector globally. It is the third-largest civil aviation market globally, after the United States and China.

During 2016-2020, domestic aircraft traffic reached 2.2 million, increasing at a compounded annual growth rate (CAGR) of 9.8 percent, while international aircraft traffic reached 4.3 million, growing at a CAGR of 3.6 percent. Due to the COVID-19 global pandemic, there was a significant drop-off in traffic. Comparing Aug. 2020 to Aug. 2019, aircraft traffic, passengers and freight decreased by 65.5 percent, 78.6 percent and 29.4 percent, respectively. Given the Indian economy's nature, post-pandemic air traffic will likely normalize without a structural change in the aviation market.

India has 137 airports, including 24 international airports, 10 customs airports, 80 domestic airports and 23 domestic civil enclaves at military airfields. In Jan. 2019, India unveiled its "Vision 2040" for the aviation sector to handle 1.1 billion passengers annually by 2040, which will require approximately 200 new airports and a financial commitment of \$40-50 billion.

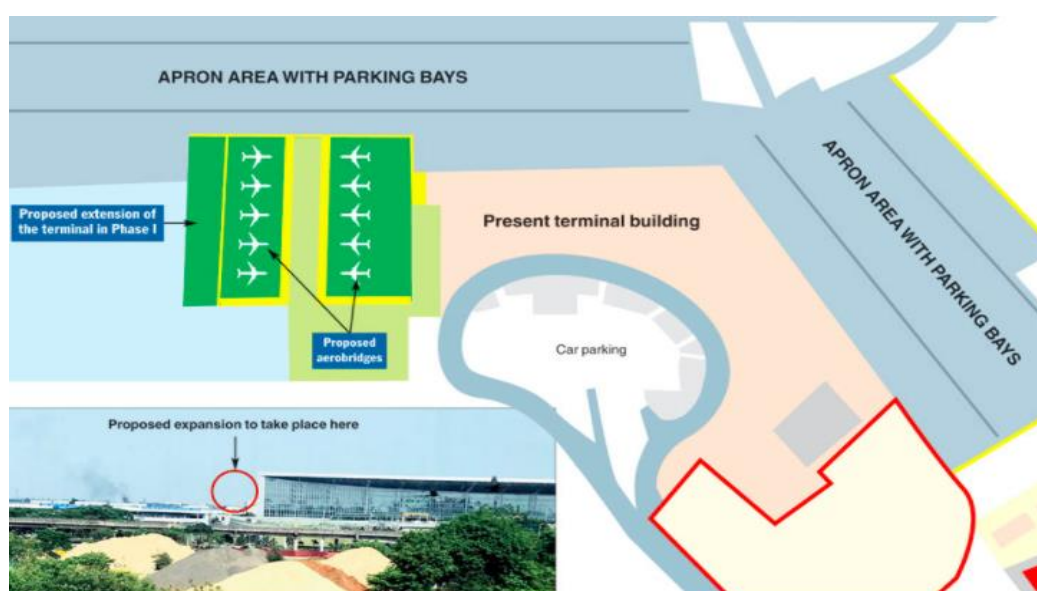
Initiatives like Nabh Nirmaan (for airport capacity augmentation), Digi Yatra (for paperless travel) and AirSewa (for online passenger grievance redressal) will result in service upgrades, facility modernizations and enhanced passenger experiences. The government also unveiled a drone (UAS) policy to ensure that civilian drones are manufactured in India, strengthening local economic development. Simultaneously, the government focuses on leveraging technologies such as artificial intelligence to improve the flying ecosystem.

Kolkata Airport, also known as Netaji Subhas Chandra Bose International Airport, is located in Dum Dum, West Bengal, in India's eastern portion, approximately 17 km from the city center. It is one of the ten largest airports in India, handling 350 flights per day, and according to Airports Council International (ACI), is among the fastest-growing in the world. The airport is controlled and operated by AAI.

Due to the extensive and continued traffic growth, AAI created a multi-decade upgrade and expansion plan for the Kolkata airport. During 2010-2013, the existing international and domestic terminals were integrated into a single, six-level, L-shaped, 233,000-square meter passenger terminal. The reconfigured terminal building contains 18 jet bridges and 45 parking bays and can handle 24 million passengers per year.

AAI plans to initiate the current project to increase airport capacity by 9 million passengers per year at an estimated cost of \$147 million. This project will involve the demolition of the air traffic control building and the old international terminal (Figure 28), replacing it with a 70,000-square meter building connected to an integrated terminal. The vast majority of the new facility's departure level will be a security hold, designed to avoid congestion and long queues during the security check and boarding processes.

Figure 28: Planned Location of the New Kolkata Airport Domestic Terminal⁴⁴



⁴⁴ Telegraphindia

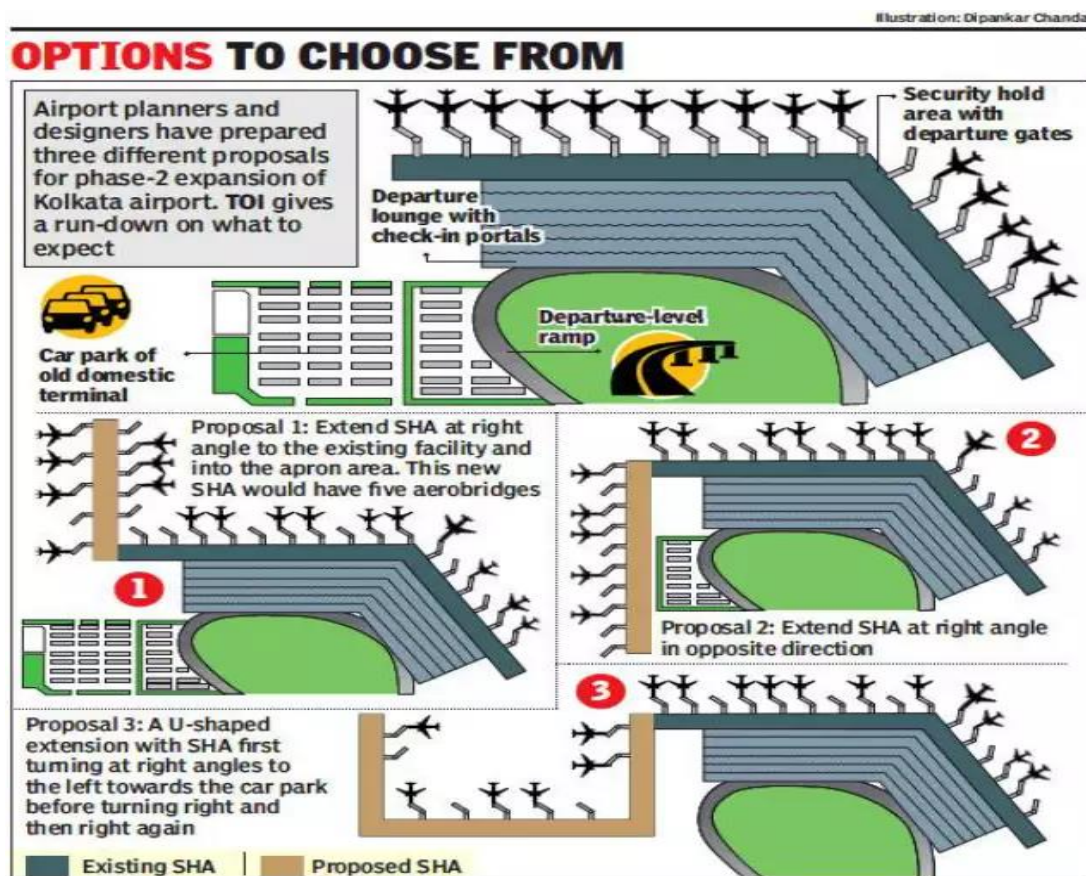
The Kolkata Airport project plan encompasses:

- New 70,000-square meter terminal.
- Increase passenger capacity/year by nine million from the current capacity of 24 million.
- Ten new jet bridges in the terminal.
- Ten more aerobridges in the new building, linked to the current terminal.
- Twenty-five new parking bays - 15 remote and 10 contact bays - allowing aircraft parked in a contact bay to be reached from an aerobridge.
- A futuristic multi-modal transport hub.

With the added jet bridges, the airport will offer direct boarding for 200 flights per day, doubling the current capacity. The security hold area (SHA) lounge to the existing terminal's left will be expanded, adding additional boarding. The new facility will cater to category C and higher aircraft (Boeing 737s and 787s and Airbus A319s, A320s, and A321s).

The designs considered for the new terminal are 'L-' and 'U-' shaped (Figure 29), both of which add boarding gates and jet bridges.

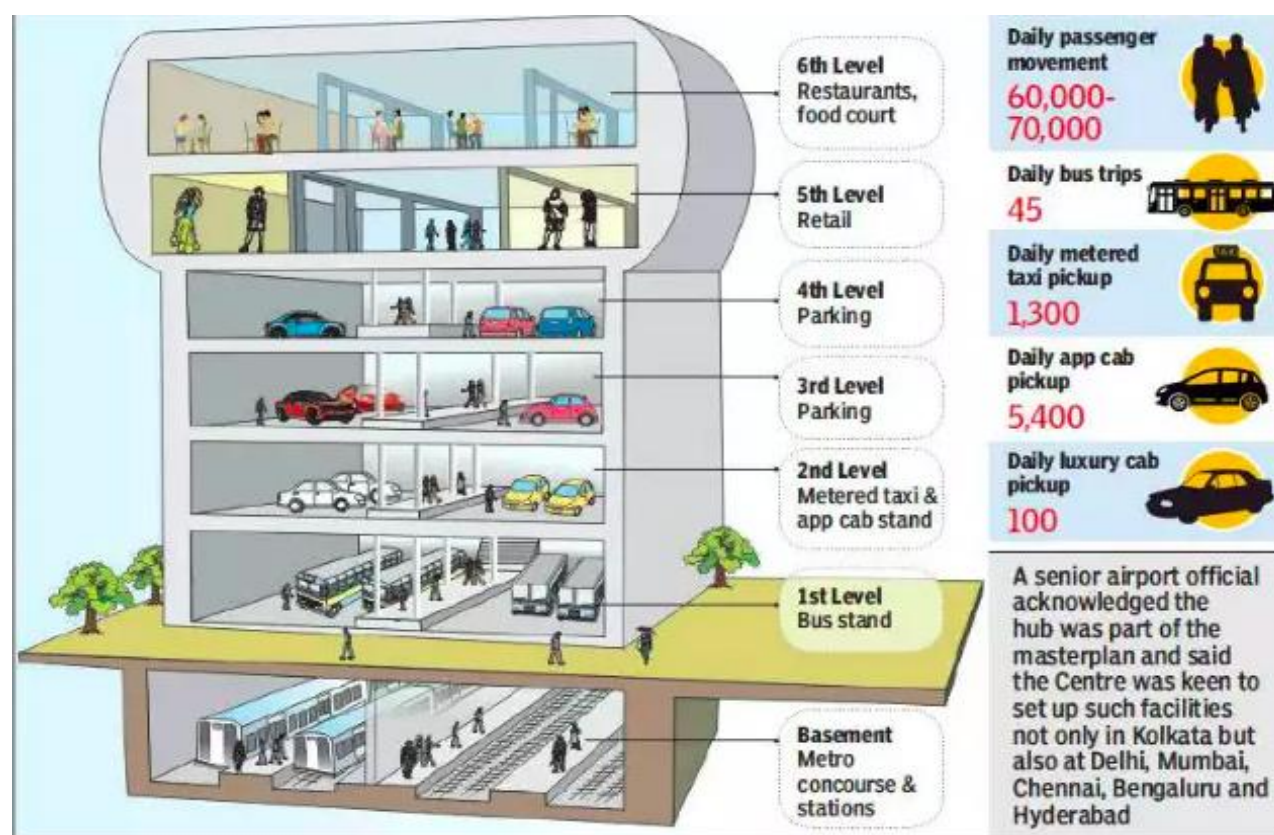
Figure 29: Design Consideration for the New Kolkata Airport Terminal⁴⁵



⁴⁵ TOIIMG <https://static.toiimg.com/photo/imgsize-505471,msid-68759151/68759151.jpg>

Landrum and Brown, a U.S.-based firm specializing in aviation planning and development, reviewed the master plan and recommended changes based on the facilities' utilization. The firm drafted a plan for a futuristic multi-modal transport hub at Kolkata airport, similar to those employed in several European airports. The proposed multi-level terminus will enable passengers to take the metro, cabs or buses from a single facility. A multi-level car park will be part of the hub, and retail and food-courts are also included in the sprawling building. The building will be above the underground metro parking stations, which are currently under-construction. Three metro lines will converge at the station, 12 meters below ground level (Figure 30).

Figure 30: Kolkata Airport Multi-modal Transport Hub⁴⁶



PROJECT STATUS AND IMPLEMENTATION TIMELINE

The AAI Board has approved the demolition of the air traffic control building and the old international terminal. In parallel, the master plan prepared by Landrum & Brown for the project was approved by the AAI in Feb. 2020. AAI is likely to appoint a project management consultant (PMC) for the project over the next few months, despite delays from the COVID-19 global pandemic work stoppage and slow-down. AAI expects the completion of construction work within approximately 30 months from the commencement of civil works.

⁴⁶ <https://timesofindia.indiatimes.com/city/kolkata>

PROJECT COST AND FINANCING

The total cost of the Kolkata Airport project is estimated at \$147 million. Airports Authority of India (AAI) is solely funding the project.


U.S. EXPORT OPPORTUNITIES

U.S. export opportunities include the following:

- Terminal design services.
- Terminal equipment and airport systems design and services including augmentation and provision of:
 - Public address system and car calling system.
 - Surveillance closed-circuit TV system (SCCTV).
 - Flight Information Display System (FIDS).
 - Baggage x-ray systems.
 - VHF FM sets.
- Firefighting systems.
- Advanced lighting systems.
- Baggage handling systems.
- IT and Terminal communication systems including:
 - Passive and active networking components.
 - Access Control System.
 - Information and communications technology (ICT) and digital systems.
 - AI and other digital enablement systems and services.
- Jet bridges design and supply.
- Parking bays design and services.
- Escalators.
- Customer experience enhancement plans and services.
- Engineering and architectural services.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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Expansion of Outer Harbor Project at Hazira Port		
	SECTOR	Transportation Infrastructure
	SUBSECTOR	Ports
	LOCATION	Hazira, Gujarat
	PROJECT VALUE	\$2 Billion

PROJECT SUMMARY

Situated in Gujarat in western India, the Adani Hazira Port (AHP) (Figure 31) is in close proximity to the Delhi-Mumbai Industrial Corridor, one of the world's largest high-tech industrial zones. AHP is also well-positioned to handle port traffic for the northern, northwestern, and central parts of India. From an export standpoint, the site also provides a convenient international trade gateway to Europe, Africa, the Americas, and the Middle East.

Figure 31: Hazira Port



Adani Hazira Port Private Limited (AHPPL) is planning to expand the Hazira Port by developing an outer harbor, at an estimated cost of \$2 billion. The outer harbor will consist of 19 multi-purpose berths capable of handling various cargo types (i.e., dry, liquids, and container). The project will increase the port handling capacity by 150 million metric tonnes per annum (mmtpa) and will have a land requirement of 7.1 square km. The port configuration after the proposed expansion will be (Table 14):

Table 14: Hazira Port Present and Future Configuration

Category	Total with Project	Existing	New
Berths	31	12	19
Cargo Handling Capacity (mmtpa)	234	84	150
Project Area (sq km)	15.83	8.73	7.1
Water Requirements (mld)	46.5	16.5	30
Desalination Capacity (mld)	115	15	100
Power Requirements	940	240	700

PROJECT DESCRIPTION

Hazira is one of India's major ports, located at Surat (Figure 32). The town is known as India's industrial hub, situated on the bank of the Tapti River, eight km from the Arabian Sea. The area is a center for health tourism, due to its natural springs, and a base for major industrial and shipping facilities. Prominent companies/entities operating in the area include Essar, Kribhco, Shell, Larsen & Toubro, NTPC, ONGC, GAIL, the GSEG power plant, Gujarat State Petroleum Corporation, UltraTech Cement, and the Hazira Manufacturing Division (HMD) of Reliance Industries.

Figure 32: Map of Gujarat Ports⁴⁷



AHPPL began operations in the first quarter of 2012. The entity currently operates all non-LNG facilities in Hazira Port under the terms of an agreement with Hazira Port Pvt. Ltd. (HPPL). AHPPL proposes to expand Hazira Port by developing the outer harbor at an estimated cost of \$2 billion. The project will increase the port handling capacity by 150 mmtpa. The key features of the project include:

⁴⁷ Hazira Port Pvt Ltd

- Developing 19 multipurpose berths.
- Creating a 2.3 km long navigation channel with dredging undertaken with 21 m chart datum (CD) and a 50 million cubic meters quantity.
- Increasing northern breakwater length.
- Dredging berth pockets depths up to (-) 21.0 m CD.
- Converting existing berths into multipurpose berths.
- Developing:
 - A Liquids terminal.
 - A 5600 m long jetty for multipurpose cargo.
 - A 560 m long jetty for two berths for liquid / cryogenic Gas up to -160° C.
- Constructing a port basin and back-up infrastructure, utilities, amenities, storage, and other ancillary facilities.
- Creating a turning circle of 700 m diameter with (-) 21.0 m CD.
- Adding back-up yard equipment and associated facilities, including a firefighting system.
- Installing water/wastewater treatment facilities and a storm water drainage system.
- Creating road and railway connectivity.
- Developing a land requirement of 7.1 sq. km.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

In Jan. 2016, the Gujarat government issued a notification allowing AHPPL to expand Hazira's port limits. On Aug. 1, 2017, the Ministry of Environment, Forest and Climate Change (MoEFCC) granted Terms of Reference (ToR) to the project, which was recommended by the Expert Appraisal Committee (EAC) in its meeting in May 2017. In response, Essar Ports filed a petition in Gujarat High Court (HC) seeking to stop the port expansion given alleged infringement on its Magdalla Port and land reclamation investment. The petition was rejected by the HC, resulting in Essar Ports taking its case to the Supreme Court (SC). On Feb. 22, 2018, the SC rejected the Essar Ports Limited plea.

PROJECT COST AND FINANCING

The total Hazira Port expansion project cost is \$2 billion, with financing terms yet to be announced.

U.S. EXPORT OPPORTUNITIES

For U.S. firms, the potential export opportunities for the Hazira Port expansion include:

- Detailed engineering and design services.
- Layout/facility planning and management services.
- Construction supervision and management.
- Automation solutions.
- Dry excavation services and equipment.
- Construction management services.
- Supply of terminal management and berthing aids.

- Software and user training.
- Port security technology and training.
- Bulk cargo management equipment, including:
 - Silos.
 - Front-wheel loaders.
 - Conveyor belts.
 - Grab-type ship unloaders.
- Piping systems and storage tanks.
- Water/wastewater and hazardous waste treatment facilities and technologies.
- Cryogenic gas transport and storage solutions.
- Intelligent transportation design and equipment.
- Telecommunications solutions.
- Cybersecurity technologies.
- Vessel traffic management system.
- Power supply equipment.
- Terminal operating system.
- Container inspection/security equipment.


Longer-term supply opportunities include:

- Cargo management software.
- Yard trucks.
- Conveyors and material handling equipment.
- Mobile cranes.
- Harbor mobile cranes (HMC).
- Pay loaders, dumpers, spreaders, and track hoppers.
- Dredging equipment.
- Barges.
- Terminal lighting.
- Navigational aids.
- Quay and yard cranes.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
<p>Adani Hazira Port Private Limited (AHPPL), “Adani House”, Shrimali Society, Nr. Mithakhali Six Road, Navrangpura Ahmedabad 380009 Gujarat India</p> <p>www.adanihaziraport.com</p>	<p>Indo-Pacific Region 1101 Wilson Blvd., Suite 1100 Arlington, VA 22209 USA Mr. Kevin Toothers Country Manager ktoothers@ustda.gov</p> <p>U.S. Trade and Development Agency U.S. Embassy in Delhi Shantipath Chanakyapuri, New Delhi Delhi 110021 India Ms. Mehnaz Ansari Senior Regional Representative, South Asia mansari@ustda.gov</p> <p>IndoPacific@ustda.gov www.ustda.gov</p>	<p>U.S. Commercial Service U.S. Consulate General, Chennai 220, Anna Salai, Chennai – 600 006 India Mr. Sham Shamsudeen Commercial Specialist sham.shamsudeen@trade.gov</p> <p>www.trade.gov</p>

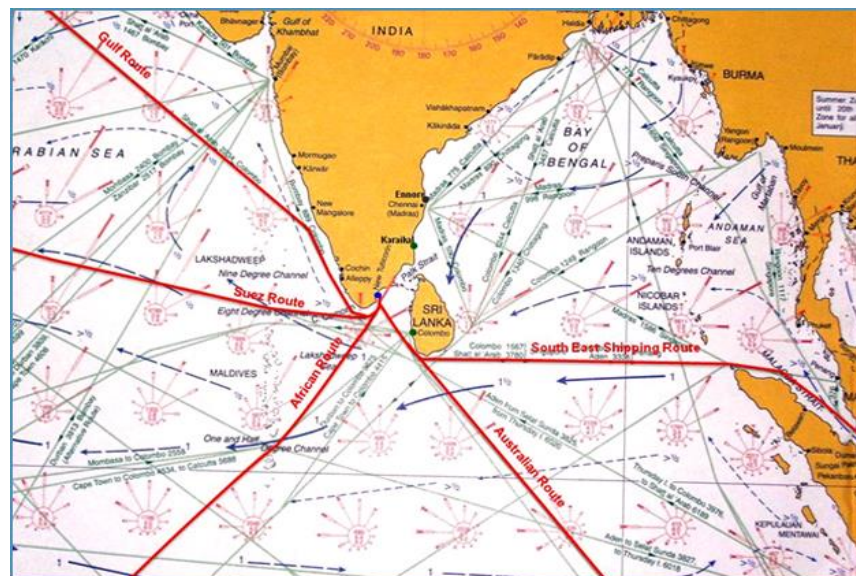
Inner Harbor Development Project at V.O. Chidambaranar Port (Tuticorin Port)

	SECTOR	Transportation Infrastructure
	SUBSECTOR	Ports
	LOCATION	Tuticorin, Tamil Nadu
	PROJECT VALUE	\$817 Million

PROJECT SUMMARY

V.O. Chidambaranar Port Trust (VOCPT), Tuticorin (Figure 33) is planning an Inner Harbor project to support regional traffic growth over the next five years. Located in the state of Tamil Nadu on the southeast coast of India, the port is one of 12 major Indian ports. Tuticorin has emerged as a coal hub for meeting regional thermal power station demand and attracting transshipment traffic due to its strategic location at the southern tip of India and proximity to east-west international trade routes.

Figure 33: Location of V.O. Chidambaranar Port Trust⁴⁸



⁴⁸ Voc.gov.in

The planned Inner Harbor expansion project will focus on deepening the harbor basin and approach channel to handle 15.2-meter draught vessels, the docking of larger container ships, modifying the port entrance, construction of six berths inside the harbor basin and strengthening/upgrading existing berths (berths 1-9, NCB-I and NCB-II). The expansion will enable the port to handle the anticipated growth in demand through 2025. In addition, the deeper channel will allow Tuticorin to compete with Sri Lanka's Colombo Port more effectively. The project is estimated to cost \$817 million.

PROJECT DESCRIPTION

India has a vast coastline of over 7,500 km, with 12 major ports and approximately 200 lesser ports scattered along its eastern and western coasts. Identified as one of India's major ports in 1974, V. O. Chidambaranar Port Trust (formerly Tuticorin Port Trust) is the second-largest port in Tamil Nadu, the fourth-largest container terminal in India, and a major port in Asia, equal in size to the Port of Singapore.

V. O. Chidambaranar Port is an artificial all-weather port located in the Gulf of Mannar, sheltered from storms and cyclones. The port currently has 14 berths with a capacity of 33.34 million metric tons per annum (mmtpa), all situated within two breakwaters (Figure 34). V. O. Chidambaranar, which initially focused on thermal coal for the Thoothukudiu Thermal Power Station, has diversified significantly. The port now handles timber logs, petroleum products, LPG, granite, salt, sugar, cement in bags, construction materials, and various other bulk, breakbulk and containerized cargoes, along with thermal coal.

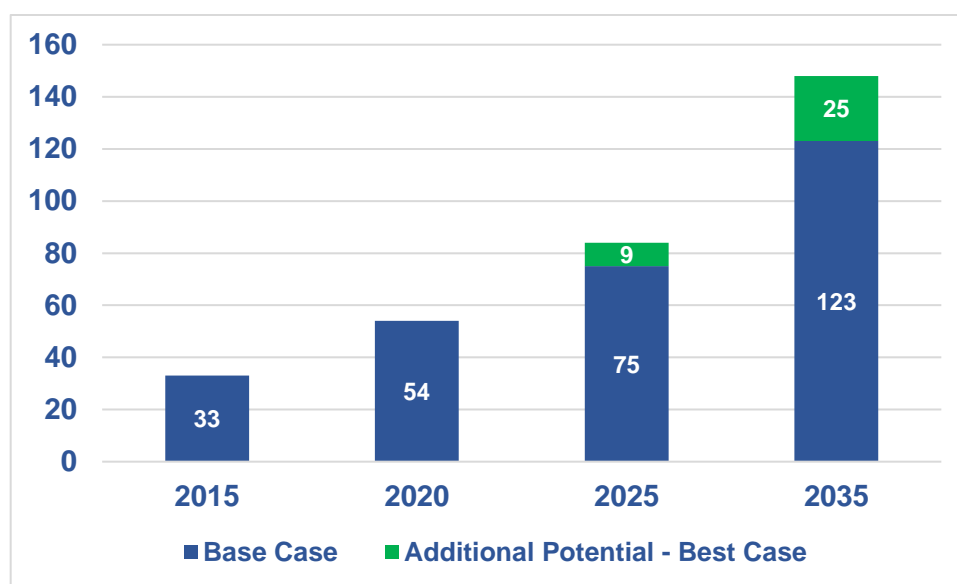
Figure 34: Satellite Image of V.O. Chidambaranar Port⁴⁹



⁴⁹ Sagarmala.gov.in

Port traffic projections in total and by category (Figures 35 and 36) indicate traffic may increase up to 84 mmtpa by 2025, a significant factor driving the inner harbor project.

Figure 35: Traffic Projections of V.O. Chidambaranar Port Trust⁵⁰



The proposed port expansion is within the existing harbor basin, with no additional land acquisition required for development. The harbor currently has a water depth of 14 meters, allowing ships with drafts up to 12.8 meters and cargo-carrying capacities of as much as 60,000 metric tons. The specific expansion plan is to:

- Increase the dock basin's depth to 16.5 meters and the approach channel to 17.2 meters to accommodate ships with drafts up to 15.2 meters.
- Increase the length of the approach channel from 3.8 km to 10.04 km.
- Widen the port's entrance from 153 meters to 230 meters to allow larger-sized vessels with a lengths overall (LOA) of up to 367 meters.

The planned inner harbor layout is designed to handle fully loaded Panamax vessels carrying 90,000 metric tons of cargo and requiring drafts of 15.2 meters (Figure 37). The inner harbor area will be optimized to ensure coal conveyor belts are economically accommodated. The widening of the inner harbor entrance and the dredging of the approach channel outside the present harbor entrance will eventually be integrated into the post-2025 outer harbor project, allowing seamless movement in and out of the harbor area.

⁵⁰ Vocport.gov.in

- **Phase One:** Construction of breakwater/reclamation bund; widening of the port entrance; dredging the approach channel and basin in front of CJ-I, CJ-II, Berth1-9, NCB-I and NCB-II (11.45 million cubic meters); and strengthening Berths 1-6.
- **Phase Two:** Dredging in front of NCB-IV, GCB-2, SEPC berth, navy and coast guard berths (3.75 million cubic meters); construction of new berths NCB-IV, CJ-III, GCB-I, GCB-II, SEPC & SDB; and strengthening Berths 7-9, NCB-I.

Navigational aids will include 12 channel marker buoys, six red channel marker buoys, six green channel marker buoys, and a fairway buoy to guide the vessels into the harbor. The existing channel transit light tower will be shifted and aligned with the new channel. VOCPT plans to relocate the Vessel Traffic Management System (VTMS) tower situated on the southern pier to a suitable location.

VOCPT will dredge a total volume of 16 million cubic meters. Materials removed will provide fill for a 1.51 sq. km area for both the proposed container terminal and a road and rail connectivity area for the future outer harbor project.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

On Feb. 25, 2019, the Ministry of Environment, Forest & Climate Change granted both an environmental clearance (EC) and a coastal regulation zone (CRZ) clearance for the project.

The Indian Institute of Technology (IIT) Chennai is preparing the detailed project report (DPR), which is expected to be complete during 2021. Bids for various components and associated contracts will be awarded post-DPR completion. Contract awards are subject to approval by the Ministry.

The appointed project consultants currently include the following (Table 15):

Table 15: Consultants Advising the V.O. Chidambaranar Port Inner Harbor Expansion

Consultant	Scope of Work	Contact Information
L&T Infrastructure Engineering Limited (L&TIEL)	Preparation of pre-feasibility report and detailed project report (DPR) for deepening of the harbor basin and approach channel	C3- C7, Triton Square, 4th floor, Thiru. Vi. Ka. Industrial EGuindy, Chennai, Tamil Nadu India Ph. +91 44 22509999 www.lntiel.com
SBI Capital Markets Limited	Financial consultant/arranger	02, Maker Tower 'E', Cuffe Parade Mumbai, Maharashtra India Ph. +91 22 22178300 www.sbicans.com
Cholamandalam MS Risk Services Limited	Environment impact assessment (EIA) consultant	4th Floor, "Parry House", N.S.C Bose Road, Parrys Chennai, Tamil Nadu India Ph. 91 44 30445620 www.cholarisk.com
Institute of Remote Sensing (IRS)	Remote Sensing/ Demarcation of high tide line, low tide line and coastal regulation zone (CRZ)	Anna University Chennai, Tamil Nadu India Ph.+91 44 2235 8156 www.annauniv.edu/
Pentacle Consultants (India) Private Limited	Project Consultant	B/406, Pranik Chambers, Sakinaka Road, near Sakinaka Junction Andheri East Mumbai, Maharashtra India Ph +91 2266952533 www.pentacleconsultants.com/

PROJECT COST AND FINANCING

The total cost of the project is \$817 million. The Port Trust has appointed SBI Capital Markets Limited as the financial consultant responsible for raising a \$286 million term loan. VOCPT will fund the remaining \$531 million project cost.

U.S. EXPORT OPPORTUNITIES

Potential export opportunities for U.S. firms will include:


- Dredging contracts (typically awarded to international players for such large dredging projects).
- Detailed engineering and design services.
- Layout/facility planning and management services.
- Construction management services.
- Port security technology and training.
- Dry excavation services and equipment.
- Mathematical modeling.
- Soil investigation services and equipment.
- Dry excavation services and equipment.
- Construction management services.

Longer-term supply opportunities include:

- Software and user training.
- Navigational aids.
- Mechanized conveyor belts.
- Grab-type ship unloaders.
- Piping systems.
- Cargo management software.
- Vessel Traffic Management Systems (VTMS).
- Yard trucks.
- Conveyors and material handling equipment.
- Mobile cranes.
- Harbor mobile cranes (HMC).
- Pay loaders, dumpers, spreaders, and track hoppers.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
<p>V.O. Chidambaranar Port Trust Tuticorin 628004 Tamil Nadu, India</p> <p>www.vocport.gov.in</p>	<p>Indo-Pacific Region 1101 Wilson Blvd., Suite 1100 Arlington, VA 22209 USA Mr. Kevin Toothers Country Manager ktoothers@ustda.gov</p> <p>U.S. Trade and Development Agency U.S. Embassy in Delhi Shantipath Chanakyapuri, New Delhi Delhi 110021 India Ms. Mehnaz Ansari Senior Regional Representative, South Asia mansari@ustda.gov IndoPacific@ustda.gov www.ustda.gov</p>	<p>U.S. Commercial Service U.S. Consulate General, Chennai 220, Anna Salai, Chennai – 600 006 India Mr. Sham Shamsudeen Commercial Specialist sham.shamsudeen@trade.gov</p> <p>www.trade.gov</p>

Outer Harbor Development Project at V.O. Chidambaranar Port (Tuticorin Port)		
	SECTOR	Transportation Infrastructure
	SUBSECTOR	Ports
	LOCATION	Tuticorin, Tamil Nadu
	PROJECT VALUE	\$3 Billion

PROJECT SUMMARY

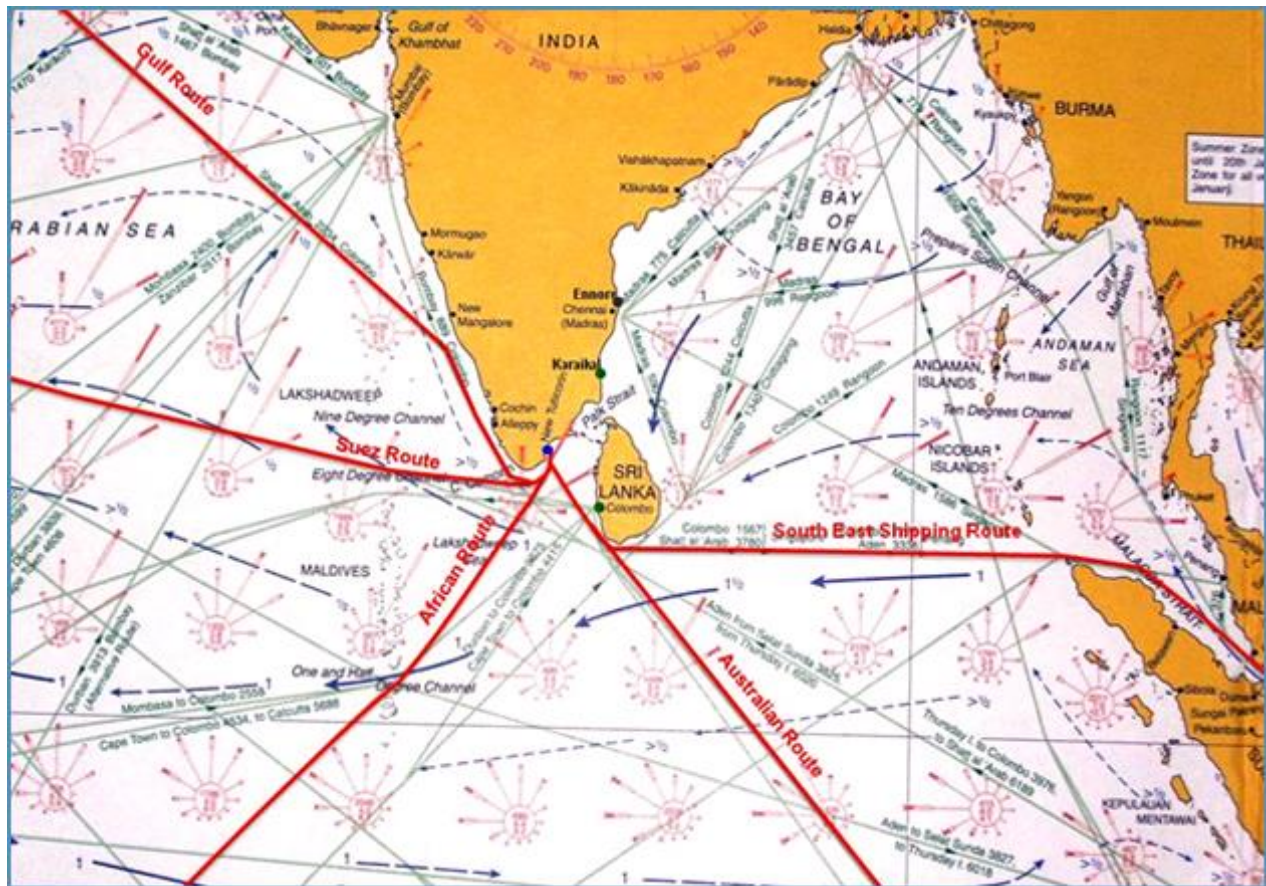
V.O. Chidambaranar Port Trust (VOCPT), Tuticorin, is planning an outer harbor project to support regional traffic growth. Located in the state of Tamil Nadu on the south-east coast of India, the port is one of 12 major Indian ports. Tuticorin is emerging as both a coal hub for meeting regional thermal power station demand and attracting transshipment traffic due to its strategic location at the southern tip of the Indian sub-continent and proximity to east-west international trade routes.

VOCPT has planned a separate Inner Harbor Expansion Project to meet demand through 2025, while the Outer Harbor Development Project meets post-2025 demand. VOCPT expects the outer harbor to handle an estimated 217.50 million metric tons per annum (mmtpa) of cargo at full capacity, with the total cost projected to be \$3 billion.

PROJECT DESCRIPTION

India has a vast coastline of over 7,500 km, with 12 major ports and approximately 200 lesser ports scattered along its eastern and western coasts. Identified as one of India's major ports in 1974, V. O. Chidambaram Port Trust (formerly Tuticorin Port Trust) is the second-largest port in Tamil Nadu, the fourth-largest container terminal in India, and a major port in Asia, equal in size to the Port of Singapore (Figure 38).

Figure 38: Location of V.O. Chidambaranar Port Trust⁵³



V. O. Chidambaranar Port is an artificial all-weather port located in the Gulf of Mannar, sheltered from storms and cyclones. The port currently has 14 berths with a capacity of 33.34 million metric tons per annum (mmtpa), all situated within two breakwaters (Figure 39). V. O. Chidambaranar, which initially focused on thermal coal for the Thoothukudio Thermal Power Station, has diversified significantly. The port now handles timber logs, petroleum products, LPG, granite, salt, sugar, cement in bags, construction materials, and various other bulk, breakbulk and containerized cargoes, along with thermal coal.

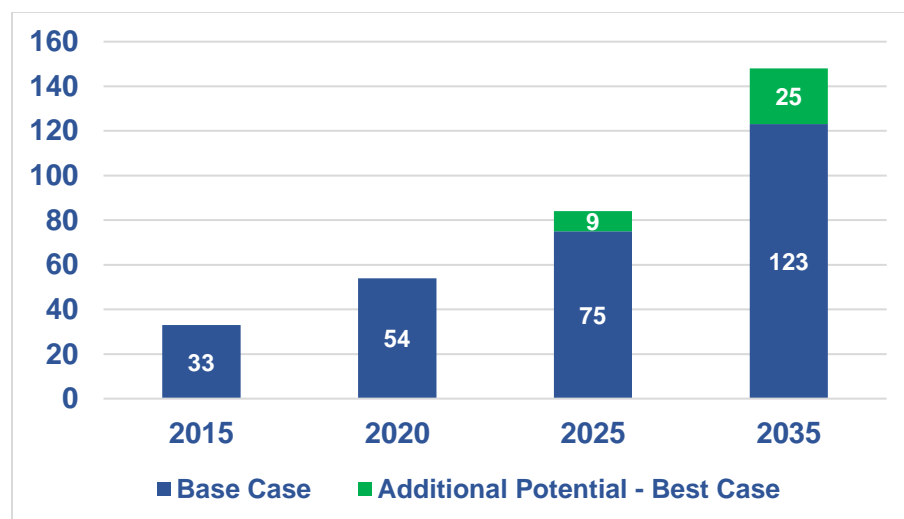
⁵³ Voc.gov.in

Figure 39: Satellite Image of V.O. Chidambaranar Port⁵⁴



VOCPT expects traffic to increase to 84 mmtpa by 2025 and 148 mmtpa by 2035 (Figures 40 and 41). VOCPT will expand the current inner harbor to meet demand through 2025. To meet demand beyond 2025, VOCPT will increase capacity by extending the present breakwaters and developing the proposed Outer Harbor Project.

Figure 40: Traffic Projections of V.O. Chidambaranar Port Trust (mmtpa)⁵⁵



⁵⁴ Sagarmala.gov.in

⁵⁵ Vocport.gov.in

Figure 41: Traffic Projections in mmtpa of V.O. Chidambaranar Port Trust by Category⁵⁶

Units: MMTPA (except Containers)

xx

Base Scenario

xx

Optimistic Scenario

Tuticorin Port - Traffic Projections

Commodity	2014-15	2020	2025	2035	Remarks	
Liquid Cargo						
POL	0.6	0.8	1.3	1.8	2.0	2.5
Dry and Break Bulk Cargo						
Thermal Coal (Loading)	0.0	0.0	0.0	0.0	0.0	0.0
Thermal Coal (Unloading)	13.8	26.5	38.3	42.3	63.4	75.8
Coking Coal	0.0	0.0	0.0	0.0	0.0	0.0
Iron Ore	0.05	0.06	0.08	0.09	0.14	0.17
Limestone	0.8	1.1	1.5	1.6	2.7	3.1
Other Ore	1.2	1.7	2.2	2.3	3.7	4.2
Fertilizers	1.5	1.6	2.0	2.1	3.1	3.4
Containers and other Cargo						
Containers (MnTEU)*	0.56	0.99	1.18	1.45	1.95	2.44
Others	3.5	4.4	5.9	6.2	9.7	11.1
Total (MMTPA)	32.5	55.7	74.5	85.0	123.2	148.6

* Due to the development of transshipment hub at Enayam, part of the traffic from Coimbatore, Namakkal, Madurai will directly go to Enayam via road hence diverting traffic away from VOC port

Conversion Factor Used for Containers Projections: 1 TEU = 19.7 Tons

VOCPT initially announced the Outer Harbor Development Project in 2013-14. The project scope was revised and finalized in July 2015. The Outer Harbor project will be executed in three phases at an estimated cost of \$3 billion. The project includes the development of 18 berths (six coal, 11 container and one POL), with a total capacity of 217.5 mmtpa. VOCPT has completed a Master Plan Layout (Figure 42).

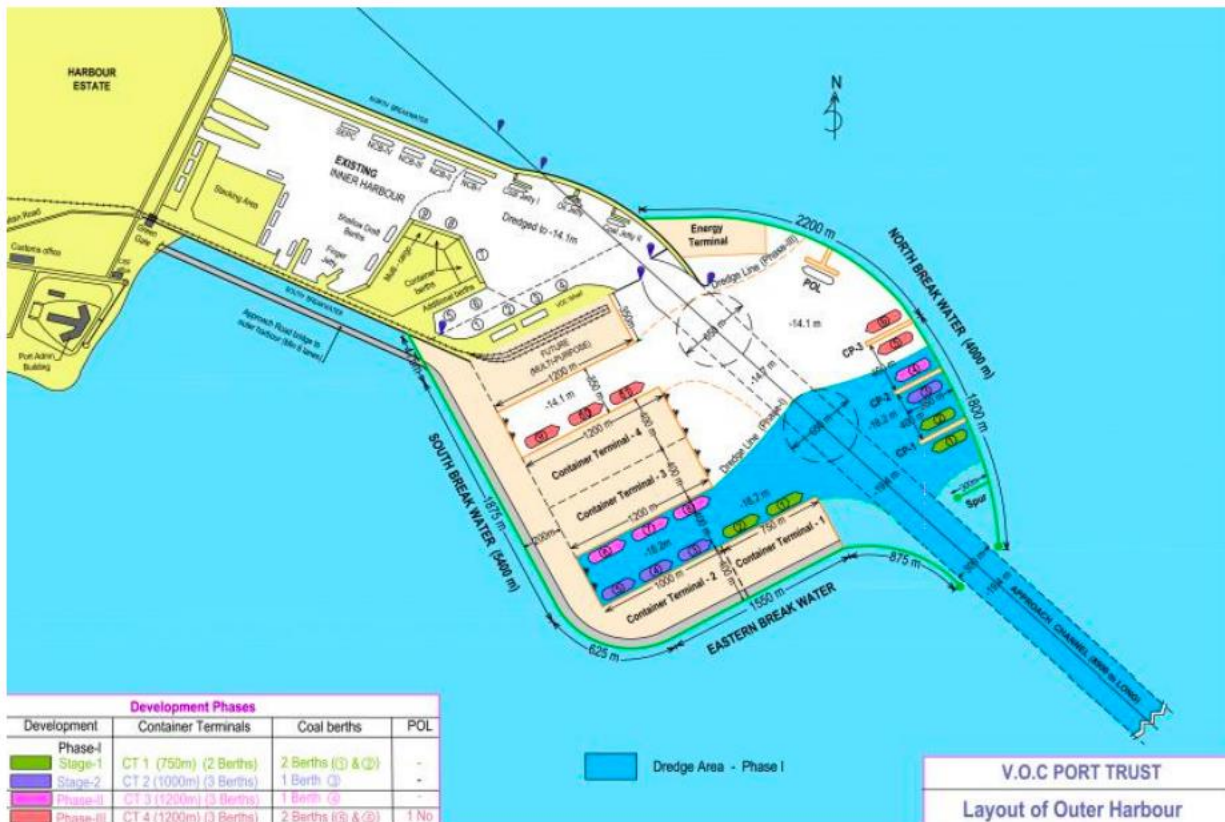
VOCPT plans to extend the north breakwater by 4,512 meters and the southern breakwater by 5,399 meters. VOCPT will also widen the existing channel to 300 meters and construct a new turning circle with a 680-meter diameter. The project timeline, consistent with the 2016 Sagarmala Report, is:

- To be completed by 2025:
 - Breakwater and dredging activities.
 - Phase One: construction of four berths (two container, two coal).
 - The estimated investment is \$1.95 billion.
- To be completed by 2035:
 - Phase Two: construction of seven berths (five container, two coal).
 - The estimated investment is \$36 million.
- Post-2035:

⁵⁶ ibid

- Phase Three: construction of seven berths (four container, two coal, one POL).
- The estimated investment is \$640 million.

Figure 42: Port Master Plan Layout - Inner Harbor⁵⁷



PROJECT STATUS AND IMPLEMENTATION TIMELINE

The Sagarmala Plan 2016 recommended the outer harbor project focus on building capacity to meet post-2025 traffic projections. The project is in its planning stage and the PPP operator has not yet been selected. However, as the breakwater and dredging activities and the construction of four berths will need to be completed by 2025, a request for proposal (RFP) for developing the Detailed Project Report (DPR) is likely to be announced soon.

PROJECT COST AND FINANCING

The total project cost is estimated to be \$3 billion, of which \$1.5 billion will be provided by the VOCPT, and the remaining \$1.5 billion will be funded by the PPP operator. To support the Port Authority financing, the Indian Navy will provide \$150 million and the central government will

⁵⁷ Sagarmala.gov.in

provide an as-yet-undefined sum under the Sagarmala Plan. Financing details are still being developed.

U.S. EXPORT OPPORTUNITIES

The potential export opportunities for U.S. firms will be with the PPP partner(s) in providing:


- DPR contracts.
- Dredging contracts (typically awarded to international players for such large dredging projects).
- Detailed engineering and design services.
- Layout/facility planning and management services.
- Construction management services.
- Port security technology and training.
- Dry excavation services and equipment.

There will also be longer-term supply opportunities for:

- Bulk cargo management equipment, including:
 - Silos.
 - Front-wheel loaders.
 - Conveyor belts.
 - Grab-type ship unloaders.
 - Piping systems.
 - Storage tanks.
- Cargo management software.
- Yard trucks.
- Conveyors and material handling equipment.
- Mobile cranes.
- Harbor mobile cranes (HMC).
- Ship-to-shore container cranes.
- Reach stackers, straddle carriers.
- Pay loaders, dumpers, spreaders, and track hoppers.
- Spreaders for containers.
- Lashing cages and equipment.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
<p>V.O. Chidambaranar Port Trust Tuticorin 628004 Tamil Nadu, India</p> <p>www.vocport.gov.in</p>	<p>Indo-Pacific Region 1101 Wilson Blvd., Suite 1100 Arlington, VA 22209 USA Mr. Kevin Toothers Country Manager ktoothers@ustda.gov</p> <p>U.S. Trade and Development Agency U.S. Embassy in Delhi Shantipath Chanakyapuri, New Delhi Delhi 110021 India Ms. Mehnaz Ansari Senior Regional Representative, South Asia mansari@ustda.gov</p> <p>IndoPacific@ustda.gov www.ustda.gov</p>	<p>U.S. Commercial Service U.S. Consulate General, Chennai 220, Anna Salai, Chennai – 600 006 India Mr. Sham Shamsudeen Commercial Specialist sham.shamsudeen@trade.gov</p> <p>www.trade.gov</p>

Paradip Port (Phase 1) – Western Dock Development		
	SECTOR	Transportation Infrastructure
	SUBSECTOR	Ports
	LOCATION	Paradip, Odisha, India
	PROJECT VALUE	\$432 Million

PROJECT SUMMARY

Paradip Port, operated by Paradip Port Trust (PPT), is one of India's major ports. In the east Indian state of Odisha, the port is near the confluence of the river Mahanadi and the Bay of Bengal.

The Western Dock project involves deepening the port plus construction of Western Dock Captive (WDC) berths to handle cape-size vessels. The project has an estimated cost of \$432 million. The proposed berths will have a handling capacity of 25 million metric tonnes per annum (mmta). PPT will develop the berths on a design, build, finance, operate, transfer (DBFOT) basis, managed and financed as a public-private partnership (PPP).

PROJECT DESCRIPTION

India has a vast coastline of over 7,500 km, with 12 major ports and approximately 200 lesser ports scattered along its eastern and western coasts. The Paradip Port, operated by PPT, is one of India's major ports. Total port traffic was 109.27 million metric tons (mmt) in 2018-19, compared to 102.01 mmt in 2017-18. Commodity traffic included the following:

- Crude oil.
- Petroleum, oil, and lubricant products.
- Iron ore.
- Thermal and coking coal.
- Chrome ore, charge chrome and ferrochrome.
- Manganese ore and ferromanganese.
- Limestone.
- Hard coke.
- Ingots, molds, billets and finished steel, as well as scrap.
- Fertilizers and fertilizer raw materials.
- Clinker.
- Gypsum.
- Assorted project cargo and containers.

Paradip Port, built on an artificial lagoon, is protected by two breakwaters (Figure 43). The port's approach and entrance channels have a minimum depth of 17.1 meters, allowing a wide range of vessels to be serviced, up to a maximum length overall (LOA) of 260 meters. The port has six berths, which can handle fully-loaded Panamax vessels.

Figure 43: Existing Paradip Port Layout⁵⁸



The existing port cargo capacity is 118.5 mmtpa. With the emergence and rapid development of industries in relative proximity to Paradip, there has been an urgent need to expand port capacity, especially to service cape-size vessels, to handle increasing port traffic (Table 16).

PPT has received environmental clearance for the overall Paradip Port project, including:

- Inner harbor expansion.
- Berth mechanization.
- Western Dock Expansion (this project).
- Outer Harbor Development.

⁵⁸ Paradip Port Trust

Table 16: Master Plan Traffic Projections at Paradip Port⁵⁹

Cargo Handled	I/E	Current Capacity (MTPA)	2020		2025		2035	
			Projected Traffic (MTPA)	Capacity Augmentation required over current (MTPA)	Projected Traffic (MTPA)	Capacity Augmentation required over current (MTPA)	Projected Traffic (MTPA)	Capacity Augmentation required over current (MTPA)
Coal - Export	E	33.21	95.00	61.79	135.00	101.79	200.00	166.79
Coal – Import	I	12.10	22.30	10.20	26.50	14.40	37.00	24.90
Breakbulk	I/E	14.76	11.64	0.00	17.03	2.27	28.81	14.05
Iron Ore	E	6.39	6.50	0.11	7.50	1.11	10.00	3.61
Fertiliser	I	7.50	5.60	0.00	7.00	0.00	10.50	3.00
Crude/ POL	I	54.50	35.20	0.00	41.80	0.00	47.50	0.00
Total		128.46	176.24	72.10	234.83	119.57	333.81	212.35

The full port expansion project will be developed in two phases and will provide 13 new deep draft berths, two of which will be part of the Western Dock Expansion. The new berths will cater to cape-size vessels of up to 225,000 deadweight tonnage (dwt). PPT is implementing the project under the Sagarmala scheme of the Ministry of Shipping (MoS), a program intended to optimize logistics in India by unlocking the potential of its waterways and coastline.

Today, Paradip Port has two docks, the Eastern Dock and the Central Dock, with a total of 14 berths. With significant traffic growth, vessel congestion has increased, despite mechanization installed to improve throughput and productivity. Initially, PPT had planned to develop the outer harbor during the first phase of the project. The Terms of Reference (ToR) for carrying out the environmental impact assessment (EIA) studies on the outer harbor were finalized by the Ministry of Environment, Forest and Climate Change (MoEFCC) in April 2017. Subsequently, PPT decided to address the outer harbor in the second phase and implement the Inner Harbor/Western Dock in the first phase.

Total capacity at Paradip Port will be 25 mmtpa, with Phases One and Two each adding 12.5 mmtpa of capacity. PPT is planning to develop common user terminals instead of captive berths for cargo, allowing participation from non-Port Dependent Industries (non-PDI) on a common user basis, further enhancing the economic attractiveness of the project. The approach is consistent with the Public-Private Partnership Appraisal Committee (PPPAC) Oct. 2019 recommendation.

The scope of work includes development, operation and maintenance of the 490 m x 280 m Western Dock, complete with berths and mechanized ancillary facilities, for a concessionary period of 30 years. PPT has a non-conventional dock layout planned, eliminating the need for a second swinging basin and incorporating 20-meter-high stockpiles due to tight land constraints.

⁵⁹ Sagarmala Master Plan for Paradip Port 2016, Ministry of Shipping/Indian Ports Association

Dry excavation has been suggested (in place of dredging) as a more cost-effective option and will enable the reuse of excavated material.

Aurecon Group prepared the detailed project report (DPR) in Jan. 2019. The layout of the project was prepared by the Indian Institute of Technology (IIT) - Madras.

Key consultants on the project are:

- Indian Institute of Technology (IIT) - project layout.
- McKinsey & Co. - techno-economic feasibility study (TEFR).
- AECOM India Pvt. Ltd. - a techno-economic feasibility study (TEFR).
- National Environmental Engineering Institute (NEERI) - environmental impact assessment.
- RITES Ltd. - feasibility report for setting up an inland container depot (ICD).

PROJECT STATUS AND IMPLEMENTATION TIMELINE

PPT has received the necessary environmental clearance and approvals for the project. The required land is already available within the Port Trust. Phase One is expected to be completed in 36 months from the start date. Phase Two will begin two years after Phase One's commissioning, with a planned completion period of 24 months.

PPT had initially planned to develop this facility by selecting a bidder who would be a PDI entity and do the detailed engineering. The initial Request for Qualification (RFQ) required bidders to submit broad details of their project proposals, overall layout drawings, and a pricing mechanism predicated on volume throughput. It was also to include a Rupees per Metric Tonne fee to be realized by PPT. On Oct. 12, 2018, PPT issued RFQs to select project developers but extended the due date twice.

By Aug. 2019, only three firms—Tata Steel Limited (TSL), Adani Ports, and Special Economic Zone Limited (APSEZ) and Essar Ports Limited (EPL)—had bid. Following this process, the Department of Economic Affairs submitted an objection, arguing the qualification criteria were unduly restrictive and that limited competition and the bid process had led to a lack of interest by bidders unconnected to the PPT. Niti Aayog, Planning Commission, Government of India, further noted that developing the port as a PPP would not require bidding restrictions on non-PDIs. After further review by MoS and PPT, MoS revised the bidding criteria. The new proposal states that all players (including PDIs) are eligible to compete on a common user basis for the project.

Bid Invitation and Award – Current Status

On Feb. 20, 2020, PPT invited bids to select a project developer, with the last date for bid submission extended from July 3, 2020 to Aug. 18, 2020. The eligibility criteria recommended for PDIs are consistent with the Captive Berth Policy, while non-PDI players must meet the RFQ qualifications of the Department of Expenditure. The financial criteria for both PDI and non-PDI players is a minimum net worth equal to 50 percent of the total project cost. The bids are still being evaluated.

PROJECT COST AND FINANCING

The Western Dock, a \$432 million project (escalated from \$300 million in Jan. 2020), is part of a larger PPT port development initiative. Bids submitted are currently under review. The project will be structured as a public-private partnership.

PPT will spend \$141 million to extend the breakwater and deepen the channel/berths to allow cape-size vessels to dock. PPT expects the private operator to invest \$290 million.

The contract terms include a clause on a minimum guaranteed cargo of 70 percent to protect the income of PPT. There is also a 20 percent total project cost performance guarantee, with high penalties for non-achievement of specified milestones. The PPPAC recommendation has been forwarded to the Cabinet for clearance ahead of issuing the call for bids. PPT has set a floor royalty rate of Rs 46.69 (\$0.66) per metric tonne for the project, with the contract being awarded to the bidder quoting the highest royalty per metric tonne above floor rate.

U.S. EXPORT OPPORTUNITIES

The potential export opportunities for U.S. firms will be to work with the PPP partner in providing:


- Detailed engineering and design services.
- Dry excavation services and equipment.
- Layout/facility planning and management services.
- Construction management services.
- Supply of terminal management and berthing aids.
- Software and user training.
- Port security technology and training.
- Bulk cargo management equipment, including:
 - Silos.
 - Front-wheel loaders.
 - Conveyor belts.
 - Grab-type ship unloaders.
 - Piping systems.
 - Storage tanks.

Longer-term supply opportunities will include:

- Cargo management software.
- Yard trucks.
- Conveyors and material handling equipment.
- Mobile cranes.
- Harbor mobile cranes (HMC).
- Pay loaders, dumpers, spreaders, and track hoppers.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
<p>Project Implementation Office Admin Building Paradip Port Trust Odisha -754 142 India Superintending Engineer (H) Project Implementation Office sehpioppt@gmail.co www.paradiport.gov.in</p>	<p>Indo-Pacific Region 1101 Wilson Blvd., Suite 1100 Arlington, VA 22209 USA Mr. Kevin Toothers Country Manager ktoothers@ustda.gov U.S. Trade and Development Agency U.S. Embassy in Delhi Shantipath Chanakyapuri, New Delhi Delhi 110021 India Ms. Mehnaz Ansari Senior Regional Representative, South Asia mansari@ustda.gov IndoPacific@ustda.gov www.ustda.gov</p>	<p>U.S. Commercial Service U.S. Consulate General, Chennai 220, Anna Salai, Chennai – 600 006 Mr. Sham Shamsudeen Commercial Specialist sham.shamsudeen@trade.gov www.trade.gov</p>

Bhanupali-Bilaspur-Beri New Rail Line		
	SECTOR	Transportation Infrastructure
	SUB SECTOR	Railways
	LOCATION	Bhanupali, Punjab Bilaspur & Beri, Himanchal Pradesh
	PROJECT VALUE	\$1.03 Billion

PROJECT SUMMARY

Rail Vikas Nigam Limited (RVNL) is constructing a new 63.1-kilometer railway line from Bhanupali to Beri via Bilaspur in the states of Punjab and Himachal Pradesh. The government has designated the project as a National Project due to its strategic importance. The rail line will be operational in 2026.

PROJECT DESCRIPTION

The 115,000 km Indian railway (Figure 44) is among the world's largest rail networks under single management. Daily operations include 12,617 passenger trains, 7,421 freight trains, and 7,349 rail stations transporting 23 million travelers and 3 million tonnes (mt) of freight. In the next five years, the Indian railway market will account for 10 percent of global traffic.

To modernize its operations and infrastructure for both passenger and commercial traffic, while also introducing high-speed trains, RVNL has formulated investor-friendly policies to attract domestic and foreign direct investment. At present, several domestic and foreign companies are seeking to invest in Indian rail projects.

Priority areas for investments identified by the Indian government include:

- Enhancing network capacity and upgrading rolling stock in the northeast.
- Complete electrification of all routes, creating dedicated freight corridors and high-speed corridors.
- Replacement and maintenance of older tracks.
- Upgrading stations.
- Building new stretches of railway and related infrastructure in frontier areas.

Figure 44: Indian Railway Map⁶⁰



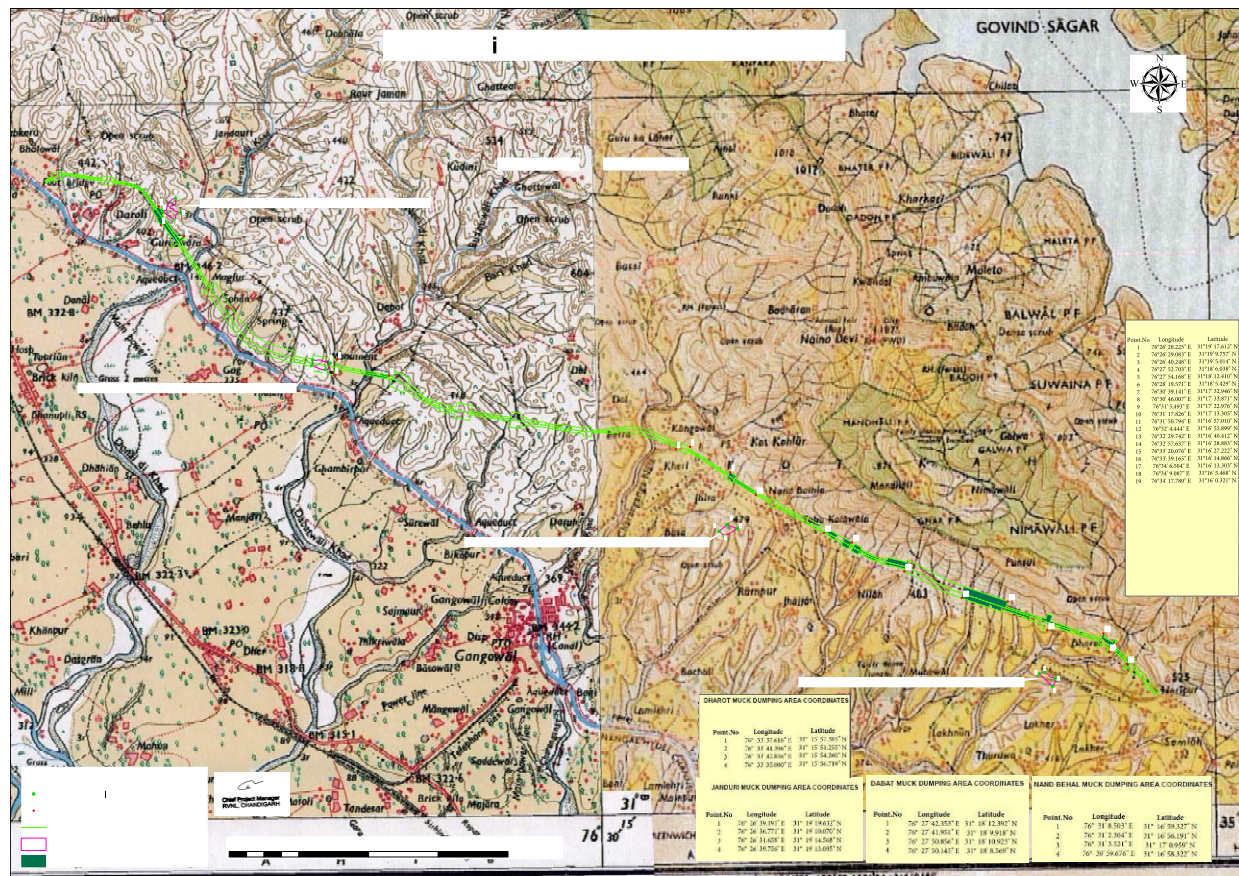
RVNL has designed the Bhanupali-Bilaspur-Bena new rail line project (Figure 45) to connect the hilly terrain frontier state of Himachal Pradesh with the rest of the Indian railway network. The two-phase, 63.1 km line construction includes numerous bridges and tunnels. Phase One encompasses the construction of the 20-km Bilaspur-Dharot section, while Phase Two comprises the remaining 43 km.

RVNL will employ the New Austrian Tunnel Method (NATM) technology to construct the rail line. The width of this broad-gauge line will be 1674 mms. RVNL will build five major bridges and six-stations:

- Tallu (Punjab).
- Dharot.
- Zakatkhana.
- Bilaspur.
- Bari Baramana.
- Govindsagar (near Bilaspur city) - including a major junction.

⁶⁰ Indiarailinfo.com

Figure 45: Alignment of the Bhanupali-Bilaspur-Bena Rail Line⁶¹



The project, which began in 2017, will span the next six years. Key steps have commenced:

- From 2016 to 2019, RVNL awarded civil engineering, geotechnical surveys, project management consultancy, and tunnel work totalling \$172 million for approximately 20 km of the 63 km project, or nearly 34 percent of the total project distance.
- In Feb. 2019, RVNL issued contracts worth \$570,000 for the detailed design and project management consultancy (PMC) services for related minor bridges, tunnels, and structural formations.
- In April 2019, RVNL awarded a contract for constructing seven tunnels and related minor bridges and associated infrastructure worth \$66 million.
- In Oct. 2019, RVNL awarded a contract to build foundations, substructures and superstructures, river draining/protection activities and supporting civil engineering for five railway bridges over Donal Khad, Dabatwali Khad, Balaknath Khad, Dharot I Nala and Dharot II Nala.
- Bids to provide related project management consultancy (PMC) services were opened in Oct. 2019.

⁶¹ Forestclearance.nic.in

Several organizations are already involved in the construction of the line (Table 17):

Table 17: Organizations Involved in Current Construction

Consultant	Contact Details	Scope of Work
RITES Limited	RITES Bhawan, No.1, Sector 29 Gurgaon, Haryana, India Ph +91 124 2571666 www.rites.com	Detailed investigation of the land acquisition proceedings
AECOM India Private Limited	5th Floor, Tower-B, Building No-10, DLF Cyber DLF Phase-II Haryana, India Ph +91 124 4830250 www.aecom.com	Providing detailed design and project management consultancy (PMC) services for the construction of tunnels and works related to minor bridges and formation on approaches of such tunnels from 3.5 km to 20 km of the project.
Geological Survey of India (GSI)	27, J.L. Nehru Road Kolkata, West Bengal, India Ph +91 33 22861676 www.portal.gsi.gov.in	Detailed geological investigation of the site for construction work
Data Technosys (Engineers) Private Limited	T. F. – II, Asha Apartments-I, 19, Ram Mohan Rai Marg Lucknow, Uttar Pradesh, India Ph +91 522 404303 http://datatechnosys.com/	Providing project management consultancy (PMC) services for the construction of roadbed, major and minor bridges including fabrication, erection, and launching of open web steel girders from 0 km to 3.5 km, general electrical works, and other allied works
Department of Anthropology, Panjab University	Sector 14 Chandigarh, Punjab, India Ph +91 172 253 4299 www.puchd.ac.in	Preparation of social impact assessment report
Max Infra (India) Limited	Survey No:120/4 Dommara Pochampally, Gandhi, Hyderabad Telangana, India +91 7797646864 http://www.necltd.com	Construction of seven tunnels including cut and cover, ballastless railway track, civil work on minor bridges, slope protection works and allied works from chainage 3.5 km to 20 km for the project.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

The railway was declared a national project in 2007 and gained Railway Board approval in 2008. From 2016 to 2019, civil engineering, geotechnical surveys, project management consulting, and tunnel work were awarded for approximately 20 km of the 63 km project, or 34 percent of the total project distance. The process for bidding and planning for the remainder of the project has been initiated by RVNL. The project is expected to be completed in Dec. 2026.

Invited bids during 2020 include the following:

- **Detailed design and drawing of foundation, substructure and superstructure, and river training/protection works for railway bridges and viaducts from the 20 km mark to Beri.** The last date for bid submission was June 9, 2020. Required completion time is 10 months, with an estimated cost of \$ 0.5 million. Due to delays resulting from the COVID-19 global pandemic, bid technical evaluations are not yet complete and RVNL has not yet made an award.
- **Bids to provide PMC services to construct tunnels from chainage 20.89 to 32.1 km, as well as works related to minor bridges and tunnel approaches.** The last date for bid submission was July 22, 2020. Required completion time is eight months at an estimated cost of \$6 million. Again, due to delays resulting from the COVID-19 global pandemic, bid technical evaluations are not yet complete, and no award has been made.
- **Request for Proposal (RFP) bids for construction of tunnels T-11 to T-16 from chainage 31.8 to 48.96 km, station yards and works related to minor bridges and tunnel approaches.** The last date for bid submission was July 28, 2020. Required completion time is eight months. Again, due to delays resulting from the COVID-19 global pandemic, bid technical evaluations are not yet complete, and no award has been made.

PROJECT COST AND FINANCING

The cost of the project is \$1.03 billion, or roughly \$16.3 million per kilometer. The Ministry of Railways (MoR) and the State Government will split the cost on a 75/25 percent basis. The Ministry of Finance (MoF) will provide part of the overall funding.


U.S. EXPORT OPPORTUNITIES

Export opportunities for U.S. firms include bidding for EPC contracts, as more than 60 percent of the project has yet to commence. Additional opportunities exist in:

- Station development.
- Track safety.
- Maintenance equipment.
- Mechanical and electro-mechanical signaling equipment.
- Parking and depot systems.
- Communication modules.

- Rail projects require local representation, either through an agent, distributor, manufacturing partner or associate. These entities can assist U.S. companies in positioning their tenders for success, including helping to define cost competitiveness and local requirements.

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
<p>Rail Vikas Nigam Limited (RVNL) Plot No. 25, First Floor, August Kranti Bhawan, Bhikaji Cama Place R. K. Puram 110066 New Delhi, India www.rvnl.org</p>	<p>Indo-Pacific Region 1101 Wilson Blvd., Suite 1100 Arlington, VA 22209 USA Mr. Kevin Toohers Country Manager ktoohers@ustda.gov</p> <p>U.S. Trade and Development Agency U.S. Embassy in Delhi Shantipath Chanakyapuri, New Delhi Delhi 110021 India Ms. Mehnaz Ansari Senior Regional Representative, South Asia mansari@ustda.gov IndoPacific@ustda.gov www.ustda.gov</p>	<p>U.S. Commercial Service The American Center 24 Kasturba Gandhi Marg New Delhi 100 001 91-11-2347-2000 India Renie Subin Commercial Specialist renie.subin@trade.gov</p>

Jammu – Baramulla Railway		
	SECTOR	Transportation Infrastructure
	SUBSECTOR	Railways
	LOCATION	Jammu and Kashmir, India
	PROJECT VALUE	\$4.60 Billion

PROJECT SUMMARY

A 356-kilometer (km) railway line will join the Kashmir Valley with the Indian Railways (IR) network from Jammu to Baramulla via Udhampur, Katra and Qazigund. The line will provide an alternate and reliable transportation system to the Jammu and Kashmir region, which faces challenges due to its mountainous terrain. Declared as a project of national importance, the Jammu-Udhampur (64 km) railway section, inaugurated in April 2005, remains unfinished, with a 292 km portion from Udhampur to Baramulla in various stages of progress.

The Jammu-Baramulla line may be the most difficult railway engineering challenge undertaken on the Indian subcontinent given unusual topographic and weather considerations. The project will have unique features representing several firsts for Indian Railways. The Indian Government has approved the 39-km extension of the Jammu-Baramulla Railway line to Kupwara. An updated aerial survey for the new Baramulla-Kupwara rail link was approved in July 2020. The estimated cost for this additional section is \$550 million.

PROJECT DESCRIPTION

Indian Railways (IR) is constructing the 356-km Jammu–Baramulla railway line to connect the Kashmir Valley to the already well-connected Jammu railway station, with onward service to the rest of the country. The project is in the jurisdiction of the Firozpur railway division of IR's Northern zone. This project is highly complex due to terrain challenges, requiring several bridges and tunnels along the route. The Chenab River Rail Bridge will be the tallest rail bridge in the world once completed.

IR suspended the project in 2008 due to construction challenges. The alignment plan of the entire project was then reviewed and resubmitted to the Railway Board. The final alignment plan (Figure 46) was approved in 2009.

Figure 46: Alignment Plan of the Jammu – Baramulla Rail Line⁶²



Of the total 356-km length, the Jammu-Udhampur section (64 km) is already operational. IR has divided the 292-km distance from Udhampur to Baramulla into three sections currently at varying stages of implementation and completion (Table 18):

Leg 1 - Udhampur-Katra (25 km) - Completed: This section was executed by Northern Railways (NR) at an estimated cost of \$163 million and involved nearly 11 km of tunnels, nine major bridges, 29 minor bridges, and 10 road-over-bridge (RoB)/road-under bridge (RuB) elements, in addition to 3.89 million tons of earthwork. The tallest bridge in this section is 85m high, and the longest tunnel is 3.15km long. The rail line enables pilgrims to reach one of India's highest religious tourist points (Vaishno Devi shrine) and travel directly to the Katra base camp of the shrine. The Katra Railway station has modern facilities with escalators, elevators, a VIP lounge, a fully air-conditioned hotel, a shopping lounge, a multi-cuisine restaurant and large parking areas. The project's construction work was completed in Feb. 2014 and the leg became operational on July 4, 2014.

Leg 2 - Katra-Qazigund (129 km) - Under Construction: IR has scheduled this section for completion in 2022 with an investment of \$3.4 billion, of which \$3.18 billion is estimated for the Katra-Banihal section and the remaining \$249 million investment for the Banihal-Qazigund section. This area is the line's most complex and challenging section,

⁶² USBRL

including 62 bridges and several tunnels totaling 10 km. The bridges will include the 1,315-meter-long Chenab River Rail Bridge to be built at a height of 359 meters.

Table 18: Elements of the Udhampur to Baramulla Rail Line⁶³

Item	Udhampur – Katra	Katra - Qazigund	Qazigund - Baramulla
Route length (km)	25	129*	119
Number of bridges	38	62	811
Total tunnels length (km)	10.90	103.00	0
Max. height of bridge (m)	85	359	22
Longest tunnel (km)	3.15	10.96	-
Number of stations	3	10+1	15
Max. curvature	2.75 ^o	2.75 ^o	2.75 ^o
Max. bridge height (m)	85	359	22
Longest span	154 m Steel Girder over Jhajjar River	467 m Steel Arch over Chenab River	45 m
Longest tunnel	3.15 km	10.96 km	-
Max. cutting depth	20 m	40 m	
*This project has various special & unique features and several firsts for Indian Railways.			

The Chenab River Rail Bridge will be the tallest in the world (Figure 47). Installation of the main arch between the two sides of the bridge has begun (Figure 48). The construction of the bridge began in 2004. IR stopped work in 2008-09 as a result of frequent, high-velocity winds.

The bridge will have railway stations at both terminal ends. IR will install sensors on the bridge to monitor the wind velocity. When wind speed exceeds 90 kmph, the signal on the railway track will turn red and stop any train movement. IR has designed the bridge to withstand winds up to 260 kmph. Norway-based Force Technology Laboratory conducted several wind tunnel tests to understand the effects of wind speed, static force coefficients and gust buffeting. IR also considered the seismic nature of the project zone during its design.

⁶³ IRICEN

Figure 47: Artist's Rendering - Chenab Bridge⁶⁴



Figure 48: Construction Progress - Chenab Bridge⁶⁵



⁶⁴ Structural Engineering Forum of India

⁶⁵ Railway Ministry

The bridge will include 17 spans in addition to the 469-meter main arch span across the Chenab River. IR will build viaducts on each side. The main span of the bridge will consist of two 36-meter long approach spans. IR is building the bridge as a 2-ribbed arch with steel trusses made of concrete-filled sealed steel boxes. Two 130-meter long, 100-meter-high pylons on either end through cables will support the structure. IR has selected steel to construct the bridge as it can resist temperatures of -20°C and wind speeds of above 200 km/h. Sixty-three-mm-thick, blast-proof steel will enhance safety and security. IR expects the structure to withstand Richter Scale Eight earthquakes and TNT blasts of up to 40 kg.

Leg 3 - Qazigund-Baramulla (119 km) - Completed: IRTC built this section in the Kashmir Valley, which is surrounded by mountain ranges. IR commissioned the entire section in 2009 at an estimated cost of \$513 million. A 39 km new Baramulla-Kupwara rail link project will be an extension.

Zone Six of this leg includes the Pir Panjal tunnel in the mountainous terrain in Jammu and Kashmir. At a length of 11 km, the tunnel is India's longest and Asia's second longest tunnel. This leg has reduced the travel distance between Qazigund and Banihal to 11 km and provides ease of travel to Baramulla. The tunnel has a finished width of 8.41 meters and a height of 7.39 meters, with a three-meter wide concrete road inside for maintenance and emergency relief.

Work currently in progress in the Katra-Qazigund section includes the following:

- Detailed design consultancy (DDC) services for tunnel ventilation and safety and electro-mechanical works for specified tunnels.
- Supply, installation, and monitoring of instrumentation during the construction of some tunnels.
- Design, supply, installation, testing and commissioning of 132/25 kV, 21.6/30.24 MVA, ONAN/ONAF (double transformer) traction substations in specified sections.
- Erection of the main arch of the Chenab river railway bridge, which entails carrying the heavy segments from two ends of the bridge (Kauri and Bakkal) and the world's longest cable crane arrangement.
- Design, supply, alteration, modification, installation, testing and commissioning of existing electronic interlocking (EI)-based signaling and telecommunication (S&T) systems, including TPC communications to suit reinforced earth (RE) at specified stations.
- Design of broad-gauge ballastless tracks, including supply, installation, testing and commissioning in the Katra-Dharam section at 39.201 km, 42.21 km and from 51.935 to 61.687 km of the project, with period of completion of 24 months.
- Design of broad-gauge ballastless tracks including supply, installation, testing and commissioning in the Katra-Dharam section from 91.2 to 101.632 km.
- Manufacture, supply, transportation, and delivery of prime quality of UIC 60 kg 1,080-grade head hardened class A rails per IR standard specifications for flat bottom rails (IRS-T-12-2009 with the latest A and C slips) at Katra, Reasi, Kauri, Dugga and Sangaldan for the Katra-Dharam section of the project.
- Provision of electro-mechanical (E&M) systems, including supply, erection, testing and commissioning of 33 kV and 11 kV HT power cable networks, gas-insulated substations (GIS), DG sets, tunnel ventilation systems (TVS), tunnel lighting, supervisory control and

data acquisition (SCADA) systems and firefighting systems, for tunnels T-6, T-9, T-10, T-11 and T-12 from 39 km to 61 km in Katra-Dharam section of the project.

Several consultants are advising the project:

- **Bernard Ingenieure, Austria** - detailed design consultancy and construction supervision of tunnels between 110 km and 125 km.
- **Lombardi Engineering India Private, Switzerland** - supervision consultancy services, detailed design consultancy for electrical and mechanical works, construction supervision of tunnels including 3-D monitoring and associated works between 110 km and 125 km.
- **Italferr S.p.A., Italy** - detailed design and construction supervision of a key river bridge on the Katra-Banihal section.
- **Flint & Neill Limited, U.K** - proof checking of designs and drawings, provision of technical guidance for a critical bridge in the Katra-Banihal section.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

The Jammu-Baramulla Railway project initially experienced delays but is now advancing on a fast track. Pre-construction surveys, geotechnical investigations, alignment studies, design of ventilation systems, fire escapes, emergency rescue, and other related electro-mechanical (E&M) systems are in place for different sections. Supervision consultancy and E&M design services for several of the tunnels, bridges, and sections are underway.

IR has approved the 39-km extension of the project to add the new Baramulla-Kupwara rail link. The project value of this section is \$550 million. The central government approved the project in 2018 and the Railway Board approved the aerial survey in July 2020. A Detailed Project Report (DPR) is in preparation at an advanced stage.

Construction work on the Chenab railway bridge in the Bakkal-Kauri section of the project resumed in May 2020, after being suspended in March 2020 due to the country lockdown resulting from the COVID-19 global pandemic. IR expects completion of the work by Aug. 2022, although delays are likely due to weather conditions. The main Katra-Banihal tunnel section of the project is 97,318 m, of which 77,897 m were completed in Sept. 2020.

At present, the project is 76 percent complete, with the balance targeted for completion by Dec. 2022. Nonetheless, further delays are likely due to the technical challenges associated with the remaining works. A more likely project completion date is 2025. The timeline for the 39-km extension of the new Baramulla-Kupwara rail link has not been determined.

During 2020, contract awards included:

- **ABCI Infrastructures Private Limited:** A \$24 million award for construction of the balance of the T-77D tunnel from chainage 146.6 km to 148.36 km in the Katra-Banihal section (on the western side of Bichelri River).
- **L&T Construction Limited:** A \$43 million project for supply, erection, testing, and commissioning of an electro-mechanical (E&M) system, including 33 kV and 11 kV high tension (HT) cable networks, gas-insulated substation (GIS) substations, DG sets, a tunnel ventilation system, tunnel lightning, a firefighting system, and a Supervisory Control and Data Acquisition (SCADA) system. Tunnels T-3 and T-5, from chainage 39 km to 52 km, on Katra-Dharam section are the subject of this work.

Bids, which have been invited and are under review, include the following:

- Design, manufacture, supply, installation, testing, and commissioning of an electronic-interlocking-based signaling system at Arpinchala and Sumber. The bid also requires provision of a combination six-quad-coax plus optic-fiber (OFC) based communications system in the Banihal-Arpinchala-Sumber single line in Dharam-Qazigund section of the project. MRT Signals Limited has emerged as the lowest bidder. However, IR has yet to award the project.
- Supply, erection, testing and commissioning of an E&M system which includes 33/11 kV and 11/0.433 kV GIS substations, a 33 kV and 11 kV power cable network, DG sets, a ventilation and control system, CCTV and a PA System, leaky cable, lighting, a UPS system, a firefighting system and a SCADA system, et al, as well as associated works for tunnel T-74R and T-77 in Dharam-Qazigund section of the project. A Joint Venture of Airef Engineers Private Limited (AEPL) and Varindera Constructions Limited (VCL) has emerged as the lowest bidder.

PROJECT COST AND FINANCING

The Jamu-Baramulla Railway is a Government of India project sponsored by Northern Railways, with an estimated cost of \$4.11 billion. The budgetary allocation for the year 2020-21 is \$540 million with estimated cost for the Baramulla-Kupwara line extension of \$500 million.

U.S. EXPORT OPPORTUNITIES

U.S. firms will have several opportunities to participate in the Jamu-Baramulla Railway project. From 2021-2026, the project will focus on fast execution, requiring significant equipment and services.

Specific opportunities exist for:


- Station development.
- Signaling.

- Track safety and maintenance equipment.
- Electrification packages.
- Technologies for safety and train protection and warning systems.
- Geotechnical investigations.
- Alignment studies.
- E&M design consultancy.
- Construction supervision of tunnels and bridges.
- Services concerning general arrangement drawings (GADs).
- Supply & installation of monitoring instrumentation.
- Design of broad-gauge ballastless tracks.

Rail projects require local representation, either through an agent, distributor, manufacturing partner or associate. These entities can assist U.S. companies in positioning their tenders for success, including helping to define cost competitiveness and local requirements.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
Vijay Sharma CAO - USBRL Northern Railway Jammu, India Northern Railways NDCR Building New Delhi 110001 India www.nr.indianrail.gov.in	Indo-Pacific Region 1101 Wilson Blvd., Suite 1100 Arlington, VA 22209 USA Mr. Kevin Toohers Country Manager ktoohers@ustda.gov U.S. Trade and Development Agency U.S. Embassy in Delhi Shantipath Chanakyapuri, New Delhi Delhi 110021 India Ms. Mehnaz Ansari Senior Regional Representative, South Asia mansari@ustda.gov IndoPacific@ustda.gov www.ustda.gov	U.S. Commercial Service The American Center 24 Kasturba Gandhi Marg New Delhi 100 001 91-11-2347-2000 India Renie Subin Commercial Specialist renie.subin@trade.gov www.trade.gov

Chennai Metro Rail Phase II		
	SECTOR	Transportation Infrastructure
	SUBSECTOR	Urban Transport
	LOCATION	Chennai, Tamil Nadu, India
	PROJECT VALUE	\$9 Billion (Excluding Rolling Stock)

PROJECT SUMMARY

Chennai is one of India's largest metropolitan cities, located in the State of Tamil Nadu in South India. Chennai Metro Rail Limited (CMRL) is the special purpose vehicle (SPV) formed by the Governments of India (GoI) and Tamil Nadu (GoTN), with equal equity participation, for a two-phase implementation of the Chennai Metro Project. Phase One is operational and, aside from some facility upgrades/modifications, is complete. Phase Two, which will extend over 118 km and encompass 116 stations, will be completed in 2026, at an estimated \$9 billion cost.

PROJECT DESCRIPTION

CMRL is an equal equity joint venture of India's Government and the Government of Tamil Nadu. It is the third-largest metro system in India after the Delhi and Hyderabad Metros. The CMRL project comprises two phases.

Phase One

Phase One partially commenced service in 2015 and was fully commissioned in Feb. 2019. This phase comprises two color-coded lines, covering 45 km, including 32 stations and operating across two-corridors. Corridor 1 is 23.1 km, while Corridor 2 is 22 km.

The system has a mix of underground and elevated stations and uses standard gauge rails. The system includes 42 trains with four coaches each (168 coaches), a depot at Koyambedu with 15 km of ballast-less tracks, as well as maintenance workshops, stabling lines, a test track, a washing plant for the trains, an Operational Control Center (OCC), ultrasonic bird repellers and strobe lights to prevent birds from entering the depot. An elevated depot at Wimco Nagar is under construction to maintain and park trains running between Washermanpet and Wimco Nagar. The elevated depot will cover an area of 3.5 hectares, with the ability to station 12 trains.

The service operates daily between 04:30 and 23:00 at varying arrival and departure frequencies, ranging from 10 to 20 minutes, with an ultimate planned reduction to seven minutes to meet

commuter needs and improve dependability. As of March 2020, approximately 125,000 people use the service daily, far below the targeted daily ridership of 776,000. The lack of dependable service, inadequate last-mile connectivity from metro-stations to neighborhoods and commercial areas, poor signage, inadequate real estate development and a lack of station air conditioning have hampered ridership. CMRL is in the process of addressing prospective passenger concerns.

Phase Two (In Planning)

Phase Two will have three corridors (Figure 49), 116 stations and 118.3 km of track. CMRL anticipates Phase Two will comprise operation of 138 trains in 4-to-10-minute intervals and carry 1.9 million passengers daily when fully commissioned in 2026. By 2021, CMRL will take over the existing Chennai Mass Rapid Transit System using Chennai Metro (Figure 50) rolling stock.

Figure 49: Phase Two Corridors⁶⁶



⁶⁶ The Hindu

Figure 50: Rolling Stock of Chennai Metro Rail⁶⁷



The three Phase Two corridors include:

- **Corridor III (47.25 km):** originating at Madhavaram and running to SIPCOT 2, connecting 12 stations. A 19.3 km section will be underground, while the 20.9 km section between Adyar and Siruseri will be elevated. CMRL has developed plans to extend the line by 9 km to Red Hills.
- **Corridor IV (27.05 km):** an underground corridor, with a depot at Poonamallee Bypass. CMRL plans to complete 13 stations from Lighthouse to Poonamallee Bypass in 2026, with an extended section to Sriperumbudur targeted for completion post-2035.
- **Corridor V (44.6 km):** connecting Madhavaram to Sholinganallur. This section features 14-km of elevated track and 20.7 km of underground track. Corridor V has a projected completion date in late 2026. CMRL expects to extend the Corridor V by 14.7 km to Wimco Nagar, though has developed no firm plan.

CMRL published a Phase Two Detailed Project Report (DPR) 2018 highlighting the key project details (Table 19). Subsequently, CMRL has made minor adjustments to the planned alignments and distances.

⁶⁷ Financial Express

Table 19: Overview of Phase Two of Chennai Metro⁶⁸

1Standard Guage: 1435 MM

2Route Length (Between Dead Ends)

Corridors	Elevated (Km)	Underground (Km)	Total Length (Km)
C-3 Madhavaram to SIPCOT	19.1	26.7	45.8
C-4 Lighthouse to Poonamallee Bypass	16.0	10.1	26.1
C-5 Madhavaram to Sholinganallur	41.2	5.8	47.0
Total			118.9

3Number of Stations

Corridors	Elevated Stations	Underground Stations	Total
C-3 Madhavaram to SIPCOT	20	30	50
C-4 Lighthouse to Poonamallee Bypass	18	12	30
C-5 Madhavaram to Sholinganallur	41 + 1 (At-Grade)	6	48
Total			128

4Traffic Forecast

Year	Max. PHPDT			Daily Boardings (in Lakh)				Daily PKM (in Lakh)			
	C3	C4	C5	C3	C4	C5	Total	C3	C4	C5	Total
2025	16,289	11,707	17,539	6.6	5.5	7.2	19.2	40.4	27.2	56.7	124.3
2035	22,115	18,944	24,528	10.1	9.3	13.2	32.6	49.3	44.2	88.3	181.8
2045	24,301	23,816	29,441	11.8	10.3	15.6	37.7	52.7	51.0	92.5	196.3
2055	27,361	29,940	35,714	13.6	11.4	18.5	43.5	56.4	58.9	96.8	212.2

Important features of the Phase Two plan include:

- **Speed:** design speed at 80 kmph, with a scheduled speed of 32 kmph.
- **Signaling:** communication-based Train Control System (CBTC) with unattended train operation permitting an operational headway of 90 seconds.
- **Telecommunications:** integrated system with Optical Fiber Transmission, SCADA, CCTV, Central Voice Recording System (CVRS), et al.
- **Station Design:** six typical designs for various station types to form the basis for planning all 128 stations.
- **Rolling stock:** detailed in Table 20.

⁶⁸ ChennaiMetroRail.org

Table 20: Rolling Stock Details of Phase Two of Chennai Metro⁶⁹

S. No.	Parameter	Rolling Stock
1	Basic Unit	3 Car basic unit 2 DMC and 1 TC. Every coach should be fully interchangeable with any other coach of same type.
2	Train Composition	3- Car: DMC + TC + DMC 6- Car: DMC + TC + MC + MC + TC + DMC Capable of GoA4 operation
3	Coach Dimensions	L= 22.6m, W=2.9m, H= 3.9m
4	Coach construction	Light weight Stainless Steel / Aluminum body
5	Axle load	≤16 T
6	Braking System	Regenerative Braking
7	Propulsion system	3 phase drive system with VVVF control
8	Type of traction supply	25kV AC OHE system

Rolling Stock Requirement:

Year	2025	2035	2045	2055
Total Coach Requirement	414	537	633	762

The overall project scope by stage is shown below.

Early Stage (2019-2020 contractor selection, 24- to 72-month period):

- General Consultants.
- Design consultancy works.
- Geotechnical investigation.
- DDC (Detailed Designing Consultancy) for works and services—civil, architectural, mechanical, electrical and plumbing (MEP), tunnel ventilation systems (TVS), ventilation air conditioning (VAC) systems, and track works covering the alignment and underground stations (including cut and cover box, U-section and switch over ramp).

Early-stage contracts for general consulting, design consulting, DDC, and geotechnical surveys for many sections have been awarded or are under bid. Some of the selected organizations include firms from the U.S., Italy, Singapore, India, Spain, and Malaysia.

⁶⁹ Ibid

Next Stages (2020-2026):

- Telecommunications Systems design, manufacture, verification, delivery, installation, testing, commissioning, operational acceptance, and technical/maintenance support, including training.
- QR code-based ticketing system using mobile and paper tickets, NFC-based open-loop payments for the ticketing system, and maintenance services for the existing automatic fare collection system (AFCS).
- Electrical and Mechanical (E&M) works—supply, installation, testing, commissioning, and training including electrical, ventilation, air conditioning systems (VAC), and fire protection, as well as SCADA works at depots.
- Construction and Civil Works under EPC.
- Power Supply System - design, manufacture, verification, delivery, installation, testing, commissioning, and technical/maintenance support, including training.
- Ballast-less track - installation, testing, and commissioning in elevated and underground sections.
- Escalators - design, manufacture, installation, testing, and commissioning (including integrated testing and commissioning) including maintenance for two years during defect liability period (DLP) at stations.
- Engineering and maintenance management services for stations, including egress shaft and associated tunnels for underground stations.
- Supply of fastening system for rails in ballast-less tracks.
- Supply of UIC-60, IRS-T-12-2009 (60E1 profile) head hardened rails of grade 1080 and UIC-60, IRS-T-12-2009 (60E1 profile), grade 880, turnouts of UIC-60, IRS-T-12-2009 (60E1 profile) and head hardened rail grade 1080 in ballast-less tracks.
- Facility management services to mechanical, electrical, and plumbing (MEP) systems for stations, cut and cover tunnels, administration buildings, and depots, as well as depot machine maintenance.
- Real-time monitoring solutions and installation of Intelligent Transport System (ITS).
- Feasibility studies for extensions.
- Coaches: Design, manufacture, supply, testing, commissioning and training.
- Developing rooftop solar capacity at stations and maintenance depots.

A difference between Phases One and Two is that in Phase Two, CMRL will award the station contracts to different parties. In Phase One, CMRL awarded a single contractor several stations.

Several organizations are already participating in the Chennai Metro Rail Phase Two project (Table 21):

Table 21: Consultants Involved in the Chennai Metro Rail Phase Two Project

Name of Consultant	Contact Details	Scope of Work
RITES Limited	RITES Bhawan, No.1, Sector 29, Gurgaon Haryana, India Ph +91 124 2571666 www.rites.com	Conducting the preliminary environment impact assessment (EIA) and preparation of DPR
CDM Smith Inc	IIA, Selvaraj Palani Towers, Door No. 81, Valluvarkottam High Road, Nugambakka Chennai, Tamil Nadu, India Ph +91 44 28211655 www.cdmsmith.com	Feasibility study for the project
Consulting Engineers Group Limited	B-11(G), Malviya Industrial Area Jaipur, Rajasthan, India Ph: +91 141 2751801 www.cegindia.com/	Detailed design consultant (DDC) for Madhavaram-Thousand Lights stretch, Thousand Lights-Tharamani Road and Nehru Nagar-Sholingnallur stretch of Corridor III
Nippon Koei India Private Limited	12th Floor, B Wing, IFCI Tower, 61, Nehru Place, New Delhi, India Ph: +91 11 49848000 http://www.nkindia.in	Provision of general consultancy (GC) services for construction of 52 km long priority section viz. Madhavaram- Sholingnallur (35.67 km) and Madhavaram-CMBT (16.34 km)
SMEC India Private Limited	5th Floor, Tower- C DLF Cyber DLF- II Gurugram, Haryana, India Ph: +91 124 4501100 www.smec.com	DDC for corridor IV (underground stretch)
Balaji Railroad Systems Limited (BARSYL)	"BARSYL Towers", Plot No. 3, Sitaram Nagar, Staff Road Secunderabad 500009 Andhra Pradesh, India Ph: +91 40 27847804 www.barsyl.com	Provision of general consultancy (GC) services for construction of 52 km long priority section viz. Madhavaram- Sholingnallur (35.67 km) and Madhavaram-CMBT (16.34 km)
Aarvee Associates Architects Engineers & Consultants Private Limited	8-2-5, Ravula Residency, Srinagar Colony Hyderabad 500082 Telangana, India Ph: +91 40 23737633 www.aarvee.net	Provision of general consultancy (GC) services for construction of 52 km long priority section viz. Madhavaram- Sholingnallur (35.67 km) and Madhavaram-CMBT (16.34 km)
AECOM India Private Limited	5th Floor, Tower-B, Building No-10, DLF Cyber DLF Phase-II Gurugram, Haryana, India Ph: +91 124 4830250 www.aecom.com	DDC for corridor IV (elevated stretch)
Systra MVA Consulting (India) Private Limited	B 307, Great Eastern Summit, Sector - 15, CBD Belapur Navi Mumbai Maharashtra, India Ph: +91 22 27572745 http://www.systra.com	DDC for corridor V

The State government is planning a Phase Three project to extend the Chennai Metro rail network across the city and two neighboring districts. CMRL appointed a consultant to identify the possible corridors for this expansion. Their report, submitted to the State government, identified six new corridors with a length of 101 km. However, these corridors will likely be developed after 2035.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

CMRL began soil testing for the project in June 2019. Due to the COVID-19 global pandemic, the work was stopped and resumed, along with the land acquisition process, in Aug. 2020. CMRL has finalized detailed designs for all three segments, with priority for the Madhavaram-CMBT and Madhavaram-Sholinganallur segments. While project construction work was to commence by June 2020, due to delays resulting from the COVID-19 global pandemic, CMRL has yet to award the tenders. The project is still targeted for completion by 2025.

In Jan. 2020, a JV of Nippon Koei India Private Limited, Aarvee Associates Architects Engineers and Consultants Private Limited, and Balaji Railroad Systems Limited (BARSYL) won a contract for providing general consultancy (GC) services for the construction of the 52 km line. Development priorities are the Madhavaram-Sholinganallur (35.67 km) and Madhavaram-CMBT (16.34 km) sections.

Also in Jan. 2020, CMRL requested bids for constructing tunnels and associated works in two packages associated with the Venugopal Nagar-Taramani Road Junction section of the project. The last date for bid submission was Oct. 6, 2020. CMRL required bids indicating the completion of tunneling and related work in 1460 days, or four years, from the contract award. Several firms bid on the tunneling work, including China Railway Tunnel Group, Shanghai Urban Construction Group, L&T, Hindustan Construction Company, Tata Projects, Afcons Infrastructure Ltd., and Turkey-based Gulermak. According to CMRL officials, the tender will be finalized and awarded by the end of 2020. While CMRL expects work to start in early 2021, delays are likely due to the COVID-19 global pandemic.

The last date for bid submission for the construction of the elevated metro stations at Chennai Bypass Crossing, Ramachandra Hospital, Iyyapanthangal Bus Depot, Katupakkam, Kumanan Chavadi, Karayan Chavadi, Mullai Thottam, Poonamallee Bus Terminus, Poonamallee Bypass, as well as associated viaducts from chainage 17.98 to 25.92 km and the approach to the Depot at Poonamallee and all related works, under Package C4-ECV-02 of Corridor IV, was Nov. 9, 2020. The work is likely to be completed in 36 months.

PROJECT COST AND FINANCING

The Phase Two Project will develop 118.9 km of railway at a cost of \$9 billion. CMRL estimates construction to comprise \$6.32 billion of the total cost, with the balance required for land acquisition and other expenses.

On Dec. 21, 2018, the Government of India (GoI) signed a \$700 million Official Development Assistance (ODA) loan agreement with the Japanese International Cooperation Agency (JICA) for the first project loan tranche. GoI had approved funding for 52.01 km of track and infrastructure with an estimated cost of \$6.02 billion. Loan assistance from JICA will represent approximately \$2.97 billion. The JICA financing stipulates 30 percent of the componentry (e.g., trains and signaling systems) must be purchased from Japanese companies, leaving 70 percent of the project open to non-Japanese interests.

The Asian Development Bank (ADB) approved a proposal for \$780 million in funds, and the Asian Infrastructure Investment Bank (AIIB) has agreed to provide \$329 million in project financing. CMRL has received in-principle approval from the New Development Bank (NDB), European Investment Bank (EIB), and World Bank (WB) for further funding.

In its 2020-21 budget, the State Government has allocated \$440 million as share capital assistance, subordinate debt and pass-through loan assistance.


U.S. EXPORT OPPORTUNITIES

This project offers U.S. firms opportunities for signaling and train component imports despite the 30 percent commitment to Japanese companies. For example, the project costs do not include completely built units (CBUs)/coaches. Additional opportunities will include:

- Design and equipment for telecommunications systems.
- E &M systems.
- Signaling packages including supplying traffic signals (i.e., traffic signal heads, controllers and cabinets, as well as the installation of new traffic signals at several intersections).
- Fire protection and SCADA systems.
- Integrated power supply packages.
- Architectural drawings.
- Design and supplies of escalators.
- Ticketing and open-loop payments systems.
- Real-time monitoring solutions and systems.
- Intelligent Transport Systems (ITS).
- Station development, including security and surveillance equipment and instrumentation packages.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
<p>Government of India (GoI) 3/F National Informatics Centre, A-Block, CGO Complex Lodhi Road New Delhi 110003 India www.india.gov.in</p> <p>Shri Rajeev Narayan Dwivedi, Director(Projects, Chennai Metro Rail Limited Admin Building, CMRL Depot, Poonamallee High Road, Koyambedu, Chennai – 600107, Tamil Nadu, India. chennaietrail@cmrl.in</p>	<p>Indo-Pacific Region 1101 Wilson Blvd., Suite 1100 Arlington, VA 22209 USA Mr. Kevin Toothers Country Manager ktoothers@ustda.gov</p> <p>U.S. Trade and Development Agency U.S. Embassy in Delhi Shantipath Chanakyapuri, New Delhi Delhi 110021 India Ms. Mehnaz Ansari Senior Regional Representative, South Asia mansari@ustda.gov IndoPacific@ustda.gov www.ustda.gov</p>	<p>U.S. Commercial Service The American Center 24 Kasturba Gandhi Marg New Delhi 100 001 91-11-2347-2000 India Renie Subin Commercial Specialist renie.subin@trade.gov www.trade.gov</p>

Delhi-Gurgaon-Rewari-Alwar RRTS – Phase I		
	SECTOR	Transportation Infrastructure
	SUBSECTOR	Urban Transport (Rail)
	LOCATION	Delhi; Gurgaon, Haryana; Rewari, Haryana; Alwar, Rajasthan
	PROJECT VALUE	\$3.67 Billion

PROJECT SUMMARY

The Delhi–Alwar Regional Rapid Transit System (RRTS) is a proposed 164-km long, semi-high-speed rail corridor connecting Delhi, Gurgaon, Rewari, and Alwar. It is one of the three rapid-rail corridors planned by the National Capital Region Transport Corporation (NCRTC). Once completed, the entire Delhi–Alwar RRTS corridor is estimated to cost \$5.5 billion. The NCRTC expects the 106 km Phase One project to cost \$3.7 billion and be completed by Dec. 2024.

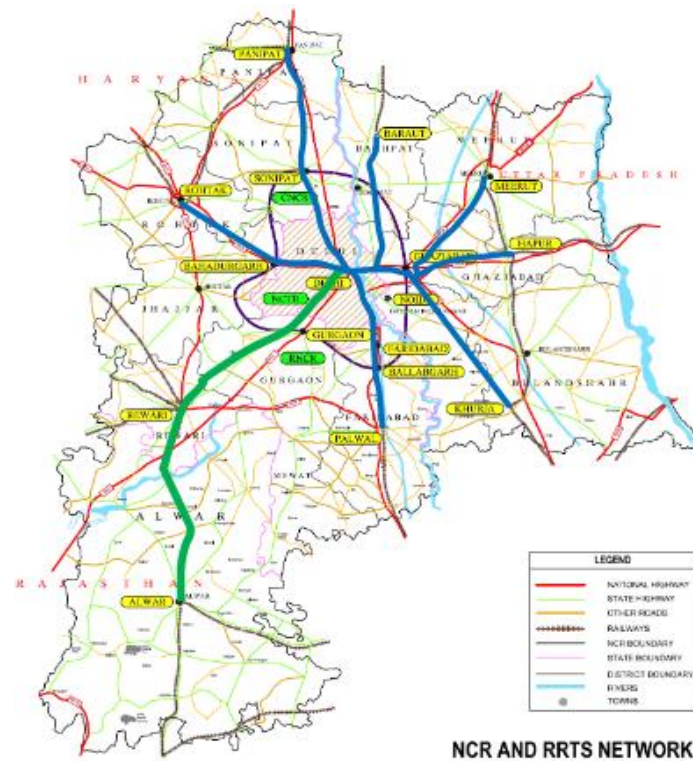
PROJECT DESCRIPTION

The National Capital Region (NCR) is a 35,000 square km multi-state region, encompassing parts of the neighboring states of Haryana, Uttar Pradesh, and Rajasthan with the National Capital Territory (NCT) of Delhi as its center. The National Capital Region Planning Board (NCRPB) has proposed an Integrated Transportation Plan connecting urban, industrial (SEZs/industrial parks), regional, and sub-regional centers with a fast, rail-based Regional Rapid Transit System (RRTS). The RRTS is projected to encompass eight rail-based, rapid-transit corridors to meet the NCR's transportation needs through 2032. The project's objectives include improving intra-regional access within the NCR and reducing commuter dependence on a highly congested road-based transportation system serving 350,000 passenger cars daily.

NCRPB has defined eight corridors for the fast-rail RRTS (Figure 51):

- **Delhi – Gurgaon – Rewari – Alwar (DGRA)** (158 km corridor - this project).
- Delhi – Ghaziabad – Meerut (67 km).
- Delhi – Sonapat-Panipat (89 km).
- Delhi – Faridabad-Ballabgarh-Palwal (60 km).
- Delhi – Bahadurgarh- Rohtak (70 km).
- Delhi – Shahadra-Baraut (56 km).
- Ghaziabad – Khurja (61 km).
- Ghaziabad – Hapur (57 km).

Figure 51: The NCR and RRTS Network⁷⁰



The Urban Mass Transit Company completed project's feasibility assessment in 2010, which was approved by the Planning Board in 2012. The project was transferred to the National Capital Region Transport Corporation (NCRTC) in 2017. NCRTC is a joint venture of India's Government and the States of Delhi, Haryana, Rajasthan and Uttar Pradesh.

Anticipated daily boarding at the stations within the Delhi-Gurgaon-Rewari-Alwar (DGRA) RRTS is growing rapidly (Table 22). As a result, the DGRA RRTS will be implemented in the three phases:

- Phase I: Delhi-Gurgaon-Rewari-Shahjahanpur-Neemrana-Behror (Delhi-Gurgaon SNB Corridor).
- Phase II: SNB Urban Complex to Sotanala.
- Phase III: SNB Urban Complex to Alwar.

⁷⁰ Feasibility Study and DPR for Delhi-Gurgaon-Rewari-Alwar RRTS Corridor

Table 22: Daily Boarding at Stations within Delhi-Gurgaon-Rewari-Alwar RRTS⁷¹

S.No	Station Name	2016	2021	2031	2041
1	ISBT Kashmere Gate	20390	24540	33095	44340
2	New Delhi RS	26030	32855	42495	54280
3	Sarai Kale Khan (Nizamuddin)	38000	44520	66395	84950
4	INA	24955	31275	47545	55515
5	Dhaulakuan	6000	9270	10140	11565
6	Mahipalpur	66035	87320	131110	145720
7	Cyber City	58210	83760	114145	125675
8	IFFCO Chowk	44760	44655	57535	67105
9	Rajiv Chowk (G)	25285	47105	57035	67145
10	Manesar	46765	61085	87410	96520
11	Panchgaon	24785	34290	38715	44440
12	Dharuhera	29375	33995	40680	45000
13	BTK	59395	76510	93535	115185
14	MBIR	24625	28865	34960	48050
15	Rewari	68000	99795	140735	161165
16	Bawal	62980	82240	135835	167035
17	SNB	38805	46915	61205	93305
18	Khairthal	18615	23155	32150	39285
19	Alwar	15320	20340	30690	44380
	Total	698330	912490	1255410	1510660

The 106-km Delhi-Gurgaon-SNB corridor will be elevated for 71 km and include 11 stations. The remaining 35 km and five stations will be constructed underground, mostly in Delhi and Gurgaon. This corridor will converge with other RRTS corridors in Sarai Kale Khan, where commuter movement from one corridor to another without changing stations will be facilitated.

With a maximum speed of 180 kmph and an average speed of 105 kmph (3 times faster than the existing metro), the RRTS will cover the distance between Delhi and Alwar in 104 minutes. The corridor includes the industrial hubs of Manesar, Bawal, and Neemrana.

Specifications for the project include the following:

- **Track Gauge:** twin tracks of 1,676 mm broad gauge.
- **Train Operating Speed:** 160 kmph, with a design speed of 180 kmph for passenger use only.
- **Traction System:** 1x25 kV AC single phase 50 Hz overhead catenary traction system.
- **Rolling Stock:** air-conditioned lightweight, stainless steel Electrical Multiple Units, each unit of three comprising two motor cars and one trailer car.
- **Axle Load:** 20 metric tons.
- **Signaling and Train Control Systems:** third generation continuous automatic train control (CATC) System.

⁷¹ Ibid

- **Automatic Fare Collection Systems:** integrated with Common Mobility Cards.
- **IT:** extensive use of IT railway operations, maintenance, traction power control and MIS.
- **Interoperability:** interoperability to enable seamless travel to all four destinations while providing cost reductions through economies of scale in equipment and coach procurement.

Overall the project will entail the following:

Early Stages (2019-2022)

Early project stages include:

- General and Design Consultancy.
- Geotechnical investigations.
- Conducting final location survey, topographic survey and other miscellaneous survey works.
- DDC (Detailed Designing Consultancy) for works and services: detailed design and drawings for civil, architectural, mechanical, electrical and plumbing (MEP), tunnel ventilation systems (TVS), ventilation air conditioning (VAC) systems, track work alignment and underground stations.

Several organizations are already engaged in the project (Table 23). NCRTC has signed an Indo-Spanish technical cooperation (government-to-government) agreement with Administrador de Infraestructuras Ferroviarias (ADIF) to provide technical advice on specific issues and technical training and collaboration related to track, signaling, rolling stock, safety, multi-modal integration, and station design.

Table 23: Consultants Involved in the Delhi–Alwar Regional Rapid Transit System (RRTS)

Name of Consultant	Contact Details	Scope of Work
Urban Mass Transit Company Limited	5th Floor, A Wing, IFCI Tower, 61-Nehru Place New Delhi, India Ph +91 11 41606074 www.umtc.co.in/	Feasibility study and detailed project report (DPR)
Delhi Metro Rail Corporation (DMRC)	Metro Bhawan, Fire Brigade Lane, Barakhamba Road New Delhi, India Ph +91 11 23417910 http://www.delhimetrorail.com	Project consultant
JURONG Consultants (India) Private Limited	JURONG House, 1/5 Palace Road, Bangalore, Karnataka, India Ph +91 80 2220 7292 http://www.jurong.com/	Preparation of master plan for the project

Name of Consultant	Contact Details	Scope of Work
CEG Test House and Research Centre Private Limited	B-11(G), Malviya Industrial Area, Malviya Nagar Jaipur, Rajasthan, India Ph +91 141 4046599 www.cegtesthouse.com	Detailed geotechnical investigation work from chainage 23.4 km to 71 km in IDPL Complex-Dharuhera section of Phase I
rites Limited	rites Bhawan, No.1, Sector 29, Gurgaon, Haryana, India Ph +91 124 2571666 www.rites.com	Conducting detailed geotechnical investigation works for the elevated sections from chainage 71 km (Dharuhera) to 106.4 km (SNB) of Sarai Kale Khan (SKK) to SNB stretch
SS Solutions	AS-4/11, Sreenagar Pally, 54 Feet Road (near Ashiyana Bhavan), Benachity Durgapur, West Bengal, India	Conducting final location survey, topographic survey and other miscellaneous survey work for the Sarai Kale Khan (SKK) to SNB stretch
Vikas Geotechnical Private Limited	H-101, Satya Apartment, Opp. Apexa Flats, Nr. Saibaba Mandir, Nr. Bhumi Nagar Society, Ghatlodia, Ahmedabad, Gujarat India Ph : +91 79 27453739 www.vikasgeotechnical.com/	Conducting geotechnical investigations works for Dharuhera to Rewari (70 km to 83.47 km) stretch
L&T Infrastructure Engineering Limited	C3- C7, Triton Square, 4th floor, Thiru. Vi. Ka. Industrial EGuindy Chennai. India Ph: +91 44 22509999 www.lntiel.com	Provision of DDC services for civil, architectural and E&M works for design of three elevated stations (Udyog Vihar, Sector-17 and Rajiv Chowk) and elevated viaduct between IDPL Complex ramp (Gurugram) to Rajiv Chowk ramp
Shree Balaji Test House Private Limited	F. C. A. 560- B., Chawla Colony Ballabhgarh, Haryana, India Ph: +91 9212774833 www.sbtthpl.com	Geotechnical investigations for underground sections from chainage 32.8 km (Rajiv Chowk) to 40.8 km (Kherki Daula toll), and chainage 45.5 km to 49.3 km (Manesar area)
Unitech Engineers	Plot No. 107, Prasanthi Nagar, Near Industrial Eukatapally Hyderabad, India Ph : +91 40 23073136 www.unitechengineers.in	Conducting geotechnical investigations works for Bawal to SNB station (93.57 km to 105.41 km) stretch

A joint venture (JV) of Systra MVA Consulting (India) Private Limited and AECOM India Private Limited has been awarded the Detail Design Consultancy (DDC). The JV will be responsible for:

- Civil, architectural, and electrical and mechanical (works) for the seven elevated stations (Panchgaon, Bilaspur, Dharuhera, Manesar-Bawal-Investment-Region (MBIR), Rewari, Bawal and SNB).
- A depot at Dharuhera.
- Stabling lines at Manesar.
- An elevated viaduct from Kherki Daula toll plaza to SNB (62 km).
- Detailed planning for five-underground stations for the Sarai Kale Khan-SNB segment of the project.

Later Stages (2020-2024)

Later stages of the project include:

- EPC Construction and Civil Engineering.
- Miscellaneous Civil Works.
- Power Supply System design, manufacture, verification, delivery, installation, testing, commissioning, and technical/maintenance support, including training.
- Ballastless track (standard gauge) installation, testing and commissioning in elevated and underground sections and depots, including supply and installation of fastening systems, head hardened rails, and buffer stops.
- Telecommunications System.
- Electrical and mechanical works, VAC systems, fire protection and SCADA works supply, installation, testing, commissioning, and training.
- Design verification and validation, manufacture, supply, delivery, installation, testing, and commissioning.
- Supply of operation and maintenance manuals, training of operation and maintenance personnel, supply of spares, special tools, and maintenance tools and assistance for maintenance during the defect liability period.
- Comprehensive annual maintenance for the complete integrated underground station system, VAC, tunnel ventilation systems (TVS) and electrical and SCADA works.
- Electrical and mechanical management services for stations, including egress shaft and associated tunnels for underground stations.
- Facility management services to mechanical, electrical, and plumbing (MEP) systems for stations, cut and cover tunnels, administration buildings, depots, and depot machine maintenance.
- Real-time monitoring solutions and installation of Intelligent Transport System (ITS).
- Design and implementation of the ticketing system, automatic fare collection systems (AFCS).
- Design, manufacture, installation, testing and commissioning (including integrated testing and commissioning) of escalators at stations, including maintenance for two years during the defect liability period (DLP).

PROJECT STATUS AND IMPLEMENTATION TIMELINE

A public-transport, travel-demand model for the NCR RRTS was prepared in 2017. Various surveys, technical studies, and a detailed project report followed. Most pre-construction work has commenced, including geotechnical investigations, provision of DDC services for civil, architectural, and E&M works and mapping of underground utilities. Remaining bidding and shortlisting for the pre-construction award phase will continue over the next six months. Due to the slowdowns resulting from the COVID-19 global pandemic, implementation is unlikely until 2022. NCRCT targets project completion within five years of commencement and station construction completion within 36 months.

PROJECT COST AND FINANCING

The project's total cost is \$3.67 billion, representing an approximate cost of \$35 million per km. Of the total project cost, about 20 percent will be funded by the central government and 20 percent by the respective state governments. The remaining 60 percent will be funded by financial assistance from multilateral funding agencies. Société Nationale des Chemins de Fer Français (SNCF) has expressed willingness to support the project.


U.S. EXPORT OPPORTUNITIES

Opportunities for U.S. firms include:

- Planning, design, and engineering services.
- Technology and goods for:
 - Rail line design.
 - Signaling.
 - Power supply and traction, and auxiliary power supply networks.
 - Telecommunication and fare collection systems.
 - Ventilation and air conditioning (VAC) systems.
 - Depot facilities and workshops.
 - Underground and elevated stations.
 - Security and surveillance equipment.
 - Locomotives and coaches.
 - Supervisory Control and Data Acquisition (SCADA) Systems.
 - IT systems for railway operations and maintenance (O&M).
 - Traction power controls.
 - Management information systems (MIS).

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
<p>National Capital Region Transport Corporation (NCRTC) 7/6 Siri Fort Institutional Area August Kranti Marg New Delhi, 110049 India</p> <p>www.ncrtc.in</p>	<p>Indo-Pacific Region 1101 Wilson Blvd., Suite 1100 Arlington, VA 22209 USA Mr. Kevin Toothers Country Manager ktoothers@ustda.gov</p> <p>U.S. Trade and Development Agency U.S. Embassy in Delhi Shantipath Chanakyapuri, New Delhi Delhi 110021 India Ms. Mehnaz Ansari Senior Regional Representative, South Asia mansari@ustda.gov</p> <p>IndoPacific@ustda.gov www.ustda.gov</p>	<p>U.S. Commercial Service The American Center 24 Kasturba Gandhi Marg New Delhi 100 001 91-11-2347-2000 India</p> <p>Renie Subin Commercial Specialist renie.subin@trade.gov</p> <p>www.trade.gov</p>

Visakhapatnam Light Metro Rail Project – Phase 1		
	SECTOR	Transportation Infrastructure
	SUBSECTOR	Urban Transport
	LOCATION	Visakhapatnam, Andhra Pradesh
	PROJECT VALUE	\$2.3 Billion

PROJECT SUMMARY

The Visakhapatnam Light Metro Rail project will develop a 79.91 km light-metro-rail network in the city of Visakhapatnam in the state of Andhra Pradesh. The project includes two phases and uses a design, build, finance, operate and transfer (DBFOT) model, operating under a public-private partnership (PPP) for 35 years. Visakhapatnam Urban Development Authority (VUDA) is the nodal agency, and Andhra Pradesh Metro Rail Corporation Limited (AMRC) is the project implementation agency. The estimated cost of the project is \$2.3 billion. The project will be operational by 2024.

The Visakhapatnam Light Metro Rail system will be similar to the systems in Delhi, Mumbai, and Hyderabad. Given the more moderate traffic in this Tier-Two city, however, this system will be designed for two-car trains.

PROJECT DESCRIPTION

Visakhapatnam (Figure 52) is the financial and executive capital of the state of Andhra Pradesh. The population of the greater Visakhapatnam urban area was 2.97 million in 2019. The city is rapidly growing, reflecting its high-quality educational, health and industrial infrastructure and its growing tourist and pilgrimage industry. To support metropolitan-area growth, the municipality plans a 140-km Mass Rapid Transport System. A light metro rail system of 79.91 km will complement a catenary-free modern tram/metrolite system over the remaining 60.2 km.

Figure 52: City of Vishakhapatnam⁷²



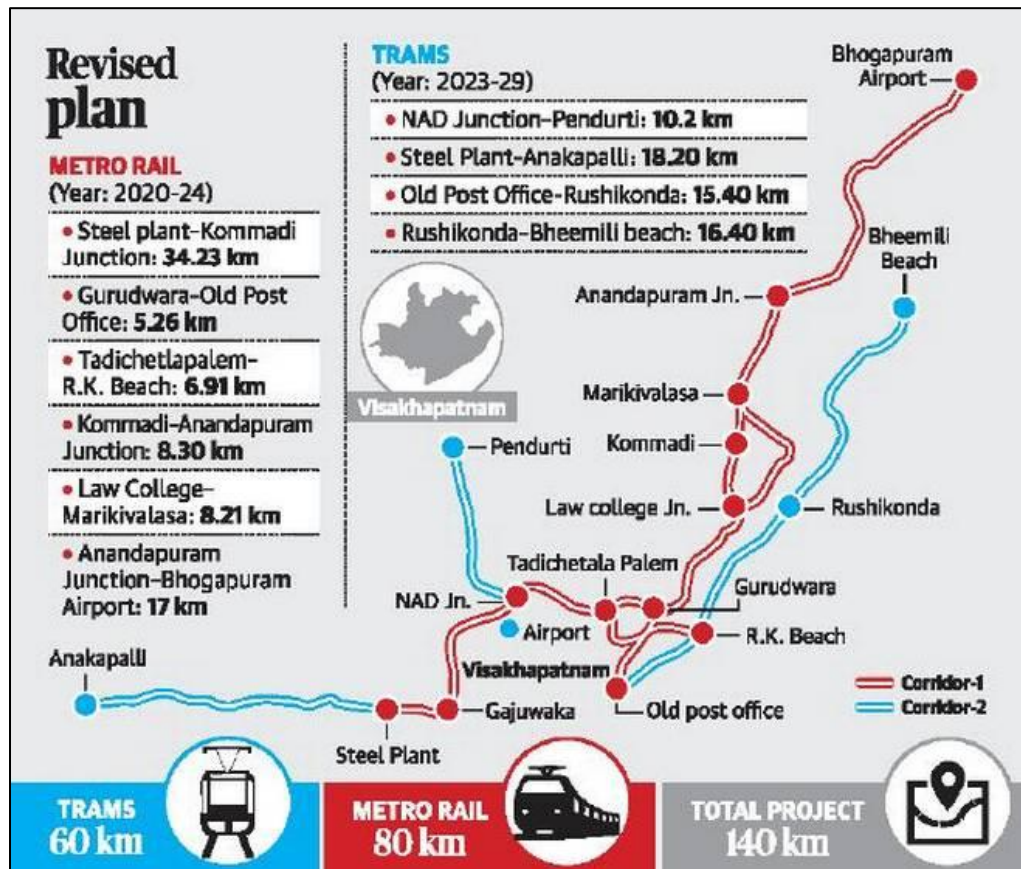
The light metro rail network (Figure 53) will include six corridors:

- Vizag Steel Plant-Kommadi Junction (34.23 km).
- Gurudwara-Old Post Office (5.26 km).
- Tadichetlapalem-Ramakrishna Beach (6.91 km).
- Kommadi-Anandapuram Junction (8.3 km).
- Law College-Marikivalasa (8.21 km).
- Anandapuram Junction-Bhogapuram Airport (17 km).

Initially, the project was a traditional 42.5 km Metro system. In 2019, however, the municipality decided to build a light rail system and extend the project to the proposed Bhogapuram International Airport to the northeast side and to the Vizag Steel Plant on the southeast side of the city. The rail line, which will be operational in 2024, will initially have a 50-60 million daily passenger capacity and gradually increase its daily passenger capacity to 200 million by 2054.

⁷² Metrorailnews.in

Figure 53: Metro Rail Plan⁷³



Key features of the project include:

- **State-of-the-Art Stations:** equipped with escalators and elevators for passenger movement. AMRC will provide the stations with CCTV cameras, X-ray baggage scanning, machines, human scanners, fire safety systems, digital signage boards (DSBs), and an announcement system (Figure 54). Stations will feature greenery planted along the tracks and natural daylight will be employed for lighting where possible and appropriate.
- **Green & Energy Efficient Metro Concept:** an eco-friendly system with a near-zero carbon footprint. Solar PV panels will be installed on station rooftops, depot boundary walls, service building rooftops, parking shelters, and viaducts. The stations will be designed to meet a Platinum-rating per the Indian Green Building Council criteria. Energy conservation measures will ensure low emissions of Green House Gases (GHGs).
- **First and Last-Mile Connectivity:** the Vishakhapatnam metro will integrate multimodal transportation modes, with feeder services available to and from the stations.

⁷³ Ibid

- **Advanced Digital Technology:** advanced digital services, including Automatic Ticket Vending (ATV) machines, start-to-end smart travel cards, and seamless travel and metro information Apps are included in the plan.
- **Metro Stations as Commercial Hubs:** eight priority stations (Kommadi, Madhurawada, Dwaraka Bus station, Gajuwaka, Saraswati Circle, R.K Beach (Chinnawaltair) and Steel Plant Junction) will feature entertainment zones, theaters, mini-auditoriums and day-care centers.

Figure 54: Planned Metro Stations⁷⁴



⁷⁴ Amrc.ap.gov.in

Several consultants already are engaged on the project (Table 24):

Table 24: Consultants Engaged on Visakhapatnam Light Metro Rail Project

Name of Consultant	Contact Details	Scope of Work
Delhi Metro Rail Corporation (DMRC)	Metro Bhawan, Fire Brigade Lane, Barakhamba Road New Delhi, India Ph. +91 11 23417910 www.delhimetrorail.com	Project consultant and preparation of feasibility report and the detailed project report (DPR)
SGS India Private Limited	New No.4 (Old No.8) , Rajiv Gandhi Salai (O.M.R), Perungudi Industrial EPerungudi Chennai, India Ph +91 22 27579611 www.imaritime.com	Environmental Impact Assessment (EIA) and Social Impact Assessment (SIA) studies
N. K. Engineers	E-356, Street No.15, Ashok Nagar, Delhi, India Ph +91 11 2280 3974 www.rites.com	Topographical survey
Infrastructure Leasing and Financial Services Limited (IL&FS)	The IL&FS Financial Centre, Plot C22, G Block, Bandra Kurla Complex, Bandra (East) Mumbai, Maharashtra, India Ph +91 22 26533333 www.ilfsindia.com	Technical and financial advisor
Urban Mass Transit Company (UMTC)	5th Floor, A Wing, IFCI Tower, 61, Nehru Place New Delhi, India Ph +91 11 41606074 http://www.umtc.co.in	Transaction advisory consultant; detailed traffic study for Anakapalle-Bhogapuram Airport stretch, preparation of revised DPR for the project
Aarvee Associates Architects Engineers & Consultants Private	8-2-5, Ravula Residency, Srinagar Colony Hyderabad, Telangana, India Ph +91 40 23737633 www.aarvee.net	Traffic Survey

PROJECT STATUS AND IMPLEMENTATION TIMELINE

The Urban Mass Transit Company (UMTC) conducted a detailed traffic study from Anakapalle to Bhogapuram and is preparing a revised Detailed Project Report (DPR). The UMTC will also prepare an alternative analysis report and provide transaction advisory consultancy services for bidding process management. On June 16, 2020, the state government allocated \$0.51 million to AMRC to provide project assistance. The DPR will be completed by the end of 2020. AMRC expects to award work in March 2021, with civil engineering beginning by June 2021. AMRC

expects project completion by 2024. The state government will provide land free from all encumbrances.

PROJECT COST AND FINANCING

The estimated project cost is \$2.3 billion. The project will employ a design, build, finance, operate and transfer (DBFOT) business model managed under a public-private partnership (PPP) structure with a 35-year concession period. The State Government will hold a 51 percent equity share. Visakhapatnam Urban Development Authority (VUDA) is the nodal agency, AMRC is the project implementation agency, and the Urban Mass Transit Company Limited (UMTC) is the project transaction advisor.

The Korea-based Exim Bank had initially proposed to provide funding but backed out in 2019. The state government is currently funding various project studies and is working with UMTC to assess financing options.

U.S. EXPORT OPPORTUNITIES

U.S. firms will have opportunities in:

- Planning, design and engineering services.
- Technology, equipment and supplies for:
- Rail line design.
- Signaling.
- Power supply and traction and auxiliary power supply networks.
- Telecommunications.
- Fare collection systems.
- Ventilation and air conditioning (VAC) systems.
- Depot facilities and workshops.
- Underground and elevated stations.
- Locomotives and coaches.
- Supervisory Control and Data Acquisition (SCADA) Systems.
- IT systems for railway operations and maintenance.
- Traction power controls.
- Management Information Systems (MIS).


Additional opportunities are likely for:

- Architectural drawings.
- Design and supplies of escalators.
- Ticketing and open-loop payments systems.
- Real-time monitoring solutions & systems.

- Intelligent Transport Systems (ITS).
- Station development, including security and surveillance equipment and instrumentation packages.

CONTACTS

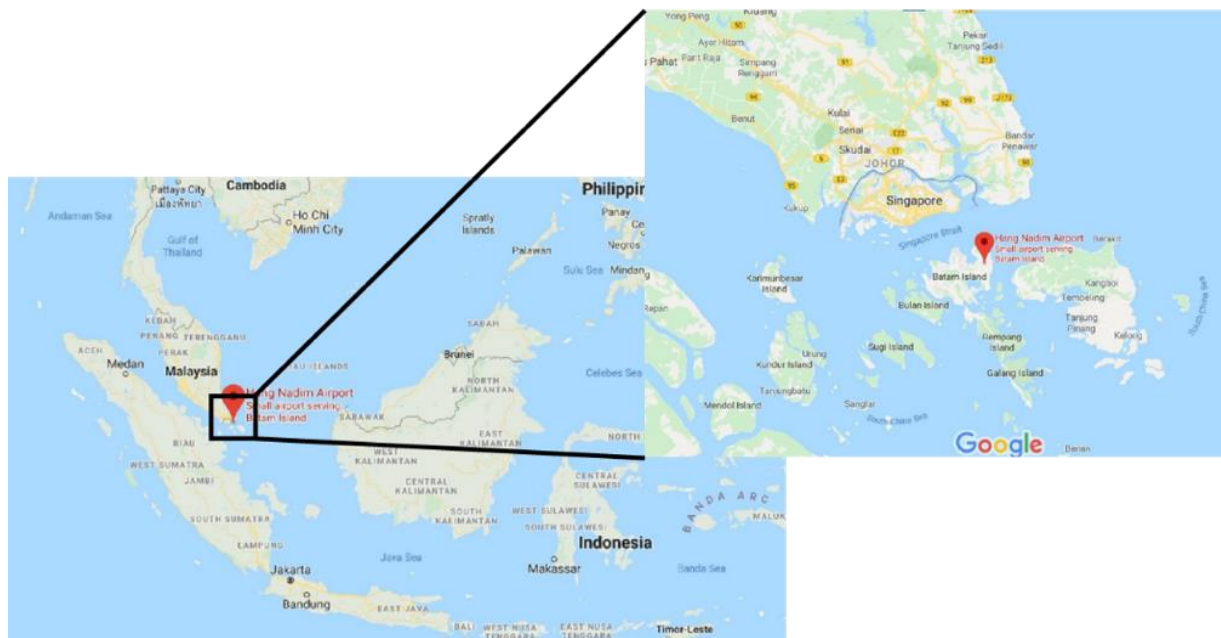
Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
<p>Government of India (GoI) 3/F National Informatics Centre, A-Block, CGO Complex Lodhi Road New Delhi 110003 India www.india.gov.in</p> <p>Government of Tamil Nadu Secretariat, Fort St. George Chennai, 600009 Tamil Nadu, India www.tn.gov.in</p>	<p>Indo-Pacific Region 1101 Wilson Blvd., Suite 1100 Arlington, VA 22209 USA Mr. Kevin Toohers Country Manager ktoohers@ustda.gov</p> <p>U.S. Trade and Development Agency U.S. Embassy in Delhi Shantipath Chanakyapuri, New Delhi Delhi 110021 India Ms. Mehnaz Ansari Senior Regional Representative, South Asia mansari@ustda.gov IndoPacific@ustda.gov www.ustda.gov</p>	<p>U.S. Commercial Service The American Center 24 Kasturba Gandhi Marg New Delhi 100 001 91-11-2347-2000 India</p> <p>Renie Subin Commercial Specialist renie.subin@trade.gov www.trade.gov</p>

Hang Nadim International Airport		
	SECTOR	Transportation Infrastructure
	SUBSECTOR	Airports
	LOCATION	Batam, Indonesia
	PROJECT VALUE	\$250+ Million

PROJECT SUMMARY

The Hang Nadim International Airport (BTH) is currently experiencing greater passenger traffic flows than it was designed to handle. BTH will undertake an expansion to manage expected future volumes, including refurbishing the existing terminal and constructing a new terminal. The expansion plan will cost approximately \$250 million, with construction beginning in 2021 (after being delayed) and operations commencing in 2023. BTH is in Batam, Indonesia, in the Riau Islands off Singapore and Sumatra (Figure 55).

Figure 55: Hang Nadim International Airport Location⁷⁵

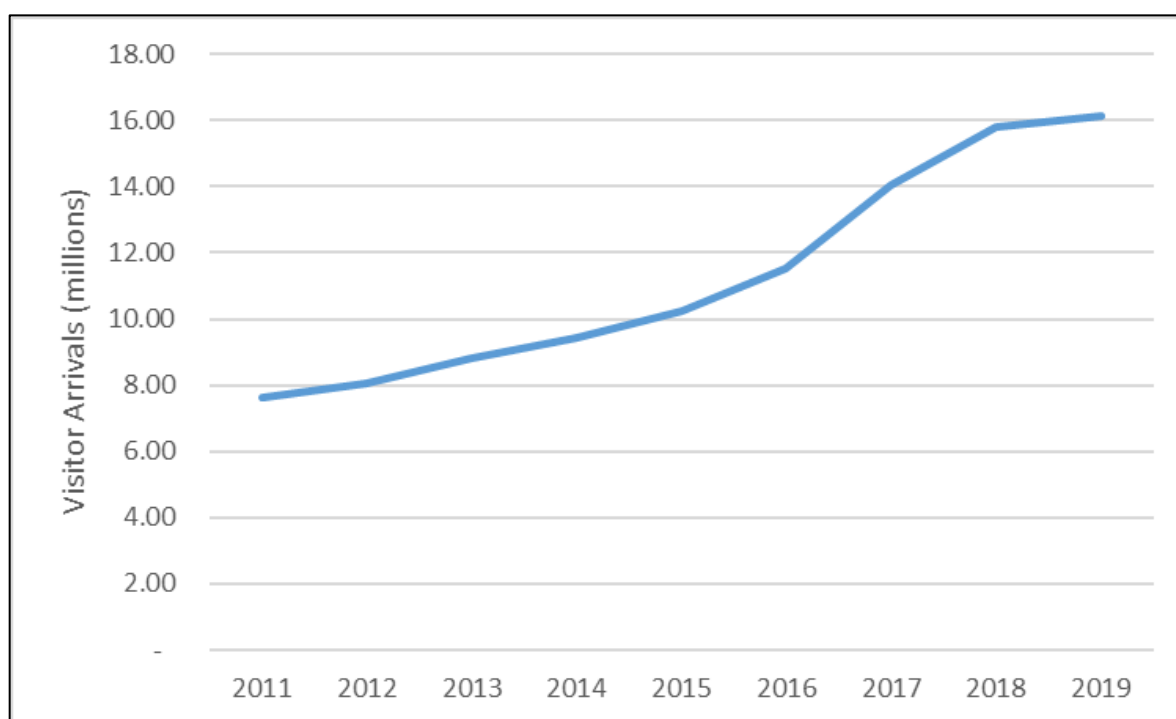


⁷⁵ Google Maps

PROJECT DESCRIPTION

The aviation market in Indonesia is the largest in Southeast Asia. With 61 scheduled and unscheduled commercial airlines in operation, Indonesia has the second-fastest-growing aviation industry, behind China. The tourism trade plays a large part in this growth. Given Indonesia's archipelagic geography, the overwhelming majority of visitors arrive by air. Visitor arrivals reached a high of 16.11 million in 2019 (Figure 56) before the border shutdown in April 2020 due to the COVID-19 global pandemic.

Figure 56: Annual Visitor Numbers to Indonesia (2008-2019)⁷⁶



As passenger levels increase, Indonesia has also seen growing load factors on aircraft arriving from overseas. In 2017, the load factor for all airlines was the highest since 2007/2008 and continued an upward trend that began in 2014. Before the COVID-19 global pandemic, nearly all of Indonesia's airports were operating above their load capacity.

To further boost tourism and enhance regional economic development across the country, Indonesia's government has launched the "Ten New Balis" program. The Indonesian government has designed the program to increase tourism revenue to eight percent of GDP while also increasing foreign exchange income and local employment. The government expects the initiative to reduce over-tourism in Bali and provide more sustainable tourism development across the

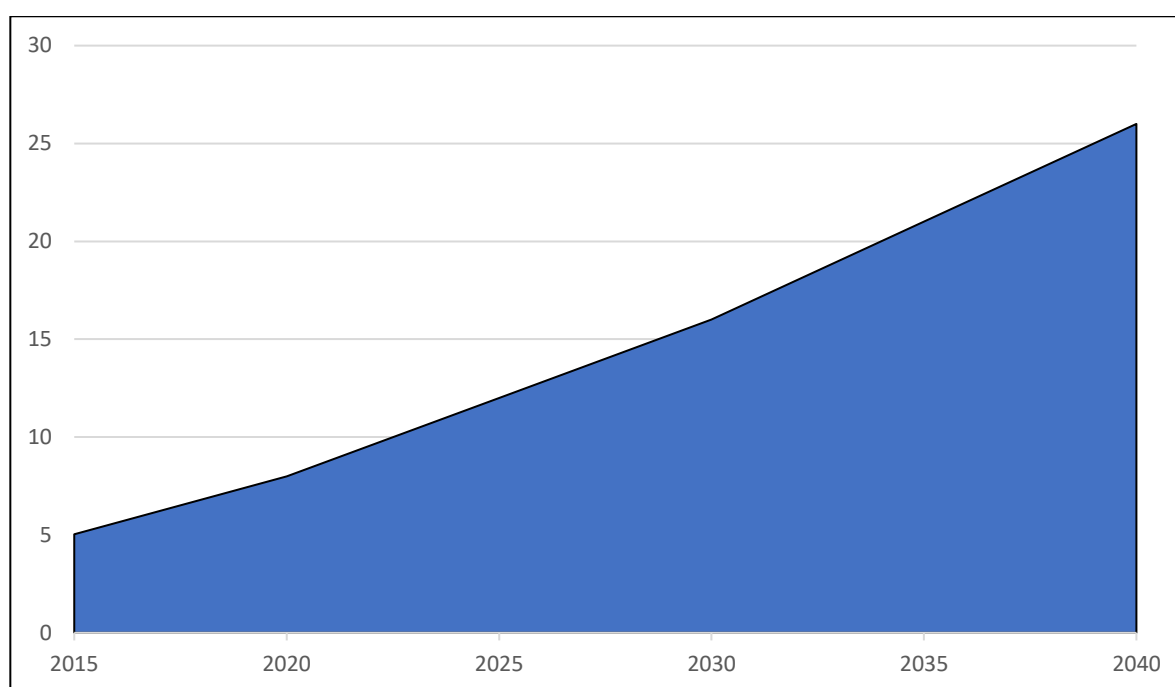
⁷⁶ CAPA – Centre for Aviation; BPS Statistics Indonesia

nation. Through this campaign, air travel is likely to increase as more visitors arrive in Indonesia, necessitating improving and expanding the existing aviation infrastructure.

BTH was originally developed to accommodate overflow planes from Singapore's Changi Airport in case of an emergency. The airport has an existing capacity of five million passengers per year and boasts Indonesia's longest runway. The runway is the second-longest in Southeast Asia, behind Malaysia's Kuala Lumpur International Airport (KUL).

In 2016, BTH experienced a passenger throughput of more than six million, with projections suggesting future volumes will continue to exceed the facility's capacity. Over the 2011 to 2016 period, the airport also witnessed a CAGR of 11.32 percent for aircraft movements, resulting in 48,620 movements in 2016. The airport operator, Batam Indonesia Free Zone Authority (BP Batam), has begun an expansion and upgrade project. The project will ease overcapacity and facilitate future passenger throughput to levels as high as 30 million passengers per year by 2045 (Figure 57).

Figure 57: Historical and Projected Passenger Flows at Hang Nadim International Airport⁷⁷



The BTH airport expansion project comprises:

- Refurbishing and expanding the existing passenger Terminal One and airside facilities to accommodate up to 10 million passengers/year.

⁷⁷ BP Batam – the estimate does not include the impact of the COVID-19 global pandemic.

- Constructing a new passenger Terminal Two and associated airside facilities to accommodate up to an additional 10 million passengers/year.
- Relocating the cargo terminal.

BTH is located inside a free trade zone and surrounded by more than 1,700 hectares of freehold land controlled by BP Batam, a Ministry of Finance unit. This structure will allow for the airport's expansion to move forward with little concern regarding land availability. The area immediately surrounding the airport will be developed as a domestic and international logistics hub.

ASEAN has listed the BTH expansion in its “Initial Rolling Priority Pipeline of Potential ASEAN Infrastructure Projects under the ASEAN Master Plan on Connectivity 2025.” This list, developed by ASEAN in conjunction with the World Bank and the ASEAN-Australia Development Cooperation Program Phase II, highlights projects creating the necessary infrastructure to accomplish a vision for connectivity in the region. As part of this pipeline, additional studies may be undertaken to determine appropriate funding/financing options, clarify economic prospects and identify associated risks.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

The airport expansion is currently under review by the Ministry of Finance. Operating contracts have not yet been awarded. Requests for Proposals were solicited, and those proposals are under review (Feb. 2021).

The bidders⁷⁸ are:

- Batam Consortium, which includes PT Angkasa Pura II, PT Adhi Karya, Egis Project S.A., and Engie South East Asia.
- Consortium of PT Angkasa Pura I, Incheon International Airport Corporation, and PT Wijaya Karya.

The adjoining free trade zone's ownership and operations, as well as the airport terminals' development, pose local challenges. Following this award, construction will begin in 2021 and span two years. Construction is expected to be complete in 2022, with operations of the expanded areas commencing in the same year.

The following organizations have been involved with the development of the airport thus far:

- Implementing Facility – PT SMI (Persero).
- Legal Consultant – Hermawan Juniarto.
- Financial Consultant – PricewaterhouseCoopers (PwC).
- Technical Consultant – Mott McDonald.

⁷⁸ <http://kpbu.djppr.kemenkeu.go.id/en/proyek/hang-nadim-airport-ppp-project/>

PROJECT COST AND FINANCING

The airport expansion project is expected to cost at least \$250 million.

The project will be structured as a public-private partnership (PPP), with the private sector responsible for designing, building, financing, operating, and maintaining the facility under a 25-year concession. The winning bidder will generate a return on investment from the revenue derived from airport facility services management. Due to Indonesian government regulations, the maximum foreign ownership for airport and airline operations is 49 percent, necessitating collaboration with a local Indonesian partner.

U.S. EXPORT OPPORTUNITIES

The Hang Nadim airport expansion to accommodate increasing passenger flows provides export opportunities for U.S. firms to provide both equipment and services. The U.S. firms PwC and Mott McDonald have already been engaged to support preparatory activities. The United States and Indonesia maintain an active Aviation Working Group to drive cooperation between the U.S. and Indonesian stakeholders in the aviation market. However, significant competition does exist in this space from regional competitors.

Specific opportunities for sales of equipment, technology, and services associated with the airport expansion plans include the following:

- Construction supervision and management.
- Project management.
- Engineering and design services.
- Jet bridges.
- Access control technologies.
- Telecommunications equipment.
- Security screening and monitoring technologies.
- Ground handling equipment.
- Baggage claim equipment.
- Air traffic control and management technologies.
- Cybersecurity solutions.
- Runway lighting and signals.
- Navigational aids.
- Firefighting equipment.
- Water treatment.
- Power plant/supply.
- Airspace planning.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
<p>Batam Indonesia Free Zone Authority Jl Jenderal Sudirman No. 1 Batam Centre, Batam Kepulauan Riau, 29400 Indonesia</p> <p>Djoko Wibowo, Transportation Team Coordinator KPPIP Gedung Pos Ibukota, Blok A, 6th Floor Jalan Lapangan Banteng Utara No. 1 Pasar Baru, Jakarta 10710 Indonesia wibowo.djoko@kppip.go.id</p>	<p>Indo-Pacific Region 1101 Wilson Blvd. Suite 1100 Arlington, VA 22209 USA</p> <p>Ms. Alissa Lee Senior Country Manager alee@ustda.gov</p> <p>U.S. Trade and Development Agency GPF Witthayu Tower A, Suite 302 93/1 Wireless Road Bangkok 10330 Thailand Mr. Brandon Megorden bmegorden@ustda.gov</p> <p>IndoPacific@ustda.gov www.ustda.gov</p>	<p>U.S. Commercial Service Embassy of the USA Jl. Medan Merdeka Selatan 5 Jakarta, 10110 Indonesia Mr. Paul Taylor paul.taylor@trade.gov www.export.gov/indonesia</p>

Indonesia Port Development		
	SECTOR	Transportation Infrastructure
	SUBSECTOR	Ports
	LOCATION	Nationwide, Indonesia
	PROJECT VALUE	\$4+ Billion

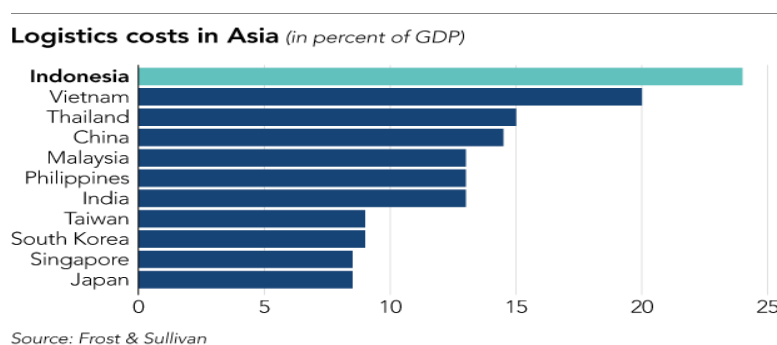
PROJECT SUMMARY

Indonesia is creating a massive port infrastructure development and expansion process coupled with industrial estate development. The projects are designated national priorities and have attracted international attention for financing and operation. Together they represent at least \$4 billion in opportunities. The port projects will enhance Indonesia's internal and external connectivity and drive economic growth across the country.

PROJECT DESCRIPTION

When he assumed office in 2014, Indonesian President Joko Widodo announced a \$50 billion effort to enhance Indonesia's maritime sector, including the development of 24 strategic ports. His plan involved linking port development to industrial estates and economic zones to reduce logistics costs, of which Indonesia's are among the highest in Asia at 24 percent (Figure 58).

Figure 58: Logistics Costs in Asia (as a Percentage of GDP)⁷⁹

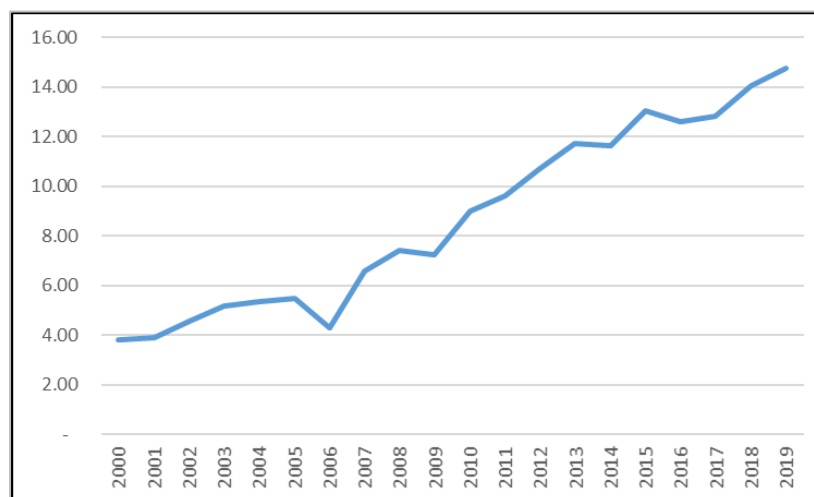


Since 2000, Indonesia's container traffic volume has steadily risen, creating the need for more facilities and advanced technologies to handle the growing cargo volumes. Despite slight decreases

⁷⁹ Frost & Sullivan via Nikkei Asian Review

in 2006 and 2009, TEU traffic volume at Indonesia's ports has tripled in the last two decades. In 2019, the country's ports handled 14.7 million TEUs, up from 3.8 in 2000 (Figure 59). Sea traffic accounted for only six percent of Indonesia's freight traffic, suggesting significant port expansions will be necessary ocean cargo transport increases further in the future.

Figure 59: Indonesia Port Container Volume (Million TEUs) ⁸⁰



As part of the Mid-Term National Development Plan (2015-2019), the Government of Indonesia reiterated its commitment to the port sector by designating ten port projects as National Strategic Projects. Of this number, three were named Priority Projects by the Committee for Acceleration of Priority Infrastructure Delivery:

- Kuala Tanjung International Hub Seaport (North Sumatra).
- Bitung International Seaport (North Sulawesi).
- Patimban Port (West Java).

Initial work has begun at all three of these ports. Indonesia plans additional work phases and expansions at these and other ports across the country.

Given Indonesia's geography, comprising 17,000 islands, maritime transport is critical to its economic development. The Minister of National Development Planning (Bappenas) continues to focus on infrastructure related to connectivity. However, the government has redirected portions of the infrastructure budgets to COVID-19 relief activities.

Other organizations, including the Association of Southeast Asian Nations (ASEAN), the World Bank, and the Government of Australia, have included Indonesia port development in their lists of priority regional infrastructure projects, with the Kuala Tanjung and Kijing seaports identified as

⁸⁰ The World Bank

priority opportunities for investment. In addition to these projects, numerous others are in the planning or expansion process, including the Maspion Port (East Java).

PROJECT STATUS AND IMPLEMENTATION TIMELINE

Presidential Decree 109/202, signed by President Joko Widodo, defines thirteen Priority Port and Maritime Projects (Table 25). The Projects shaded in the table are profiled following.

Table 25: Priority Port and Maritime Projects in Indonesia

Project No. in Presidential Decree 109/2020	Project Name	Project Cost (in billion rupiahs)	Location	Status as of January 2021
56	Port KEK Maloy	204	East Kalimantan	Complete
57	Port Sanur – Nusa Ceningan/Lembongan	398	Bali	Transaction
58	Port Likupang	180	North Sulawesi	Preparation
59	Makassar New Port	1,890	South Sulawesi	Partially Operating
60	Terminal Multipurpose Labuan Bajo	409	East Nusa Tenggara	Construction
61	Inland Waterways Cikarang - Bekasi - Laut (CBL)	3,416	DKI Jakarta	Preparation
62	Port Development Patimban	43,221	West Java	Partially Operating
63	Port Development Terminal Kijing	5,048	West Kalimantan	Partially Operating
64	Port Development Kupang	223	Nusa Tenggara Timur	Partially Operating
65	Port Development Existing Sorong and Arar (Pelindo IV)	564	West Papua	Preparation
66	Port Development Pantoloan	496	Central Sulawesi	Preparation
67	Port Development Hub International Kuala Tanjung	30,000	North Sumatra	Partially Operating
68	Port Development Hub International Bitung	34,365	North Sulawesi	Phase 1 Finished

Kuala Tanjung International Hub (Project 67)

Phase One of the Kuala Tanjung International Hub project, both an Indonesian national Priority Project and a priority project for ASEAN, involved constructing a Multipurpose Terminal

completed and operational as of Feb. 2019. Phase Two is currently in the planning process, with an expected operation date of 2023. The second phase will develop an integrated industrial area associated with the new port and a bulk terminal for dry goods. The expanded port will act as a transshipment hub and gateway to Western Indonesia for international shipments and provide connectivity to ports in Eastern Indonesia. The Ministry of Transportation estimates port container throughput will be 12.4 million TEU by 2039, reaching more than 180 million tons of trade per year by 2065. Land acquisition for Phase Two is ongoing, with the regional government currently addressing land acquisition challenges.

Patimban Port (Project 62)

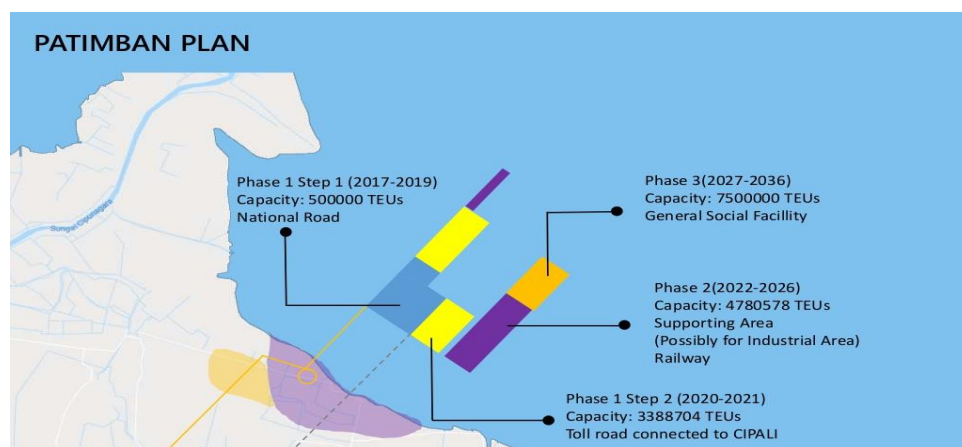
The Patimban Port, another national Priority Project, is nearing Phase One completion. A soft launch occurred in Dec. 2020. Construction is ongoing with targeted completion in 2022 using Japanese ODA loan assistance. Patimban port is near Indonesia's busiest port, Tanjung Priok, and is designed to alleviate some of the latter's overcapacity. Additionally, Patimban port will cater to the expected growth in logistics demand for the eastern part of West Java.

Three stages comprise the port's expansion (Figure 60):

- Phase One - 3.5 million TEU and 600,000 vehicles handling capacity.
- Phase Two – expansion to 5.5 million TEU capacity.
- Phase Three – further expansion to 7.5 million TEU capacity.

At present, the project is six to twelve months behind schedule due primarily to impacts from the COVID-19 global pandemic. Subsequently, the port authority plans a logistics park of up to 365 hectares.

Figure 60: Patimban Port Expansion Project⁸¹



Kijing Port (Project 63)

The greenfield Port of Kijing, identified as a priority project by ASEAN and the World Bank, is under construction and will become the largest port in Kalimantan. The port's development spans four phases and includes the construction of four terminals: container, dry bulk, multipurpose, and

⁸¹ RPX <https://www.slideshare.net/rhephialow26/patimban-analysis-for-java-logistics>

liquid bulk. The container terminal has a planned capacity of one million TEU. The liquid and dry bulk terminals will have capacities of 8.3 million and 15 million tons, respectively. The multipurpose terminal capacity will be a 50,000 tons/year.

A 5,000-hectare special economic zone will be integrated into the port to drive further expansions beyond Phase One. Phase One is 70 percent complete and has been granted docking authorization by the Ministry of Transportation. The only issue remaining is land acquisition for the connector toll road to the national highway. The project has remained on schedule during the COVID-19 global pandemic.

East Java Port (Gresik)

In July 2019, DP World (UAE) and Indonesia's Maspion Group signed an agreement to build a \$1.2 billion container port and industrial logistics park in East Java. PT Pelindo III, an Indonesian state-owned maritime services operator, will collaborate on the port. A 360-hectare industrial and logistics park to support seaport operations will be integrated with the East Java port.

In Aug. 2020, the Indonesian Minister of Transportation, Budi Karya Sumadi, estimated the first phase of construction would begin in 2021. Later, he indicated the port's focus on multipurpose uses, namely containers and liquid bulk. DP World projects throughput of eight to nine million TEUs by 2034. The project is running about one year behind schedule.

PROJECT COST AND FINANCING

The majority of these Indonesian port expansion and development projects will use a public-private-partnership (PPP) model. The government of Indonesia does not have funds to develop all independently. Thus, they desire outside investors and developers. Each new port will require over \$1 billion investment and require additional resources to be successful. Indonesia seeks assistance from international public sector sources of financing (i.e., JICA support for Patimban), multilateral development banks, and the private sector.

U.S. EXPORT OPPORTUNITIES

The U.S. port development industry is robust. It can supply not only equipment and technologies but also services to support the seaport development and expansion in Indonesia. Strong competition can be expected from regional competitors, including Japan, China, Korea, Singapore, and Australia, particularly where ODA funds may support individual port development/expansion. Possible Middle Eastern developers may drive sources of supply to their home region or Europe.


The specific opportunities for U.S. firms will vary from port to port, based on the primary cargo target, but are likely to include:

- Construction supervision and management
- Engineering and design services
- Water and wastewater treatment facilities

- Waste treatment facilities
- Hazardous waste treatment technologies
- Automation solutions
- Intelligent transportation
- Access control
- Telecommunications solutions
- Cybersecurity technologies
- Dredging equipment
- Barges
- Terminal lighting
- Navigational aids
- Quay and yard cranes
- Vessel traffic management system
- Power supply equipment
- Terminal operating system
- Transtainers
- Container inspection/security equipment
- Rail signaling

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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Map Ta Phut Port - Phase III Expansion		
	SECTOR	Transportation Infrastructure
	SUBSECTOR	Port
	LOCATION	Rayong, Thailand
	PROJECT VALUE	\$1.85 Billion

PROJECT SUMMARY

As part of Thailand's Eastern Economic Corridor (EEC) plan, the Map Ta Phut port will undergo a \$1.85 billion (THB 55.4 billion) Phase III expansion. The Phase III expansion will increase handling capacity for liquids and liquified natural gas (LNG). The primary development within Phase III will be constructing a new LNG receiving terminal with a storage capacity of at least 5 million tons.

PROJECT DESCRIPTION

Located approximately 185 kilometers from Bangkok, on the Gulf of Thailand's eastern seaboard, Map Ta Phut Port is Thailand's largest industrial port. The port is established inside the Map Ta Phut Industrial Estate, occupying 1,000 rai (160 hectares/395 acres). The Phase III expansion of the Port (Figure 61) is one of the megaprojects Thailand is undertaking as part of the EEC development.

Thailand established Map Ta Phut Port in 1992, with two liquid and one general cargo berths. In 1999, the port underwent an expansion, including dredging the channel to allow larger ships and, hence, more cargo. Commercial operation of the country's first five-million-ton-per-year capacity LNG receiving terminal in the Map Ta Phut port began in 2011. PTT, the state-owned oil, gas and chemicals enterprise, operates the LNG terminal. LNG handling capacity has subsequently increased to 11.5 million tons per year. Additionally, port expansions have added two liquid cargo berths for a total of four.

In 2016, the port managed 43 million tons of cargo. The largest cargo was oil and gas (57 percent), with coal representing 18 percent and chemicals another 16 percent. The balance (9 percent) is general cargo (especially granite), wood chips and project cargo (e.g., heavy machinery and equipment). Currently, the port is operating at full capacity, necessitating the planned expansion phase.

The Phase III expansion's principal goal is to increase overall port capacity to 14 million tons per year of LNG handling. A joint venture between Gulf Energy Development and PTT Tank Terminal will develop Phase III in two separate periods. The First Period will involve land reclamation for

an LNG terminal with a capacity of at least five million tons per year. The Second Period will include the development of the seaport's superstructure. In the future, the Industrial Estate Authority of Thailand (IEAT) can expand the LNG terminal to 10.8 million tons per year capacity.

The components of Phase III include:

- 160-hectare (395-acre) land reclamation for a new LNG terminal.
- Channel dredging to a depth of 16 meters.
- Expansion of public utility systems.
- Further implementation of vessel traffic control systems.

Figure 61: Map of Map Ta Phut Port⁸²



The Thai government's power development plan calls for the country to derive 53 percent of its electric power from gas by 2037. Thailand will require LNG imports to reach this goal, as domestic

⁸² Industrial Estate of Thailand

gas production dropped by 13.4 percent between 2014 and 2018 with depletion of domestic supplies (Figure 62). During the same period, LNG imports rose from fewer than 2 million tons per year to approximately 5 million tons per year (Figure 63). Some estimates suggest LNG will supply 80 to 90 percent of the power sector by the end of 2037, although the government plan presents a more balanced mix of LNG and renewables. The new Map Ta Phut Phase III terminal will accommodate the required imports to meet future power requirements, providing greater energy security and stability.

Figure 62: Thailand Natural Gas Production, 2014-2019⁸³ (Million Metric Tons per Year)

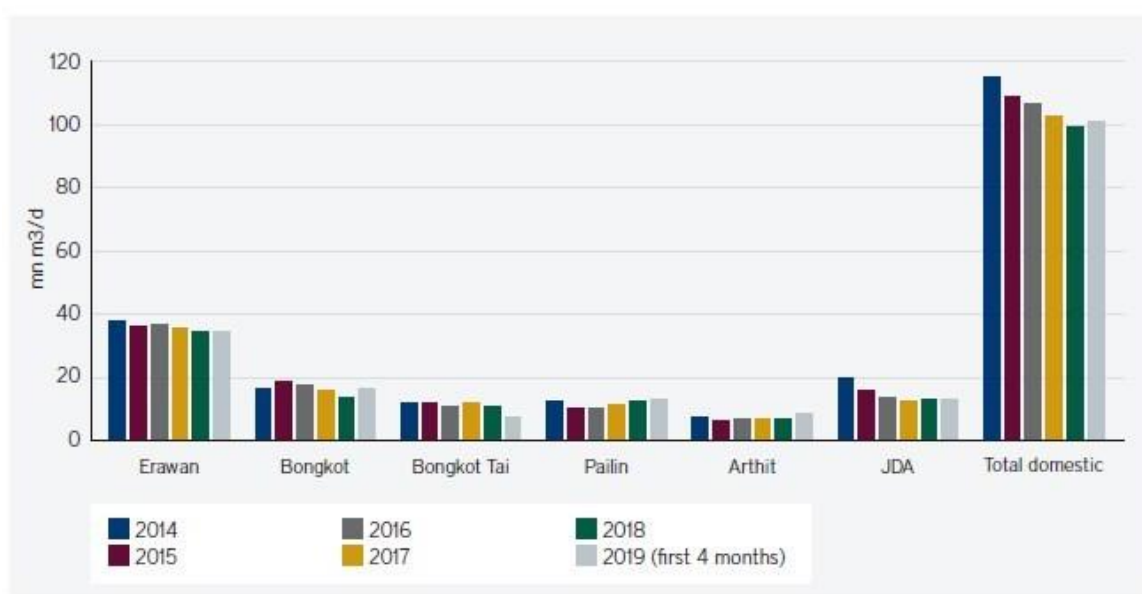
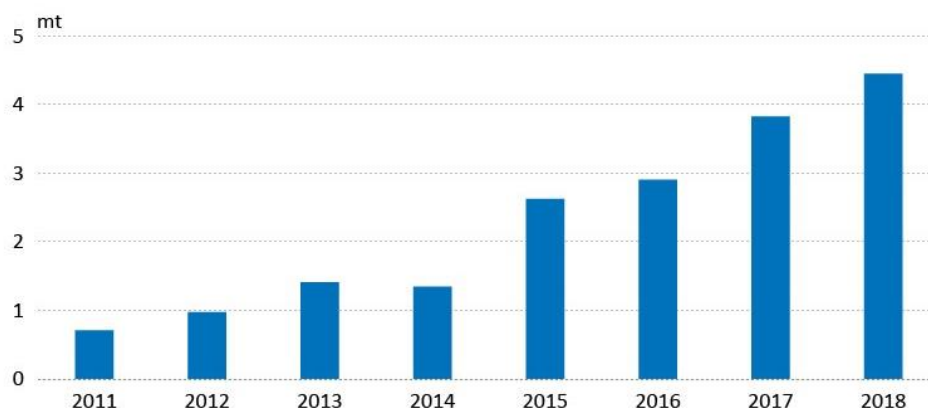


Figure 63: Thailand LNG Import Volumes⁸⁴ (Million Metric Tons per Year)



⁸³ Department of Mineral Fuels, PTT via Petroleum Economist

⁸⁴ Ministry of Commerce via Interfax Global Energy

PROJECT STATUS AND IMPLEMENTATION TIMELINE

In October 2019, Gulf MTP LNG Terminal won the bid to develop Phase III of the Map Ta Phut Port. The company is a joint venture between two Thai-based firms: Gulf Energy Development (70 percent) and PTT Tank Terminal (30 percent). This project is the first of the megaprojects underway in the EEC, with the contract already signed for development.

The First Period of this project began in late 2019, with operations to commence in 2025. The First Period will facilitate the import of up to 10.8 million tons per year of LNG, establishing the foundation for the necessary increase in shipments to support the government's energy plan. Gulf MTP LNG Terminal Company Limited (Partner of Industrial Estate of Authority) has signed the contract to hire the contractor for infrastructure design and construction. IEAT expects construction for the infrastructure to start in March 2021 and be completed by 2024.

The Second Period of the project, for which construction will run from 2024 to 2026, focuses on developing wharves and up to 4 million tons per year of other (non-LNG) liquid cargo capacity. Specifically, a liquefied products terminal and warehouse behind the port will be constructed (i.e., port superstructure). Once all of the Second Period construction is complete, operations will commence in 2027/2028.

The overall environmental impact analysis for the port is complete. However, the JV operator will conduct supplemental analyses should new elements of the project be pursued. The COVID-19 global pandemic has not affected the progress of the project.

PROJECT COST AND FINANCING

The Map Ta Phut Port Phase III expansion will cost \$1.85 billion (THB 55.4 billion). The project's First Period investment is estimated at \$1.6 billion (THB 47.9 billion), while the Second Period will require \$250 million (THB 7.5 billion).

The project is structured as a public-private-partnership (PPP) scheme, with a 35-year duration. The Thai government will contribute 27 percent of the First Period investment, with the joint venture investing the balance. Under the PPP, the Thai government will be responsible for land reclamation and utility system construction. The joint venture will construct the port, install the port handling equipment, and manage port operations.

US EXPORT OPPORTUNITIES


Significant opportunities may be available to U.S. companies with experience in the development of seaports and supporting infrastructure. The U.S. firm PwC is serving as an advisor to the EEC Office in support of project development. U.S. companies may face competition from China, Japan, Sweden, and the Netherlands. For the earlier receiving terminals constructed at Map Ta Phut, Thailand sourced extensively from East Asian countries.

Possible areas for engagement of U.S. companies in the Map Ta Phut Phase III expansion include:

- Construction supervision.
- Detailed design.
- Power supply systems.
- Vaporizers.
- Compressors and blowers.
- Pumps and auxiliaries.
- Valves and controls.
- Access control systems.
- Telecommunications architecture.
- Safety solutions.
- Water treatment technologies.
- Control systems.
- Cybersecurity solutions.

CONTACTS

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Westports Expansion		
	SECTOR	Transportation Infrastructure
	SUBSECTOR	Ports
	LOCATION	Malaysia (Peninsular)
	PROJECT VALUE	\$250+ Million

PROJECT SUMMARY

Malaysia is expanding and upgrading several ports. Near-term expansion of Westports, the larger of Port Klang's two ports, is expected to increase cargo handling capability by 50 percent. Port Klang is Malaysia's largest and most international port.

PROJECT DESCRIPTION

Malaysia, as a maritime nation, is home to some of the world's largest ports. The largest of these is Port Klang, comprising the international Westports, more regional Northport and an economic free zone. In 2018, two ports, Klang and Tanjung Pelepas, handled 64 percent of Malaysia's total cargo throughput.

For centuries, the Strait of Malacca has been a strategic waterway in global trade. Malaysia holds the world's fifth position in shipping line connectivity after China, Singapore, the Republic of Korea, and Hong Kong (counted separately from China)⁸⁵. The country is a key container transshipment hub in the region (Figure 64) and a market leader in handling and exporting oil and gas products.

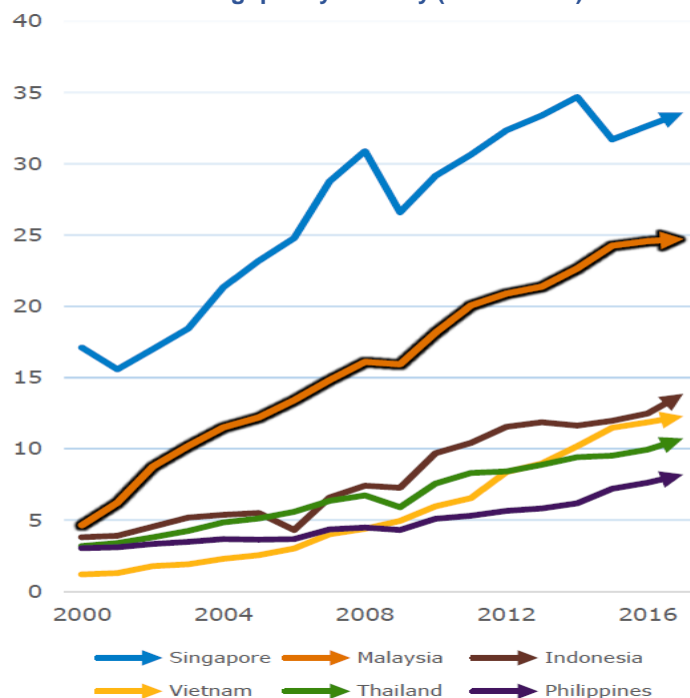
Specialized ports are located in different parts of Malaysia, with oversight by government-assigned authorities under the Federal Ministry of Transport. Ports are operated by private parties, commonly under 30-year concessions. The principal container handling ports are in Peninsular Malaysia and are supervised by the Federal Government, with bulk handling ports in Sabah and Sarawak supervised by each State Government.

Currently, Malaysia has nine federally-administered ports: Klang, Tanjung Pelepas, Johor, Penang, Bintulu, Melaka, Kuantan, Kemaman, and Labuan. Several port projects are in development across Malaysia, ranging from pre-feasibility studies to active development. Focal

⁸⁵ United Nations Conference on Trade & Development, <https://unctad.org/news/maritime-connectivity-countries-vie-positions>

areas for Malaysian port enhancement are increasing cargo sources, expanding bunker and other ship supply services, and digitization across all port functions and parties.

Figure 64: Southeast Asian Container Throughput by Country (Million TEU) ^{86 87}



Westports is large, international, and a priority of Malaysia's transport and logistics agenda, given its global connectivity (Figure 65). For example, Swedish furniture retailer IKEA recently announced a \$220 million regional distribution and supply chain center at Pulau Indah, Selangor, nearby.

Operated by Westports Holdings Bhd., Westports handles 18 percent of containers passing through the Straits of Malacca and 76 percent of containers at Port Klang. Transshipment represents 74 percent of the business mix, with the remaining 26 percent focused on gateway containers. Westports services global shipping, although the majority of container volume is intra-Asia (Figure 65 and 66).

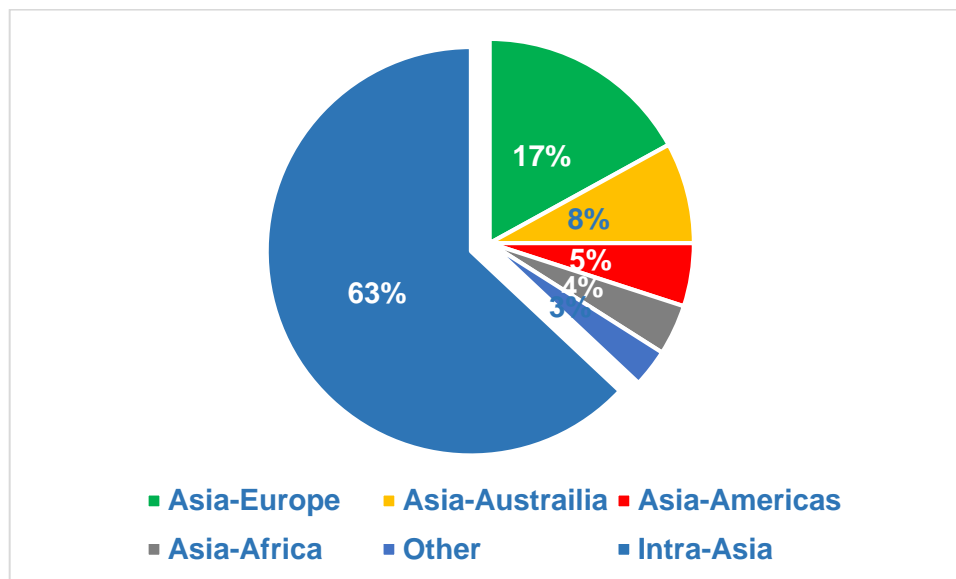
⁸⁶ Twenty-foot equivalent

⁸⁷ The World Bank, <https://data.worldbank.org/indicator/IS.SHP.GOOD.TU>

Figure 65: Westports Global Connectivity⁸⁸



Figure 66: Westports Container Volume by Trade Lane



Westports is designated to become the country's maritime center and bunkering hub. The Westports expansion will increase port capacity by 50 percent and include the addition of terminals (CT10 to CT19) beyond the current nine (CT1 through CT9) (Figure 67). Also, the project includes construction of a 600-meter wharf at CT9. Advantages both in amounts of cargo handling capacity and reduction of cargo handling time (from 40 to 35 gross moves per hour) are objectives. A further aim is improving digital connectivity across all port functions and stakeholders.

⁸⁸ Westports <http://www.westportsmalaysia.com/default.aspx>

Figure 67: Current Westports Container Terminal⁸⁹



The Malaysian government has set the creation of a single integrated port community as a priority. The main objective is to simplify and reduce the formalities, documentary requirements, and procedures during the arrival, stay and departure of ships at Malaysian ports. The desired system will streamline and integrate all the digital services of:

- Terminal operators.
- Shipping agents.
- Depots.
- Haulers.
- Merchants.
- Forwarding agents.
- Customs.
- Other services present.

In the fragmented Malaysian port landscape, this sector will require the greatest expertise from outside the country.

Westports has secured approval-in-principle from the government for the expansion, which will double its container-handling capacity to about 30 million twenty-foot equivalent units (TEUs) annually by 2040.

In 2020, the Westports Group Managing Director noted that “the momentary pause (due to the COVID-19 global pandemic) in the relentless volume growth experienced in recent years incidentally has provided Westports more time to plan and execute the land reclamation phase at a more competitive cost for the mega Container Terminal expansion from CT10 to CT17.

⁸⁹ Ibid

Westports remains committed to reinforcing Port Klang as one of the main transshipment hubs in South East Asia for international container shipping alliances.” Construction will now extend thirty years, adding five years to the original estimate.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

Westports has begun expansion feasibility studies and expects to tender near term. Phase One of the Westports expansion was slated for 2019 to 2024 and has received agreement-in-principle from the Malaysian government. Westports received an approval letter from the Economic Planning Unit to proceed with the proposed land acquisition of 146.4 hectares from Pembinaan Redzai Sdn Bhd (PRSB) in 2020. The land is south-west of Pulau Indah, which is underwater.

Westports has temporarily adopted a payout ratio of 60 percent to conserve cash due to the COVID-19 global pandemic. Management expects the land reclamation for the expansion to commence in 2021 and the development of container terminals to begin in 2022. Westports has extended the total proposed construction timeline by five years, from 25 to 30 years, due to the COVID-19 global pandemic impact.

PROJECT COST AND FINANCING

The Westports expansion has a budget of \$2.5 to \$3.5 billion. Financing is typically 30 percent equity and 70 percent debt. Major local and international banks have been active in port financing in Malaysia. Westports anticipates using a mix of internal funding, sukuk (bond) and Western forms of debt. Westports affirmed in 2020 that it expects to fund the development costs through internally generated funds, bank borrowings, and proceeds from fundraising exercises.

U.S. EXPORT OPPORTUNITIES

The Westports expansion may be attractive to U.S. firms for several reasons:

- Large established port and maritime market.
- Expanding container transshipment hub.
- A preferred gateway to Southeast Asia.
- Market for smart port development.
- Larger-scale and numerous port expansion and land development plans.
- One of the world’s principal palm oil exporters.
- Oil & gas producing and trading hub.
- Offshore supply and maintenance base (Sabah & Sarawak).
- Growing cruise ship destination.

Specific U.S. export opportunities for the Westports expansion include:


- Dock cargo handling products, services, and technologies.

- Port cargo handling transport equipment.
- Engineering and design.
- Operations services.
- Project development, architecture, and technical and business consulting services.
- Industry-specialized port handling equipment.
- Smart-port technologies (integrated port community systems and related digital solutions).

With the free commercial zones in Port Klang, Westports is also an attractive location for U.S. companies seeking to establish regional distribution centers to serve the growing regional market.

CONTACTS

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Sabah – Sapangar Bay Container Port Expansion		
	SECTOR	Transportation Infrastructure
	SUBSECTOR	Ports
	LOCATION	Sapangar Bay, Sabah, Malaysia
	PROJECT VALUE	\$310 Million

PROJECT SUMMARY

The State of Sabah, Malaysia has scheduled an expansion of the Sapangar Bay Container Port to begin at the end of 2020. The two-phase project seeks to position the port as a major Brunei-Indonesia-Malaysia-Philippines East Association of Southeast Asian Nations (ASEAN) Growth Area (BIMP-EAGA) regional trading hub. Aiding in economic development in the region, the project will also reduce living and purchased-goods costs for residents. The project is valued at \$310 million and includes financial support from the Federal Government of Malaysia.

PROJECT DESCRIPTION

Unlike Peninsular Malaysia, where the Malaysian federal government administers most ports, the state government oversees the ports in Sabah. Located on the island of Borneo, Sabah is coincident with intra-ASEAN and European-Asian sea-trade routes. Sabah expects its ports to become important trading hubs for BIMP-EAGA. In conjunction with the Pan-Borneo Highway project, logistics linkages across the island of Borneo will enhance economic development and port traffic.

While Singapore remains the leading port in the region, it has little space to expand and few land connections. Sabah is at the heart of the area where intercontinental and intra-Asian sea trade routes meet. Also, Sabah offers available and affordable land. With the development of the Pan Borneo Highway, land transportation/logistics are becoming more efficient. Coupled with strong natural resource positions, Sabah is also an attractive tourist destination with growing industries in cruise and medical tourism.

In addition, the shipbuilding and repair industry is active in Malaysia but is regionally distinct by vessel focus. While shipyards in Peninsular Malaysia focus on steel and aluminum vessels for the oil and gas industry and federal government, Sabah primarily handles steel vessels for offshore supply, tug and barge, and river ferries.

Today, Sabah has nine ports servicing 370,000 twenty-foot equivalent units (TEUs) annually (Table 26). These ports have an outgoing cargo base largely derived from agriculture and timber in the area and are poised for growth in new industries. Sabah Ports Sdn Bhd (SPSB), a subsidiary

of Suria Capital Holdings Bhd, operates Sabah’s ports, which are administered by the state government. Numerous port expansion projects are underway in Sabah, from planning stages to active implementation.

Table 26: Sabah Ports and Development Projects (Development Projects shaded)

Port	Authority	Operator	Status
Sapangar Bay Container Port	Sabah Port Authority	SPSB	Premier transshipment hub First expansion will start in 2020 and be completed in 2024 ~\$310 million for the initial phases SPSB open to joint management of port for volume and connectivity
Sapangar Bay Oil Terminal	Sabah Port Authority	SPSB	Refined petroleum products and liquid chemicals Esso, PETRONAS, Shell
Kota Kinabalu	Sabah Port Authority	SPSB	General cargo and dry bulk Jesselton Quay development
Kudat	Sabah Port Authority	SPSB	Proximity to the Philippines General cargo and timber products \$30M new deep-water port pre-feasibility
Kunak	Sabah Port Authority	SPSB	Crude palm oil and palm kernel
Lahad Datu	Sabah Port Authority	SPSB	Robust palm oil, oleochemicals, and bio-diesel Sabah Port prioritized for imports of bulk fertilizer
Sandakan	Sabah Port Authority	SPSB	Palm oil-related products, container, general cargo and dry bulk
Sipitang	Sabah Port Authority	SPSB	Strategic location next to Labuan Port and Brunei Sipitang Oil 7 Gas Industrial PARC (SOGIP) Part of the economic master plan to attract investment and stimulate port development
Tawau	Sabah Port Authority	SPSB	Multipurpose Strategic to Kalimantan region of Indonesia Considered to have the highest potential

The Sapangar Bay Port hosts both bulk liquids and container transshipment sites. The Sapangar Bay Oil Terminal (Figure 68) is dedicated to refined petroleum products and liquid chemicals. Sabah promotes the port as “the oil & gas terminal hub,” given the port’s proximity to major oil and gas facilities, including Shell, Esso, and PETRONAS. A \$5 million expansion is currently underway to add more berth and facilities to accommodate large tankers, including the large-scale supply of bunker and freshwater.

Figure 68: Sapangar Bay Oil Terminal



The Sapangar Bay Container Port (Figure 69), like most other ports in Sabah, handles general cargo and containers. Today, 70 percent of Sabah's total container traffic passes through the port, with cargo growth over several years steadily achieving five to six percent annual growth. While Sabah intends to build Sapangar Bay into a premier transshipment hub for the BIMP-EAGA region, the lack of modernized roads constrains more rapid growth. One of the driving forces of this port expansion project is reducing the cost of living and the prices of goods for residents in the surrounding area. Road development, including the various tender packages described in the Pan Borneo Highway project section, will be required to achieve these efficiencies.

Figure 69: Sapangar Bay Container Port



Sabah had slated a \$310 million, two-phase expansion to begin in late 2019 for the Sapangar Bay Container Port. In part because of the COVID-19 global pandemic, the expansion has been delayed, and is now scheduled to begin at the end of 2020. The Malaysian Federal Government, via development allocations, will participate with the State of Sabah to upgrade the Sapangar Bay Container Terminal into a major transshipment hub. The port recently added two ship-to-shore cranes.

The container port expansion includes the constructing a 1,000-meter jetty, land reclamation of 69 hectares, seabed deepening to 15 meters, seawall construction spanning 1500 meters, superstructure development, geological research and engineering and architecture. In addition, port management, using strategic pricing models, will seek to secure business with mainline operators (MLOs) to fill the expansion.

In combination with the second phase (focusing on cargo handling capability and efficiency, and for which expansion funds have been specifically allocated), the overall Container Port Expansion Project will more than double cargo handling capacity from the current 500,000 to 1.25MM TEUs.

The completion of the first phase is targeted for 2024. The second phase had an original target completion date of 2026, which likely will extend given the project delays. Sabah is considering a third, long-term phase covering the next thirty years.

Sabah ports are behind Peninsular Malaysia in terms of digital enablement. The Malaysian government has set the creation of a single integrated port community system as a priority in its ports strategy. The main objective is to simplify and reduce the formalities, documentary requirements, and procedures during the arrival, stay, and departure of ships at local ports. The desired system will streamline and integrate all the digital services of terminal operators, shipping agents, depots, haulers, merchants, forwarding agents, customs, and other services present. In the fragmented Malaysian port landscape, this may be the sector's biggest challenge. This project will take some steps to advance the digitization process.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

The Sapangar Bay Container expansion project includes two currently-defined phases with a third, more visionary phase under discussion. In conjunction with the Federal Government, Sabah completed a Master Plan in 2017. The State expects construction to begin in late 2020, with completion of the current phase by 2024. The second phase was originally planned for completion in 2026 and will likely be extended.

PROJECT COST AND FINANCING

The Sapangar Container Port Expansion project has a budget of \$310 million. The Federal Government will provide up to \$247 million of the total. Port project development costs in Sabah today are typically lower than in Peninsular Malaysia. Major local and international banks have been active in port financing in Malaysia, with a Sukuk (bond) often being required.

U.S. EXPORT OPPORTUNITIES

Sabah port expansion opportunities are attractive to U.S. firms for several reasons:

- Established port and maritime market.
- Expanding container transshipment hub.
- Supporting ground logistics infrastructure plans/projects.
- Growing cruise ship destination.


Specific U.S. export opportunities include:

- Dock cargo handling products, services, and technologies.
- Port cargo handling transportation equipment.
- Engineering, design, and operations services.

- Project development, architecture, and technical and business consulting services.
- Industry-specialized port handling equipment.
- Smart-port technologies (integrated port community systems and related digital solutions).

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Pan Borneo Highway - Sabah		
	SECTOR	Transportation/ICT
	SUBSECTOR	Surface Transportation
	LOCATION	Sabah, Malaysia
	PROJECT VALUE	\$4 Million Total \$220 Billion – 2020 Packages

PROJECT SUMMARY

The Pan Borneo Highway spans the Malaysian states of Sabah and Sarawak, linking them to Brunei and Indonesia's Kalimantan region. The road is poorly developed, and travel times are impeding overall economic development in the area. While not likely an opportunity for U.S. interests in basic roadbuilding labor and materials (e.g., paving, sand, and gravel), the project is large, the road is long, and the topography presents numerous challenges. Foreign technology capabilities spanning engineered materials/components, heavy equipment, and certain services are desired.

PROJECT DESCRIPTION

Two Malaysian states, Sabah and Sarawak, line the northwestern coastline of the island of Borneo. Given their history and lack of proximity to the government center, Putrajaya, these states have been slower to develop economically than the rest of Malaysia. One impediment to development has been limited and dated transportation infrastructure.

In Malaysia's most recent budget, released on Oct. 11, 2019, the development of modern infrastructure in Sabah and Sarawak was a prominent feature for the first time in 50 years. The budget specifically cited road development, with \$78 million and \$54 million allocated for rural road development in Sabah and Sarawak, respectively.

The main road connecting the two states is the Pan Borneo Highway, a much larger endeavor. The concept for a trunk road connecting the two states with the nation of Brunei, also on the island of Borneo, originated in the 1960s. At that time, the road was called the Trans-Borneo Highway. In the 1970s, Malaysia, Brunei, and Indonesia developed a broader plan to construct a modern highway along the western coast of Borneo to connect Sabah, Sarawak, Brunei, and the Kalimantan region of Indonesia, dubbed the Pan Borneo Highway.

This central trunk road system is Federal Route 1 in Sarawak and Routes 1, 13, and 22 in Sabah. Today the Pan Borneo Highway is over 5300Km (3300 miles) long, but large sections of it remain

a two-lane single carriageway (Figure 70). For example, only 13 percent of the portion between Sarawakian cities Sematan and Lawas is a four-lane highway. Today, that 1151Km (715 miles) trip requires about 20 hours. The planned improvements to the Pan Borneo Highway will cut this time to twelve hours. Thus, the improvement of the Trans Borneo Highway is critical to the overall economic development in both Sabah and Sarawak.

Figure 70: Trans Borneo Highway – Sabah Today⁹⁰



The Malaysian portion of the highway is roughly 1700km (1056 miles) long, with 706km (450 miles) in Sabah and the balance in Sarawak. Road development is progressing in sections in both states. Each state had its own Project Delivery Partner (PDP) until 2019 when Putrajaya (the Malaysian Federal Government) took the oversight. As of June 2020, Phase One of the project is 32 percent completed with the implementation of 11 packages.

The Sabah route is pictured (Figure 71) and its associated economic development areas described below:

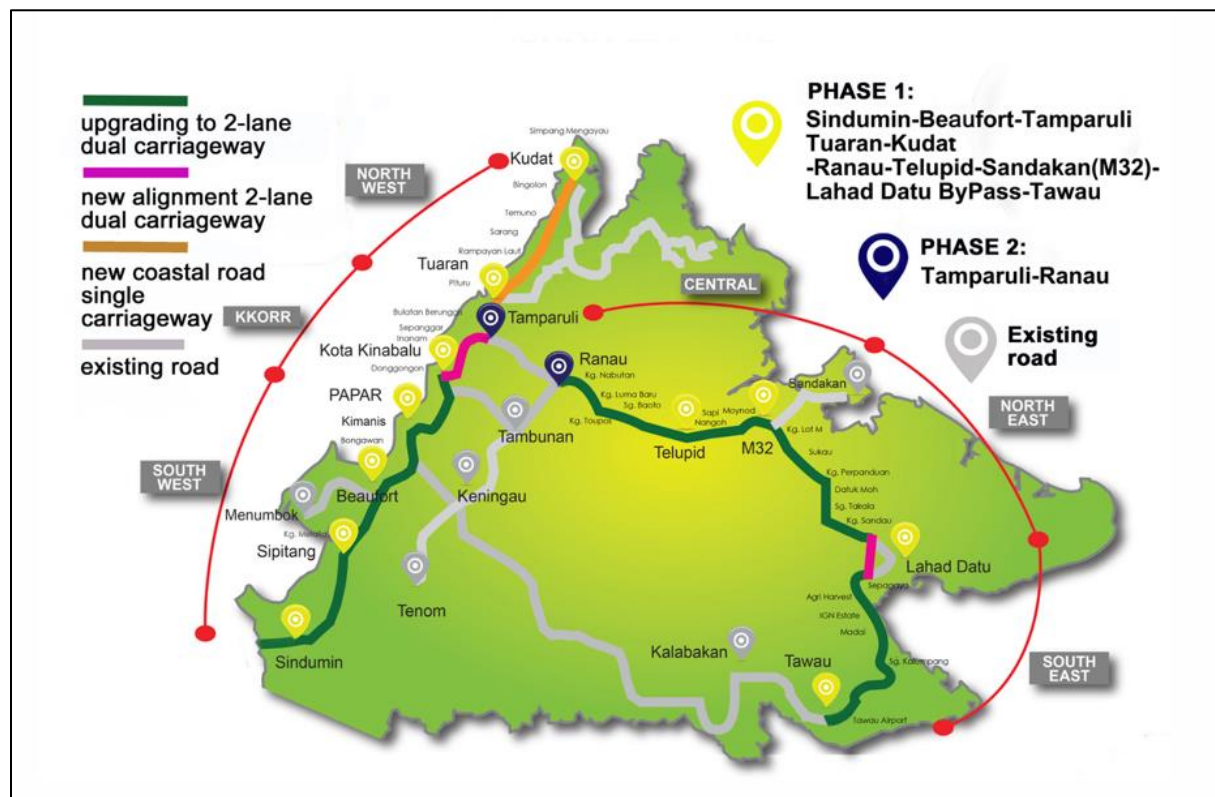
- Marine Integrated Cluster (MIC) in the southeast region (Tawau, Kunak, and Semporna).
- Palm Oil Industrial Cluster (POIC) in Lahad Datu and Sandakan.
- Sandakan Education Hub (SHE) in Sandakan.
- Kinabalu Gold Coast Enclave (KGCE) from Tuaran to Kudat.
- Sepangar Bay Manufacturing and Logistic Cluster (SBMLC) in Sepangar.
- Sabah Agro-Industrial Precinct (SAIP) in the interior south region (Papar, Kimanis, Beaufort, Keningau, Nabawan, and Tenom).
- Sipitang Oil and Gas Industrial Park (SOGIP) in Sipitang.

Much of Sabah's terrain is swampy wetlands, making construction and movement of heavy equipment challenging and engineered bridge hardware necessary. Also, information and communications technology (ICT) infrastructure is not well developed or even existent in certain

⁹⁰ Borneo Post, YouTube

sections. ICT-related improvements are funded under Malaysia's National Digital Infrastructure Plan.

Figure 71: Sabah Pan Borneo Highway Project⁹¹



PROJECT STATUS AND IMPLEMENTATION TIMELINE

Work on the Pan Borneo Highway is already underway, but the effort has been plagued by cost and timing overruns, in part due to the engineering/construction and communications challenges. As of the second half of 2019, the Malaysian Federal Government had assumed oversight of the project.

Phase One, involving 35 packages, covers 706 km starting from the southwestern border town of Sindumin, passing through Kota Kinabalu and wending to the east coast of Sandakan-Tawau. As of June 2020, the progress of Phase One stood at 32 percent, with 11 packages complete.

⁹¹ Borneo Highway PDP Sdn. Bhd. website <http://sabahpanborneo.com/about-us/>

Phase Two involves upgrading the 98km road from Tamparuli to Ranau, while Phase Three develops 432 km in southern Sabah, linking the east coast town of Tawau to interior Keningau and beyond to southwestern Beaufort.

Completion of the highway was initially slated for 2021, but the latest estimate is now 2023. Delays occurred due to changes in policies, the termination of the Project Delivery Partner Agreement (PDPA), and the retendering of several work packages.

The 12th Malaysian Plan (2021-2025), addresses the remaining 20 Packages awaiting approval for tender. The release of the 12th Malaysia Plan is postponed from Aug. 6, 2020, to early next year.

PROJECT COST AND FINANCING

The value of the Pan Borneo Highway project in total is just over \$4 billion. Sections for tender near term in Sabah have a value of \$222 million. The Malaysian Federal Government is funding a portion of the construction, reconfirming its intent in Budget 2021, released on Nov. 6, 2020. The Pan Borneo Highway is featured in a \$3.6 billion (RM15 billion) allocation covering a portfolio of transportation infrastructure development projects. Still, the state of Sabah has a specific desire to attract foreign investment to ensure the success of the project and to speed progress, as the road is a bottleneck to overall economic development in the state.

U.S. EXPORT OPPORTUNITIES

The opportunity for U.S. exports is in engineered materials and components, heavy equipment, and ICT technologies that can speed construction and ensure roadway safety and durability. This project is not a likely opportunity for U.S. interests in basic roadbuilding labor and materials (e.g., paving, sand, gravel). Sabah is desirous of exploring financing options and associated creative business models to speed progress, as ground transportation infrastructure is a critical bottleneck to economic development.


U.S. export opportunities include:

- Engineered road and construction materials (access/rig mats, engineered fabrics, specialty chemicals including adhesives, coatings, and sealants).
- Heavy equipment and local MRO inventory.
- Roadway safety supplies (roadside and lane identification, signals, temporary barriers, and markers).
- Highway communications and control systems (overlap with Malaysia's National Digital Infrastructure efforts).
- Bridge design and installation services.
- Bridge hardware (hangers, overhang brackets, forms, specialized structural components).
- Smart street lighting (luminaires).
- Design and project/operations management services.

The State of Sabah is also interested in and open to considering unique and creative business models proposed by foreign investors to hasten road development. These include design-build-own-operate-transfer (DBOOT) models, as have been used for the development of water utilities and some toll roads.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
<p>Jabatan Kerja Raya (Ministry of Works) Beg Berkunci 2032 Jalan Sembulan 88582 Kota Kinabalu Malaysia Datuk Seri Bung Moktar Radin, Minister +60 (088) 244333</p>	<p>Indo-Pacific Region 1101 Wilson Blvd. Suite 1100 Arlington, VA 22209 USA Mr. Kevin Toohers Country. Manager ktoohers@ustda.gov</p> <p>U.S. Trade and Development Agency GPF Witthayu Tower A, Suite 302 93/1 Wireless Road Bangkok, 10330 Thailand Mr. Brandon Megorden Regional Manager fo Asia bmegorden@ustda.gov</p> <p>IndoPacific@ustda.gov www.ustda.gov</p>	<p>U.S. Embassy Kuala Lumpur 376 Jalan Tun Razak 50400 Kuala Lumpur Mr. Dennis Simmons Senior Commercial Officer</p> <p>Phone: 60-3-2168-5000 dennis.simmons@trade.gov</p> <p>www.trade.gov</p>

Laem Chabang Port - Phase III Expansion		
	SECTOR	Transportation Infrastructure
	SUBSECTOR	Ports
	LOCATION	Sriracha, Chonburi, Thailand
	PROJECT VALUE	\$3.8 Billion

PROJECT SUMMARY

The Port of Laem Chabang, Thailand will undergo a \$3.8 billion (THB 114 billion) Phase III expansion designed to increase its container and roll-on/roll-off cargo capabilities and improve linkages with domestic and international rail lines. With the goal of becoming the premier port in the region, Laem Chabang will integrate automation technologies to improve efficiencies and safety. Operations at the expanded facilities will begin in 2025.

PROJECT DESCRIPTION

As part of Thailand's plan to develop its Eastern Economic Corridor (EEC), the Port of Laem Chabang will undergo a Phase III expansion. The expansion is one of the megaprojects the EEC is developing under a public-private partnership (PPP) model. The port has an area of 2,536 acres and is located on Thailand's eastern seaboard in Sriracha, Chonburi, approximately 130 kilometers from Bangkok (Figure 72). Laem Chabang is operated by the Port Authority of Thailand (PAT).

Laem Chabang is Thailand's largest commercial port, currently handling 54 percent of Thailand's imports and exports. The majority of the throughput is containerized cargo, plus approximately one million vehicles annually. Two previous construction phases created the port's ability to handle 11 million twenty-foot equivalent units (TEU) per year.

With the Phase III expansion, Laem Chabang will increase container capacity to 18 million TEU and vehicle handling to 3 million per year. The percentage of shipments via rail will increase to 30 percent, along with an increase in automation. The Port Authority of Thailand (PAT) aims for Laem Chabang to compete with, or surpass, Singapore as the premier port in the region. Container throughput has grown rapidly (Figure 73) and PAT projects continued strong growth.

Figure 72: Laem Chabang Port Terminal III⁹²

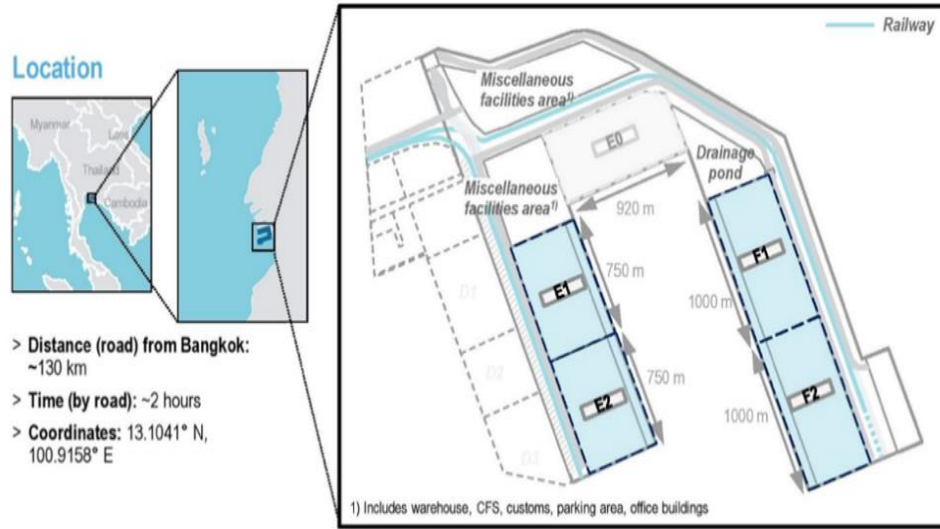
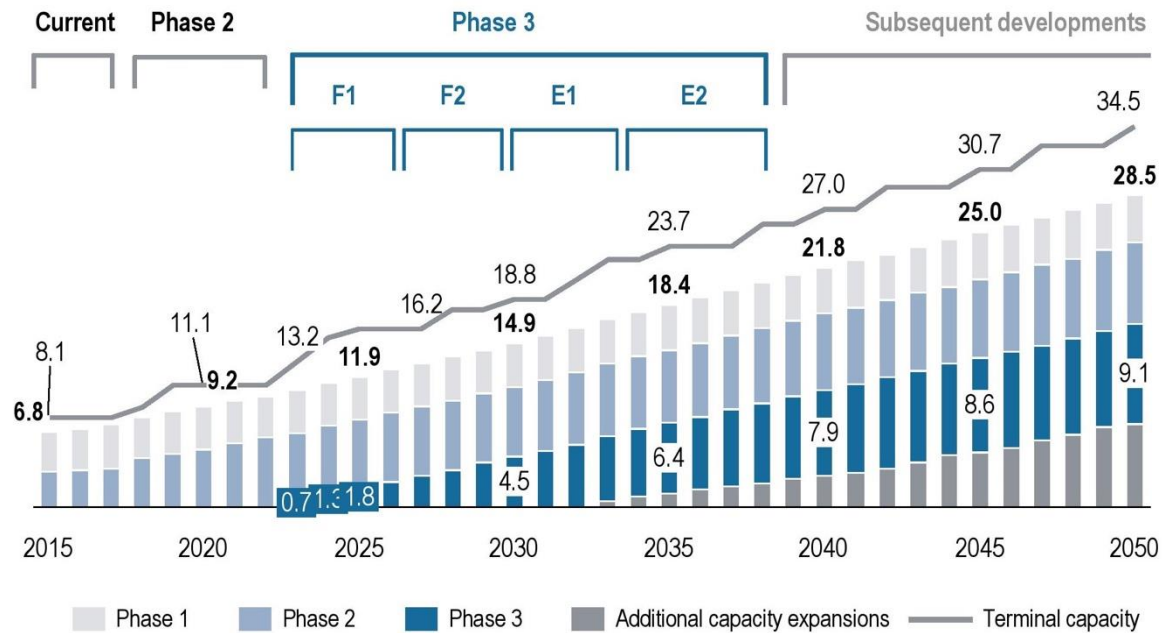


Figure 73: Laem Chabang Port – Historical TEU Capacity and Phase III Projections⁹³



1) Productivity improvement from 2,130 TEU per berth meter in 2015 to 2,900 TEU per berth meter in 2050

⁹² TEAM Group

⁹³ Ibid

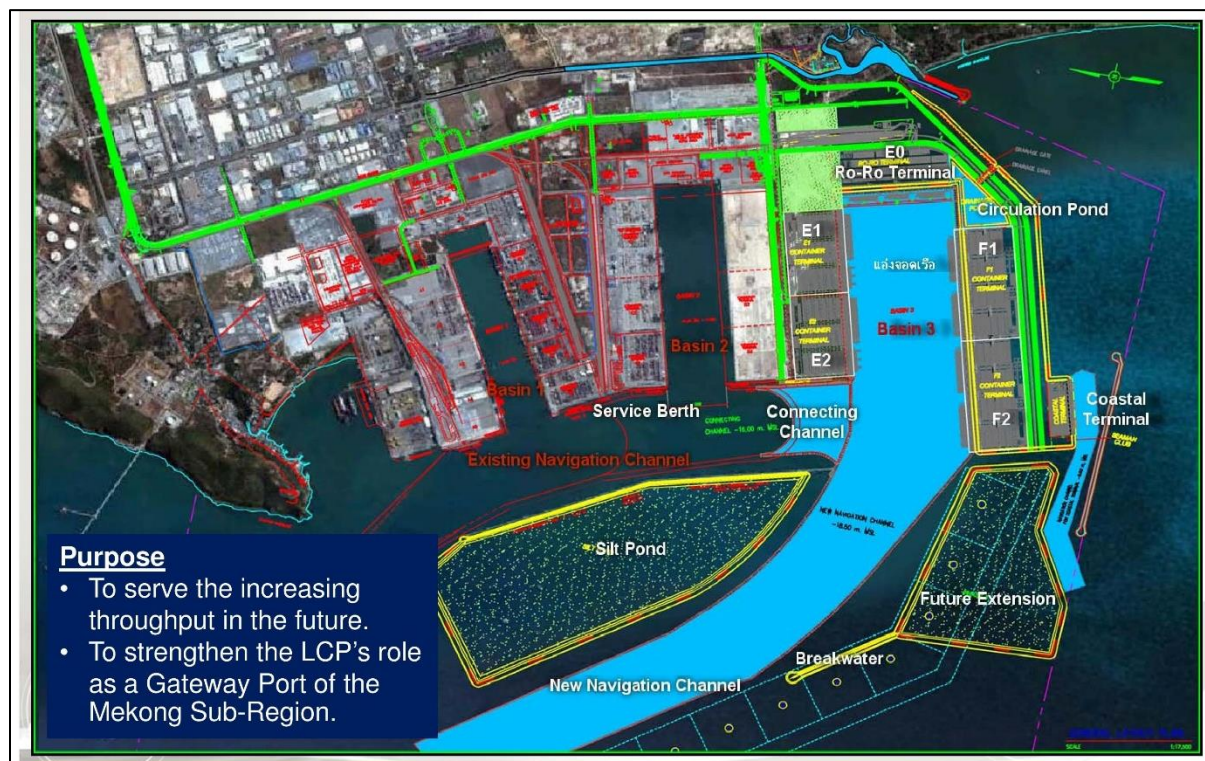
The existing port infrastructure includes:

- Eleven container berths.
- One cruise ship/roll on-roll off (Ro-Ro) terminal.
- One dedicated Ro-Ro terminal.
- One container berth.
- One general goods berth.
- One bulk goods berth.
- One repair and maintenance shipyard.

The Phase III expansion project (Figure 74) will add the following components:

- Four international container terminals (E1, E2, F1, F2) with a combined capacity of seven million TEU/year.
- One domestic coastal terminal (adjacent to F2), with up to one million TEU/year.
- One multipurpose/Ro-Ro terminal (E0) designed for up to one million vehicles/year.
- Rail lines to connect the new terminals to the existing railway network.

Figure 74: Map of Laem Chabang Port Terminal III⁹⁴



⁹⁴ Port Authority of Thailand

The new infrastructure will add two kilometers to the wharf at Terminal F and more than 2.5 kilometers at Terminal E, with a channel depth of 18.5 meters. The terminal sizes and new water depth will allow Post-Panamax vessels to dock. The further integration of rail infrastructure, combined with the ongoing rail network expansion being conducted by the State Railway of Thailand (SRT), will offer even greater domestic connectivity and trade connections with regional neighbors Laos, Cambodia and Myanmar.

During Phase III of the Port expansion, PAT will develop Terminals F1 and F2 first. The E Terminals and the domestic coastal terminal will follow approximately two years later, once land reclamation is complete.

A key element of the Phase III expansion is the integration of port automation technologies. PAT aims to integrate intelligent solutions to improve the efficiency and safety of port operations. Possible technologies include real-time forecasting of ship arrival times, predictive maintenance, automated yard planning, and demand planning at the gate to plan for arrivals and departures.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

In March 2019, PAT received two bids from consortia interested in developing and operating the Laem Chabang Port Expansion. In December 2020, PAT announced its intention to contract with GPC Joint Venture Group for the \$3.8 billion (THB 114 billion) award. Operations will begin in 2025. GPC Joint Venture Group comprises PTT Tank Terminal Company, Ltd. (Thailand), Gulf Energy Development Public Co. Ltd. (Thailand) and China Harbor Engineering Company (China).

In July 2020, PAT approved the CNCC Joint Venture to carry out the land reclamation based on the CNCC JV's winning offer through an e-bidding process. CNCC JV includes NTL marine (a subsidiary of Prima Marine (Pakistan)), Nathalin (Thailand) and Zhonggang Construction Group (China). Construction began in Q3 2020 and will be completed within four years.

Construction will begin in early 2021 on Terminals F1 and F2. Terminal F1 will be operational by 2024. PAT expects Terminal F2 to be operational by 2027. PAT is currently engaged in seeking a transportation logistics company to manage and operate the F terminals.

The development of Terminal E, which includes two container terminals, the Ro-Ro terminal, and the coastal terminal, is slated to commence approximately two years after construction begins on Terminals F1 and F2. Terminals E1 and E2 will be operational by 2031 and 2035, respectively.

PROJECT COST AND FINANCING

The cost of the expansion of Laem Chabang Port is \$3.8 billion (THB 114 billion). The project is a public-private partnership (PPP), with the government providing \$1.8 billion (THB 53.5 billion) and the private sector partners contributing the remaining \$2 billion (THB 60.6 billion).

The government will be responsible for reclaiming the land where the terminals will be positioned and for the construction of the utility systems. The PPP structure calls for the private sector partners to design, build, operate, and maintain the facility for a period of 35 years. The original budget for land reclamation was \$730 million (THB 21.95 billion). CNCC JV won the bid for a below-budget offer of \$710 million (THB 21.32 billion).

US EXPORT OPPORTUNITIES

The expansion of the Laem Chabang Port presents opportunities for U.S. firms to become involved. PAT will require both equipment and services to make the expansion a success. Currently, the U.S. firm PwC is serving as a port advisor to the Eastern Economic Corridor Office.


U.S. companies may expect strong competition from Asian and European firms who have experience with port developments in Southeast Asia, as well as China, Korea and Japan.

Specific opportunities for U.S. firms related to the Phase III expansion of Laem Chabang include the following:

- Construction supervision and management.
- Engineering and design services.
- Water and wastewater treatment facilities.
- Waste treatment facilities.
- Hazardous waste treatment technologies.
- Automation solutions.
- Intelligent transportation.
- Access control.
- Telecommunications solutions.
- Cybersecurity technologies.
- Dredging equipment.
- Barges.
- Terminal lighting.
- Navigational aids.
- Quay and yard cranes.
- Vessel traffic management system.
- Power supply equipment.
- Terminal operating system.
- Transtainers and container inspection/security equipment.
- Rail signaling.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
Port Authority of Thailand 444 Thanon Tharua Klongtan, Klong Toei Bangkok 10110 Thailand Lt. JG Kamolsak Promprayoon, RTN kamolsak_p@port.co.th www.port.co.th	Indo-Pacific Region 1101 Wilson Blvd. Suite 1100 Arlington, VA 22209 USA Mr. Kevin Toohers Country Manager ktoohers@ustda.gov U.S. Trade and Development Agency GPF Witthayu Tower A, Suite 302 93/1 Wireless Road Bangkok, 10330 Thailand Mr. Brandon Megorden Regional Manager for Asia bmegorden@ustda.gov IndoPacific@ustda.gov www.ustda.gov	US Commercial Service GPF Witthayu Tower A, Suite 302 93/1 Wireless Road Bangkok, 10330 Thailand Ms. Oraphan Boonyalung oboonyal@trade.gov www.export.gov/thailand

SRT Network Expansion		
	SECTOR	Transportation Infrastructure
	SUBSECTOR	Rail
	LOCATION	Thailand
	PROJECT VALUE	\$15 Billion Network-wide >\$120 Million Rolling Stock

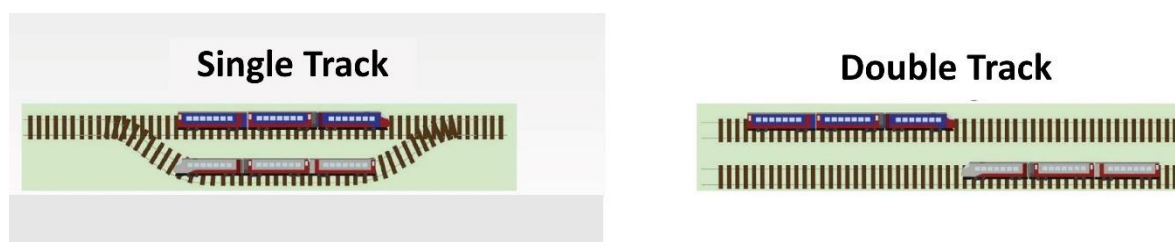
PROJECT SUMMARY

The State Railway of Thailand (SRT) is embarking on a massive infrastructure development plan throughout the country. Within the next 10 years, SRT will double track up to 80 percent of its intercity rail network. The upgrade will also include new investments in signaling and telecommunications. Contemporaneously, SRT will purchase and lease substantial new rolling stock, specifically new and refurbished locomotives, new diesel multiple units (DMUs) or bi-mode multiple units (BMUs), and flat cars to transport goods and passengers throughout the expanded system.

PROJECT DESCRIPTION

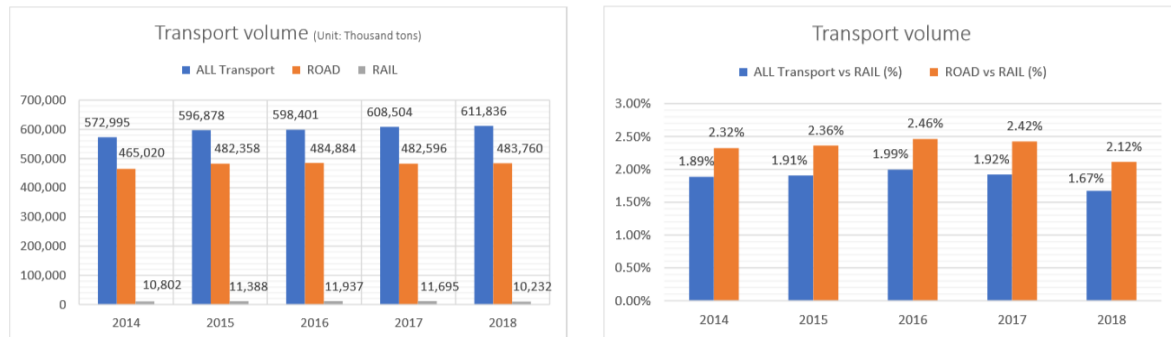
As part of the Thai Transport Infrastructure Development Plan 2015-2022, Thailand plans to expand its existing rail network (Figure 75) significantly by increasing double-tracking across the SRT system (Figure 76). In 2020, 650 km of Thailand's 4,044 km of track was double- or triple-tracked. The remaining 3,394 km was single-track, resulting in delays and inefficiencies in transporting passengers and cargo. To reduce congestion on roads by shifting cargo transport to rail, significant system upgrades are necessary.

Figure 75: Single and Double Track Layouts⁹⁵



⁹⁵ Office of Transport and Traffic Policy and Planning

Figure 76: Thailand Rail Transport Volumes⁹⁶



By 2022, Thailand aims to add 993 km of double-tracked rail, expanding that amount to 2,161 km by 2027 (Figures 77 and 78). By 2027, SRT expects approximately 78% of its network to be double-tracked with new signaling, automatic train protection systems, and a telecommunications network. The Thai government has expressed strong support for SRT's double-tracking projects, with an overall goal of increasing the market share of rail transportation in Thailand.

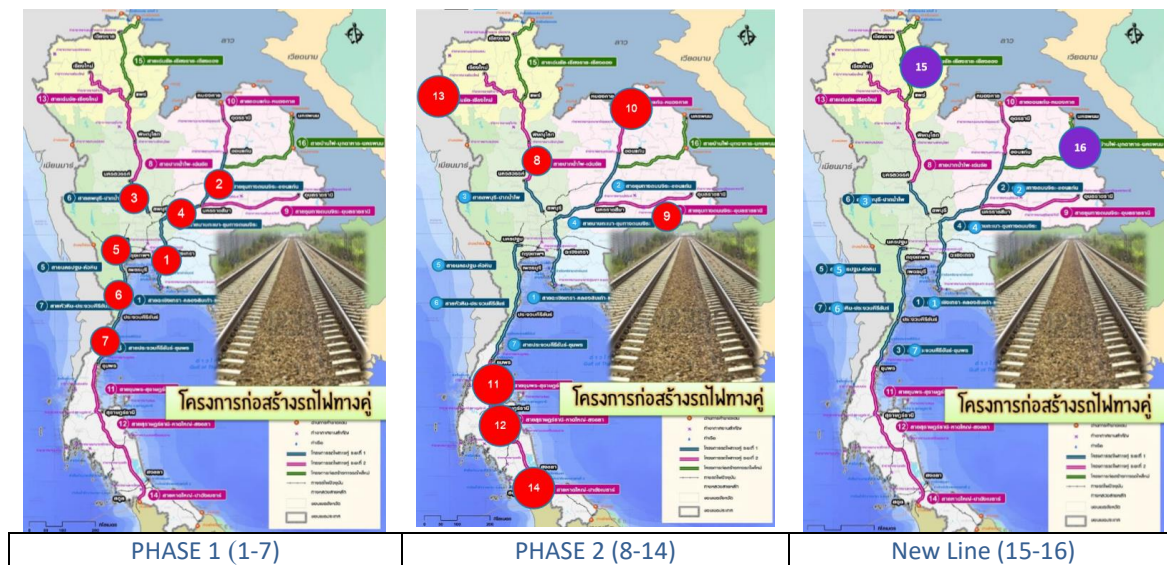
Figure 77: Current Thailand Rail Transportation Network⁹⁷



⁹⁶ State Railway of Thailand

⁹⁷ Ibid

Figure 78: Expanded Thailand Rail Transportation Network⁹⁸



In 2019, SRT completed double-track construction with signaling in the Chachoengsao to Kaeng Khoi section, including incorporating three chord lines at Chachoengsao Kaeng Khoi Junction and Ban Phachi Junction. The chord lines reduce the shunting, or switching, time for locomotives at the junctions. With this project, SRT is able to:

- Increase the freight trains' average speed in the section from 26-28 to 60 km/h.
- Facilitate greater freight train transportation of up to three times current capacity.
- Reduce fuel costs and other expenses, while improving punctuality.

SRT expects these improvements to increase cargo-customer confidence in shifting more of their logistics to rail service. Important SRT customers include liquefied petroleum gas (LPG), oil and container shippers at the Inland Container Depot (ICD) Lat Krabang and Laem Chabang Port. SRT is working with the private sector operator at ICD Lat Krabang to better service all freight trains and cooperates with the single-rail transfer operator (SRTO) at Laem Chabang Port. With the planned service upgrades, SRT expects to increase the associated amount of railway transportation from 350,000 to 400,000 TEU per year (with a TEU average weight of 15 tons) to 800,000 TEU per year.

For future cargo transportation, SRT has studied a new concept, under a feasibility study, with the JR-Freight company. The study addressed small-size container applications to Thai consumer goods markets, including parcels. The study also explored opportunities for border transportation between Thailand and neighboring countries, with a target market of about 38 million tons of railway transportation by 2027.

⁹⁸ Ibid

An important objective of the rail network expansion is increasing passenger travel, particularly in the Bangkok metropolitan area and for travelers making journeys of 250 to 300 km. Better connections from the central Bang Sue Station to nearby provinces is a focal point.

SRT plans to extend electric commuter train (CT) service in the red line project areas (Figure 79), including:

- Rangsit - Thammasart University, Siriraj - Taling Chan – Salaya (Mahidol University).
- Bang Sue station - Hua Mak station.
- Bang Sue station - Hua Lamphong station.

Figure 79: Expanded Thailand Rail Transportation Network⁹⁹



SRT also expects to prepare the infrastructure for long-distance (LD) electric train service to other provinces, including Ayutthaya, Nakhon Pathom, Chachoengsao and Ratchaburi (Pak Tho district). Further, SRT will develop additional railroad links to major provinces, for example, constructing high-speed tracks from Bangkok to Nakhon Ratchasima and Nong Khai and track connecting three Bangkok-area airports.

⁹⁹ Ibid

SRT has signed an agreement with Charoen Pokphand (CP) Group for the high-speed rail linking the three airports—Don Mueang (DMK), Suvarnabhumi (BKK) and U-Tapao (UTP). The railroad has created Eastern High-Speed Rail Linking Three Airports Co., Ltd. (EHSR) as the vehicle to manage the project. Preparations to deliver the construction area, including the relocation of public utilities, are in process. SRT is conducting due diligence to explore the transfer of the airport rail link system to EHSR within two years following the final contract signature. The high-speed rail linking the airports will commence service by 2026.

Substantial rolling stock additions will be required to support the rail network expansion. SRT has already received 20 electric diesel locomotives of 20 tons/axle since 2015 for freight train operations. SRT has also procured 308 bogie flat wagon cars since 2016 to support increased container weights following railway track additions capable of carrying loads of 20 tons per axle.

The railroad plans to lease diesel-electric locomotives to support the track-doubling project and associated new double-track lines for Phase 1, with a total distance of approximately 1,000 km. Phase 1 includes two new double-track lines, one from Den Chai to Chiang Rai to Chiang Khong (323 km) and the other from Ban Phai to Mukdahan to Nakhon Phanom (355 km). This portion of the expansion will be complete during 2024 and 2025 and support cargo shifting from road to railway.

SRT passenger trains include two types: 1) public service operations (PSO) trains; and 2) commercial trains, which currently convey 32 percent of total passengers. SRT is focusing new developments on the commercial passenger group, of approximately 11 to 12 million passengers annually, as the commercial market represents approximately 90 percent of total passenger revenue.

SRT expects to procure 965 bogies for domestic assembly through 2023. For passenger traffic, the railroad expects to procure 184 BMUs by 2024 for service within a 250 to 300km radius of Bangkok. Although SRT is about to begin undertaking tenders for the refurbishment of 57 existing locomotives (36 General Electric and 21 Hitachi), ultimately, SRT plans to shift its locomotive fleet to electric, focusing first on transport within a 250 km radius of Bangkok. In Q3 2020, SRT contracted with Chinese state-owned CRRC Corporation for 50 new diesel-electric locomotives.

SRT will source the locomotives from overseas suppliers but will try to establish and expand local capabilities to support the flat cars and bogies. The railroad will source the flat cars from Thailand over the next ten years, but the bogies will originate outside the country. SRT is encouraging manufacturers to invest in Thailand to service their bogies within 5-10 years. SRT will develop long-term maintenance contracts with bogie manufacturers able to undertake maintenance on the equipment domestically.

The new locomotives and flat cars will support the Thai government's plan to shift transport away from road and air to a safer and more economic expanded rail network. In 2016, the share of rail transport was only one percent, with road transport making up 92.6 percent. SRT expects the proportion of rail freight to increase to 4 to 5 percent as a result of the project.

For passengers, rail is used only 3.7 percent of the time, with cars and buses on roads and highways, representing nearly 90 percent of passenger travel. The new track, locomotives, and flat cars will provide SRT with the means to offer rail services to decongest Thailand's road network. Passenger rail competes with low-cost airlines, and SRT believes assertive marketing will be required to shift the pattern. SRT expects the target market of 10-11 million passengers per year to double by 2027.

The final component of the SRT network expansion is installing signaling and telecommunications along the newly constructed rail lines. In 2019, SRT awarded three contracts for three different rail lines.

- Southern Line (Nakhon Pathom to Chumporn) to China Railway Signal & Communication Co., Ltd. (China)
- North Line Lop Buri to Pak Nam Pho to Bombardier Transportation Signal (Thailand) Co., Ltd.
- North-East Line Map Kabao to Thanon Chira Junction LSIS Co., Ltd. (Korea)

The Thai Government has also approved the construction of double-tracking (meter gauge), including a modernized train control system, for two new lines and is preparing the process for construction tenders expected in 2021:

- **New Northern Route** - among Denchai - Chiang Rai - Chiang Khong. The line will pass through Phrae, Phayao, and Chiang Rai and reach the border of Laos PDR at Chiang Khong District, covering a total distance of 323 km.
- **New Northeast route** - among Banpai - Mokdahan - Nakhon Panon, covering a total distance of 355 km.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

The double-tracking project is in the construction phase, and procurement is ongoing. The project will be complete in 2027 with interim completion dates for various portions. The high-speed rail connecting the three airports in the Bangkok metropolitan area, similarly, will be complete by 2026. SRT will offer construction tenders for two new rails lines in 2021 but has not announced target completion dates yet.

With respect to rolling stock, SRT procured 20 locomotives from CRCC Corporation Limited (then CSR Corporation), a Chinese state-owned locomotive manufacturer, approximately five years ago. On August 21, 2020, SRT signed a contract for 50 new locomotives. Tenders for the refurbishment of 57 older locomotives will be released in early 2021, with work completed by 2025. Of the locomotives to be refurbished, 36 are General Electric, with the balance Hitachi (HID) locomotives. SRT expects to release the GE refurbishment tender in January 2021 and contract by midyear. SRT expects to release the Hitachi refurbishment tender early in 2021, with work beginning Q4 2021. The draft tender for the BMUs is currently undergoing internal approval.

The tenders for 965 flat cars and bogies will be issued periodically over the next ten years, with incentives to encourage domestic maintenance and require local content requirements for spare

parts. Tenders for signaling and telecommunications for two new, double-tracked rail lines of 350-km each will be issued in 2021.

PROJECT COST AND FINANCING

The SRT rail network expansion's overall investment, including double-tracking, signaling, and rolling stock, will exceed \$15 billion. The 57 refurbished locomotives will require an investment of \$60 to 75 million. The new diesel locomotives will cost approximately \$2 million each.

SRT will finance the network using a combination of methods, including public-private-partnerships, government-directed resources, and SRT funds. However, SRT has significant debts and has been losing money annually for several years. SRT expects network coverage expansions and service quality improvements from the expansion to shift significant road cargo to rail. The shift will improve the railroad's capacity utilization and improve finances.

US EXPORT OPPORTUNITIES


U.S. firms are well-positioned to secure diesel locomotive supply and refurbishment contracts. G.E. manufactured many of the locomotives planned for service. The U.S., however, does not manufacture electric locomotives. On the signaling side, European and Asian firms have won the previous three tenders.

Opportunities for U.S. firms include:

- New locomotives.
- Refurbishing locomotive contracts.
- Long-term maintenance contracts.
- Bogies (trucks).
- Signaling systems.
- Telecommunications systems.
- Engineering services.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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Bangkok Airport Expansion and Thailand Airport Additions		
	SECTOR	Transportation Infrastructure
	SUBSECTOR	Airports
	LOCATION	Bangkok, Thailand
	PROJECT VALUE	\$4.2 billion

PROJECT SUMMARY

Airports of Thailand (AoT) is planning for new terminal construction at Bangkok's two main international airports, Suvarnabhumi (BKK) and Don Mueang (DMK), to ease overcrowding at both locations. With a combined value of \$2.5 billion (THB 75 billion), these two projects are part of a larger infrastructure improvement plan in the Eastern Economic Corridor (EEC). Both projects are awaiting final approvals from the government before they can proceed.

Thailand is also planning new airports for Chiang Mai and Phuket (Phang Nga). The Chiang Mai airport will require an investment of approximately \$525 million (circa THB 16 billion). AoT estimates the Phang Nga airport will require an investment of \$366 million.

PROJECT DESCRIPTION

The Bangkok metropolitan area is currently served by two major international airports, Suvarnabhumi (BKK) and Don Mueang (DMK). A third airport, U-Tapao, is under construction.

In 2018, combined passenger traffic at BKK and DMK was 104 million, well above their combined rated capacity of 75 million. AoT, the operator of these airports and four others across the country, is planning to construct new facilities in both locations and a new airport in Chiang Mai, to ease overcrowding and boost overall passenger-handling capacity. Tourism, prior to the COVID-19 global pandemic, was a critical factor in Thai airport traffic (Table 27), with the Tourism Council of Thailand estimating a 5.5 percent increase for 2019 over 2018. The country expects the growth trend to continue post-pandemic.

DMK is the older of Bangkok's two current airports. First constructed in 1914 and opened to commercial flights in 1924, DMK has undergone two previous development phases. AoT had planned to close DMK following Suvarnabhumi's (BKK's) construction and operation. To manage increasing passenger flows, however, the airport remained open and now primarily serves the low-cost carrier (LCC) market.

Table 27: Airports of Thailand Statistics - 2018¹⁰⁰

	Passenger Volume		Aircraft Movements (flights)		Cargo and Mail (tons)	
	2018	% change from 2017	2018	% change from 2017	2018	% change from 2017
Suvarnabhumi	63,379,077	4.14%	369,476	5.41%	1,494,599	3.80%
Don Mueang	40,758,148	6.42%	272,361	6.08%	55,250	-18.48%
Chiang Mai	10,989,869	7.42%	78,210	8.63%	14,612	-17.18%
Hat Yai	4,256,107	-2.55%	29,203	-2.87%	8,440	-27.05%
Phuket	18,221,525	8.11%	118,280	11.49%	60,950	14.34%
Chiang Rai	2,867,289	14.54%	20,072	13.65%	3,545	-26.56%
Totals	140,472,015	5.53%	887,602	6.54%	1,637,398	2.65%

The planned DMK (Figure 80) third phase of development will:

- Demolish the existing and construct a new international terminal.
- Improve the existing terminals.
- Add airport frontage and additional parking.
- Upgrade utilities and internal driveways.

AoT will demolish the existing Terminal 3 (8 million passengers per year) and replace it with a new international terminal serving 16.5 million passengers annually. Terminals 1 and 2 will also receive upgrades to increase their combined capacity to 22 million domestic passengers annually (Figure 80). Overall, capacity will be expanded from 30 to approximately 40 million passengers annually.

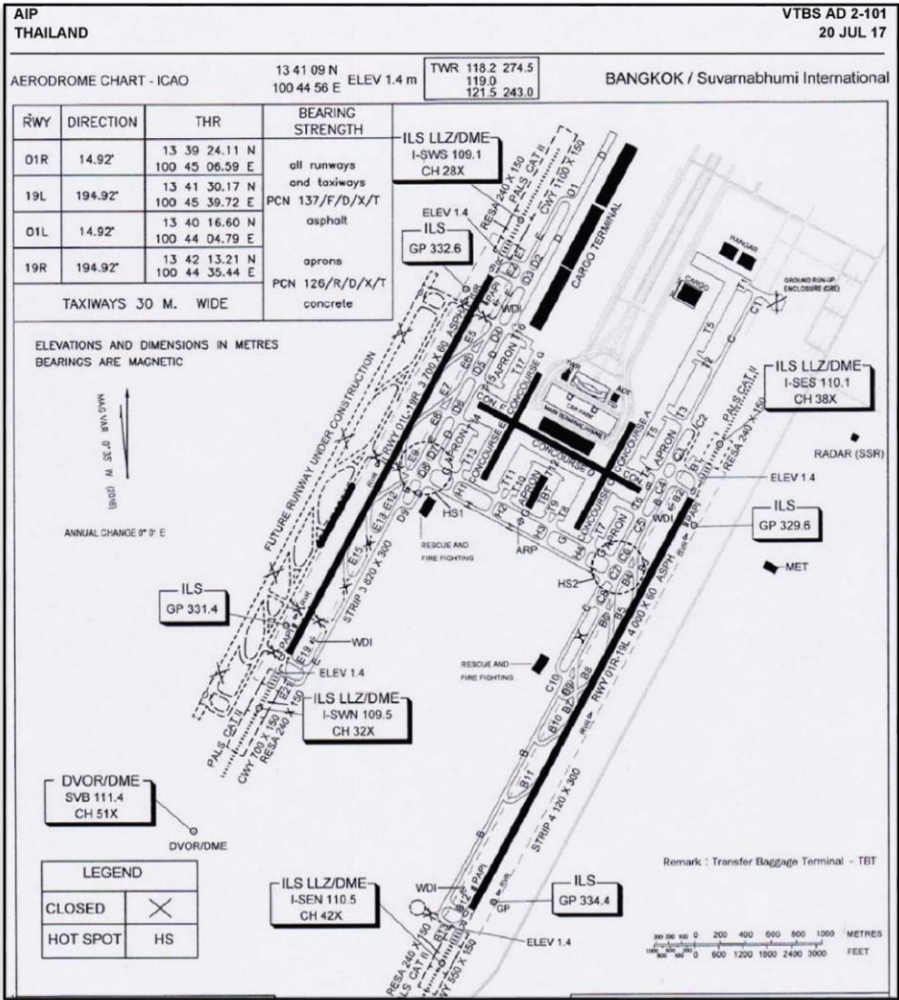
AoT has encouraged carriers operating out of DMK to use wide-body aircraft to ease congestion on the ground. Wide-body aircraft require fewer airport slots than narrower vessels to accommodate the same number of passengers. AoT had projected by the end of 2019, DMK would again exceed its maximum passenger handling capacity, with 41 million passengers expected in 2021 and 45 million passengers by 2023. DMK's runways have reached their full capacity of 52 flights per hour. Given its location, the airport is not able to expand or construct another runway.

BKK (Figure 81) opened in 2006 with a capacity of 45 million passengers per year. Before the COVID-19 global pandemic, BKK was handling over 63 million passengers annually. A second terminal has been proposed to ease overcrowding and is awaiting final approval from the government following disagreements over its location. The current design and site (northeast of the existing terminal) are not in line with the original master plan (i.e., terminal location south of the current one) developed over 10 years ago. Discussions are ongoing regarding which site would be the best solution to the overcrowding.

¹⁰⁰ Airports of Thailand.

flights/hour. The addition of a third will increase that figure to 94 flights/hour. The Cabinet has already approved this runway expansion, and work will soon commence on its construction.

Figure 81: Layout of Suvarnabhumi Airport¹⁰²



Additionally, AoT is currently developing Terms of Reference (ToRs) for feasibility studies for two new airports, one in Chiang Mai and the other in Phuket (Phang Nga) with contractor selection expected by April 2021.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

The expansion project at DMK is in the advanced planning process. On October 20, 2020, the Office of the Economic and Social Development Council (NESDC) reviewed the Master Plan and

¹⁰² International Virtual Aviation Organization

the North Expansion Structure proposal. AoT has prepared additional information for NESDC as a result.

On November 27, 2020, the Office of Natural Resources and Environmental Policy and Planning (ONEP) presented an environment impact study to the Committee of Environmental Impact Screening Experts meeting and invited AOT to provide details of the project. The committee acknowledged the receipt of the study and requested AOT to revise the report. AOT is now working on revisions to present to the committee.

During its 4Q 2020 Board meeting, the AoT Board endorsed revised details for project development, including a review of passenger numbers and project scope in light of COVID-19. The COVID-19 assessment was submitted to MOT for review on October 16, 2020.

Upon resolution of items pending, AoT expects cabinet approval in early 2021, with selection of design and build contractors later in the year. The Target completion date for the project is 2026.

Before COVID-19, AoT was studying whether the site would help alleviate the overcrowding at the existing terminal, as well as its effect on transportation and traffic flows in the area. A key consideration is a linkage between the BKK Airport and the soon-to-be-constructed high-speed rail link connecting all three Bangkok area airports (BKK, DMK, and U-Tapao).

AoT projects BKK passenger traffic will return to pre-pandemic levels by 2023. In December 2020, however, AoT announced its intention to revise the plan for BKK's northern expansion based on "a new normal" due to the COVID-19 global pandemic, estimating two months for the plan revision. Capacity and budget have been adjusted downward by approximately 10%.

The Airport Development Planning Department of AOT submitted a study and project analysis for the North Expansion of Suvarnabhumi Airport Development Project Phase 3 to the Ministry of Transport (MOT) on December 16, 2019. The Minister of Transport endorsed the study on July 9, 2020. The Office of National Economic and Social Development Council (NESDC) accepted the project for review on October 7, 2020 and now the project is pending the NESDC meeting resolution. AoT expects project implementation to be complete in 2023.

Planning for other airports within AoT's system is also underway. AoT has proposed to the government a new airport in Chiang Mai for approval. Investment for the Chiang Mai airport is estimated at \$635 million (THB 19 billion, up from prior estimates of THB 16 billion). The AOT Board of Directors approved the additional budget on November 25, 2020. AOT has received budget approval to hire a consultant to conduct a Preliminary Feasibility Study. At present, AOT is preparing the Terms of Reference (ToR) for the feasibility study scope of work, with:

- Contractor selection expected by April 2021.
- Completed study to be submitted within 12 months of award.
- Presentation of the final study to MOT and CAAT (The Civil Aviation Authority of Thailand) by October 2023.

An airport in Phuket (Phang Nga) is also under consideration. AoT received budget approval of \$370,000 (THB 11 million) for fiscal year 2021 to hire a consultant to conduct a preliminary feasibility study and investment assessment and is in the process of preparing the ToR. The timeline for the study includes:

- Selection of contractor by April 2021.
- Study completion within six months of award with deliverable to be submitted by October 2021.
- Presentation of the final study to MOT and CAAT by January 2022.

In December 2020, the Thai government announced the country would remain closed to tourism through at least the beginning of 2Q 2021. This announcement may presage further airport development project delays.

PROJECT COST AND FINANCING

The overall cost of AoT's airport development and expansion plan is approximately \$3.7 billion (THB 111 billion), including:

- \$1.375 billion (THB 41.2 billion) for the new BKK terminal.
- \$720 million (THB 21.7 billion) for the third runway at BKK.
- \$1.1 billion (THB 32 billion) for expansion and upgrades at DMK.
- \$640,000 (THB 19 million) for the Chiang Mai preliminary feasibility study.
- \$370,000 million (THB 11 million) for the Phang Nga (north of Phuket) preliminary feasibility study.

US EXPORT OPPORTUNITIES

The expansion of two existing Bangkok airports and construction of a new one, to accommodate increasing passenger flows, provides significant equipment and services export opportunities for U.S. firms. Thailand is a net importer of products in the aviation sector, including aircraft, parts, maintenance services, and airport/ground support equipment.

Historically, Thailand has been quite receptive to U.S.-sourced aviation equipment and technology. Nonetheless, significant competition does exist from regional competitors in China, Japan, Australia, and Korea, as well as from European suppliers in the UK, France and Italy.

Specific opportunities include:

- Construction supervision and management.
- Project management.
- Engineering and design services.
- Jet bridges.
- Access control technologies.

- Telecommunications equipment.
- Security screening and monitoring technologies.
- Ground handling equipment.
- Baggage claim equipment.
- Cybersecurity solutions.
- Air traffic control and management technologies.
- Cybersecurity solutions.
- Access control solutions.
- Runway lighting and signals.
- Navigational aids.
- Firefighting equipment.
- Water treatment technologies and systems.
- Power plant/supply.
- Airspace planning.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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U-Tapao International Airport Development		
	SECTOR	Transportation Infrastructure
	SUBSECTOR	Aviation
	LOCATION	Rayong, Thailand
	PROJECT VALUE	\$6.6 Billion

PROJECT SUMMARY

As part of Thailand's plan to develop the Eastern Economic Corridor (EEC), U-Tapao International Airport, located in Rayong, will be expanded, in the first phase, to include a new passenger terminal, MRO facility, air cargo facility, and an aviation-training center. This \$6.6 billion (THB 200 billion) project will spur further investment in the EEC area and ease the burden of passenger congestion at Bangkok's two other international airports. Due to the COVID-19 global pandemic, the MRO facility, for which the Thai government had attempted to create a joint venture with Airbus SAS, has been suspended until the aviation sector recovers.

Thailand plans a total of four development phases at the U-Tapao International Airport over the fifty-year contract. Starting with the land handover to the PPP Co. (the project's public-private partnership), the project will ultimately create a passenger-handling capability of 60 million passengers annually.

PROJECT DESCRIPTION

To combat overcrowding in Bangkok's two main international gateways, Suvarnabhumi (BKK) and Don Mueang (DMK) airports, and support the Eastern Economic Corridor development, the Thai government has approved the expansion of the U-Tapao International Airport, located in Rayong. Currently operated by the Royal Thai Navy for civilian and military purposes, U-Tapao is located approximately 150 kilometers (93 miles) from Bangkok (Figure 82).

Both BKK and DMK have exceeded passenger traffic capacity and have expansions planned to meet future traffic projections. In 2018, those two airports saw a combined passenger volume of 104 of 160 million passengers at all airports throughout the country (Figure 83). At BKK, the rated capacity is 45 million passengers, yet the airport saw 63.4 million in 2018. The new U-Tapao airport will accommodate some of the overflows of passengers from both BKK and DMK.

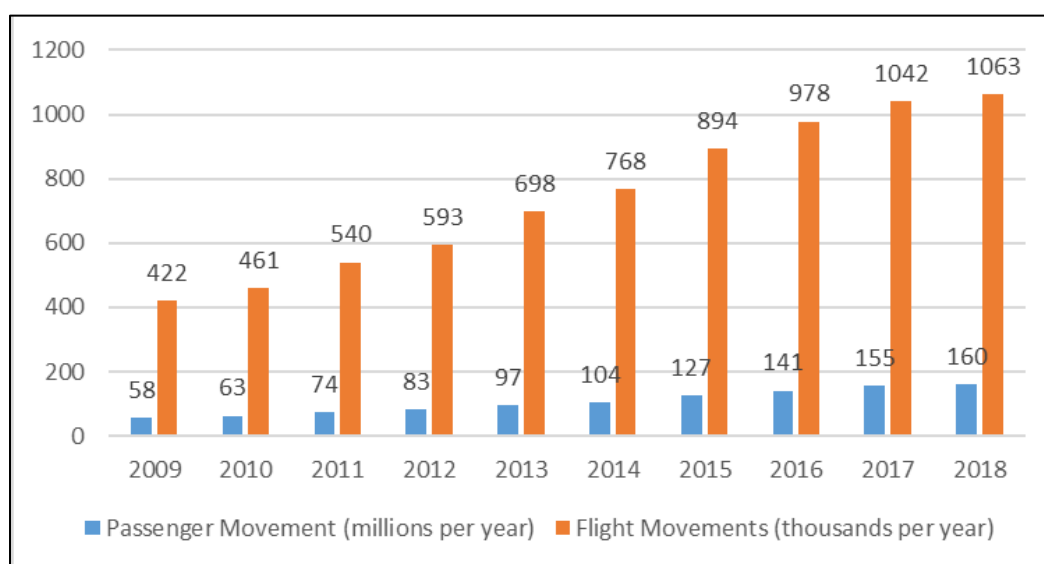
The U-Tapao airport currently has one runway of 3,500 meters, with 52 bays for aircraft parking and two terminals, which combined can handle 3 million passengers annually. In 2015, the airport serviced 170,000 passengers, growing to 700,000 passengers in 2016, and 1.4 million in 2017. Passenger traffic in 2018 was approximately 1.9 million and 1.7 million in 2019. In 2020, due to

the COVID-19 global pandemic, U-Tapao had accommodated 530,000 passengers as of October, the most recent date for which the EEC has made figures available.

Figure 82: Thailand Eastern Economic Corridor Airports¹⁰³



Figure 83: Thailand Passenger and Flight Movements¹⁰⁴



¹⁰³ Thai Board of Investment; Civil Aviation Authority of Thailand

¹⁰⁴ Ibid

Thailand plans a second U-Tapao runway, which the Royal Thai Navy will construct. A third terminal will manage the 12-15 million passengers expected within the next ten years. Ultimately, the U-Tapao airport will serve 60 million passengers annually by 2032, rivaling the throughput of BKK. The airport handles both scheduled and chartered flights, with the majority originating from and departing to China. Other high-frequency destinations include Southeast Asia and Eastern and Central Europe.

Passenger traffic at U-Tapao is mostly tourists visiting the beaches of Thailand’s eastern seaboard. Growth in the tourism industry was steady from 2014 through at least early 2019 (Jan. and Feb., for which data was available), resulting in increased visitor arrivals (Figure 84). Seat availability for U-Tapao, before the COVID-19 global pandemic, had shown high growth from 2014, particularly in 2015 and 2016, at annual rates of 138 percent and 312 percent, respectively. Since 2016, growth rates have lessened but remained strong through 2018 (Figure 85). The 2020 pandemic has markedly, though likely temporarily, disrupted this trend. According to IATA, however, Revenue Passenger Kilometer values are expected to recover globally by 2024 (Figure 86). Therefore, by the time this project is open for operation, passenger and airline traffic levels are projected to have returned to nearly normal, pre-pandemic levels.

Figure 84: Visitors to Thailand, 2010-2019¹⁰⁵



¹⁰⁵ CAPA - Centre for Aviation; Ministry of Tourism; via The Blue Swan

Figure 85: U-Tapao System Airline Seat Availability Growth, 2012-2019¹⁰⁶

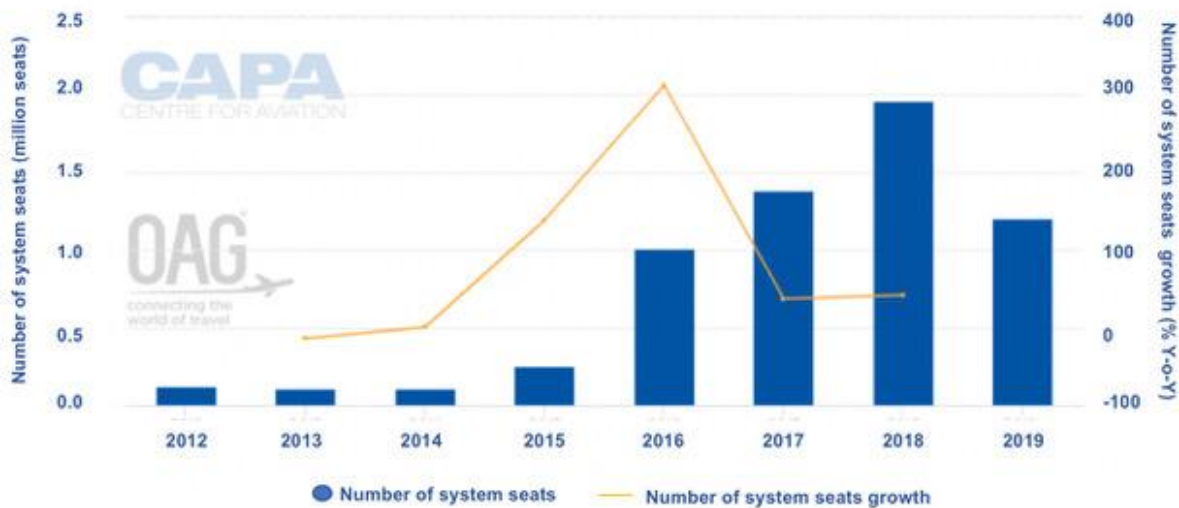
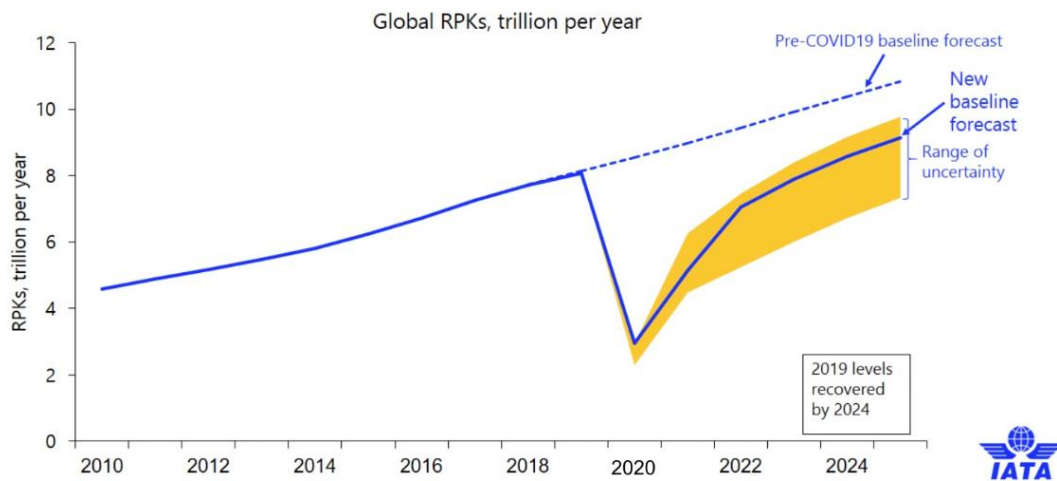


Figure 86: IATA Post COVID-19 Global Revenue Passenger Kilometer Forecast¹⁰⁷



The U-Tapao Airport Phase 1 development plan (Figure 87) includes the following upgrades and expansions (which are subject to change per the PPP Co.'s master plan review):

- New passenger terminal building to accommodate 15.9 million passengers annually.
- Addition of a second runway.
- Addition of air cargo facilities.

¹⁰⁶ CAPA – Centre for Aviation; OAT; via the Blue Swan

¹⁰⁷ IATA

- Development of a Maintenance, Repair, and Overhaul (MRO) facility (to be managed under its own public-private partnership (PPP)).
- Creation of an aviation training center.
- Addition of a 157,000 square meter passenger terminal.
- Addition of 60 aircraft parking bays.
- Creation of a Free Trade Zone.

Figure 87: U-Tapao International Airport Expansion Plan¹⁰⁸



Thailand has plans for three additional construction phases at U-Tapao (also subject to the PPP Co.'s master plan review):

- **Phase 2**
 - To be completed by 2030 and accommodate 30 million passengers annually.
 - Addition of a 107,000 square meter terminal building with an automated people mover (APM) system.
- **Phase 3**
 - To be completed by 2043 and accommodate 45 million passengers annually.
 - Expansion of the Phase 2 terminal by 107,000 square meters.
- **Phase 4**
 - To be completed by 2055 and accommodate 60 million passengers annually.
 - Expansion of Phase 2 terminal by another 82,000 square meters.

With three major international airports in a relatively small area, approach and departure procedures from BKK and DMK are essential in planning U-Tapao's expansion. This effective three-airport metroplex, sharing airspace across multiple airports, may become unduly congested

¹⁰⁸ Source: Eastern Economic Corridor Office

without proper planning, resulting in delays across all three airports. Nonetheless, with planned expansions at each of the three airports, Bangkok and Thailand as a whole will be seen as an ever more critical aviation hub for the ASEAN region.

Thailand is also planning the construction of a high-speed rail line to service the three airport expansions. Before the COVID-19 global pandemic, the government had undertaken contract negotiations with a developer (a PPP comprising Charoen Pokphand Holding Co. and China Railway Construction Corporation Limited (CRCC)) to link these three Bangkok airports. The High-Speed Rail Linking Three Airports Project is currently undergoing preparation for the land handover. The U-Tapao airport expansion and the associated high-speed train are two of the flagship projects to expand Thailand's Eastern Economic Corridor.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

Following a tender in 2019 for the airport's development, on June 2, 2020, the Thai cabinet approved a bid by BBS Joint Venture to undertake the U-Tapao Airport development (excluding the MRO facility). BBS Joint Venture comprises Bangkok Airways, BTS Group Holdings and Sino-Thai Engineering and Construction. BTS and Sino-Thai will manage the construction, while Bangkok Airways will provide aviation expertise. Share allocations are Bangkok Airways 45 percent, BTS Group Holdings 35 percent and Sino-Thai 20 percent. The parties signed a PPP contract on June 19, 2020. The consortium will undertake an environmental impact assessment (EIA) shortly. The Royal Thai Navy has undertaken the environmental health impact assessment (EHIA) for the second runway. The EEC expects the U-Tapao Airport reconstruction to be completed by 2024. The EEC office has been in discussions with air freight companies, including FedEx and DHL, to secure air cargo for the expansion.

In June 2019, Airbus signed a preliminary agreement with Thai Airways International to establish a joint venture MRO facility at the airport. The MRO facility was to be developed under a separate PPP and involve constructing a new hangar. The site of the existing MRO facility will become the second runway and third passenger terminal. In April 2020, Airbus SAS failed to tender a final bid. Thai Airways continues discussions with possible other interested parties, but its bankruptcy filing constrains making immediate investments. In Sept. 2020, the Thai bankruptcy court-approved rehabilitation plans for Thai Airways. The airline anticipates the project will ultimately proceed, as it will create sizeable revenues, but with an operation date of 2024, a delay of two to three years.

PROJECT COST AND FINANCING

The U-Tapao Airport expansion will use a PPP model, with the government assuming 6.1 percent (\$590 million or THB 17.8 billion) of the investment cost. The private-sector partner will carry the remainder. The government will construct the second runway, while the private sector partner will undertake the balance of development (excepting the MRO facility). The total project investment is approximately \$6.6 billion (THB 200 billion), consisting of a government investment

of \$590 million (THB 17.8 billion) and a private-sector investment of \$6.2 billion (THB 187 billion).

US EXPORT OPPORTUNITIES

Opportunities exist for U.S. firms to become involved with the development of the U-Tapao airport. U.S. firms have already teamed with Thai companies to compete for upcoming design and engineering contracts.

The U-Tapao expansion has drawn international firms' attention, including Chinese, Japanese, European, and Southeast Asian. Of particular note, the largest market for flights to and from U-Tapao is China, resulting in significant interest from Chinese firms.

Opportunities for providing U.S. technologies or services include the following:

- Design and engineering services.
- Construction supervision.
- Air traffic control and management technologies.
- Cybersecurity solutions.
- Access control solutions.
- Baggage claim systems.
- Ground handling equipment.
- Runway lighting and signals.
- Navigational aids.
- Firefighting equipment.
- Communications technologies.
- Jet bridges.
- Security screening technologies.
- Water treatment technologies and facilities.
- Power plant/supply.
- Airspace planning.
- Ground Transportation Center service management.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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4 ENERGY

Electricity Background

The Energy Sector in the Indo-Pacific region is among the fastest-growing globally, with the growth in demand for additional power exceeding five percent annually in many Indo-Pacific countries (Table 28). This additional demand requires expanded generation, transmission, and distribution infrastructure. Specific technology opportunities to provide additional regional power include:

- Solar and wind generation.
- Natural gas import terminals.
- Gas-fired, hydro and geothermal energy generation.
- Coal-fired generation.
- Waste-to-energy and energy recovery from biomass.
- Transmission line upgrades.
- Energy storage.
- Smart grid development.

Table 28: Electricity Capacity and Growth Rates¹⁰⁹

Country	Installed Generation Capacity (MW)	Growth Rate 2019/2018 (Percent)
India	367,800	6.2
Indonesia	61,430	5.0
Malaysia	33,000	3.8
Philippines	22,130	5.7
Thailand	44,890	0.5
Vietnam	40,770	10.6

While the COVID-19 global pandemic has slowed progress on some projects, nearly all are proceeding, even if at temporarily slower paces. Over the last several years, governments in the region have focused on meeting the requirement that all people have access to electricity. As of late 2019, most of the Resource Guide countries have met this goal. Access to remote populations is the greatest challenge to the delivery of reliable grid power at reasonable rates. Electricity penetration rates and populations without access are described below (Table 29).

¹⁰⁹ CIA World Factbook

Table 29: Electricity Penetration Rate¹¹⁰

Country	2019 Energy Penetration Rate (Percent)	Population without Access to Electricity (millions)
India	99	13.7
Indonesia	99	2.8
Malaysia	100	0
Philippines	96	4.4
Thailand	100	0
Vietnam	100	0

Power Generation

Each of the Resource Guide countries faces power generation and distribution challenges. Indonesia and the Philippines are challenged by their geographies, with many distant islands and small population centers making it difficult to deliver reliable, affordable power. Vietnam has difficulty with high technical transmission losses due to the country's topography and geographic balance of supply and demand by region. In Vietnam, the Northern region is a net exporter of power, while the Southern region is a net importer. India is challenged by its landmass and the significant population living in rural areas without reliable grid access. Considerable opportunities are available to U.S. companies to assist in tackling these issues.

Overall demand growth is an important issue in the power sector. With high demand growth rates, supported by continued industrialization and disposable income growth, additional power is required. Most Resource Guide countries have large coal deposits; thus, coal-fired power plants are being built, because of fuel access and national energy security concerns. LNG projects are also being developed in most of the Indo-Pacific countries. Vietnam has at least five large-scale LNG import terminal projects in development. Indonesia and Malaysia are net LNG exporters, while Indonesia is an LNG importer due to its lack of new gas finds and the difficulty of moving stranded gas to markets because of the country's topography. The Philippines, India, and Thailand also have LNG import terminal projects, some that are profiled following in this Resource Guide.

Along with the numerous LNG projects are many for natural gas-based power generation. Well over 10 GW of combined cycle gas turbine power generation projects are currently being developed in the region, some profiled in this Resource Guide. Many of these projects are large-scale combined cycle LNG to power projects. Smaller gas development efforts include simple-cycle gas turbine projects to capture stranded gas value and projects to replace older, less-efficient oil-fired generation plants.

Large-scale import terminals capable of handling large LNG carrier delivery are in development, as are breakbulk projects, where smaller volumes of LNG can be delivered into smaller markets. The region as a whole has considerable interest in the importation of U.S. LNG to fuel electric

¹¹⁰ Ibid.

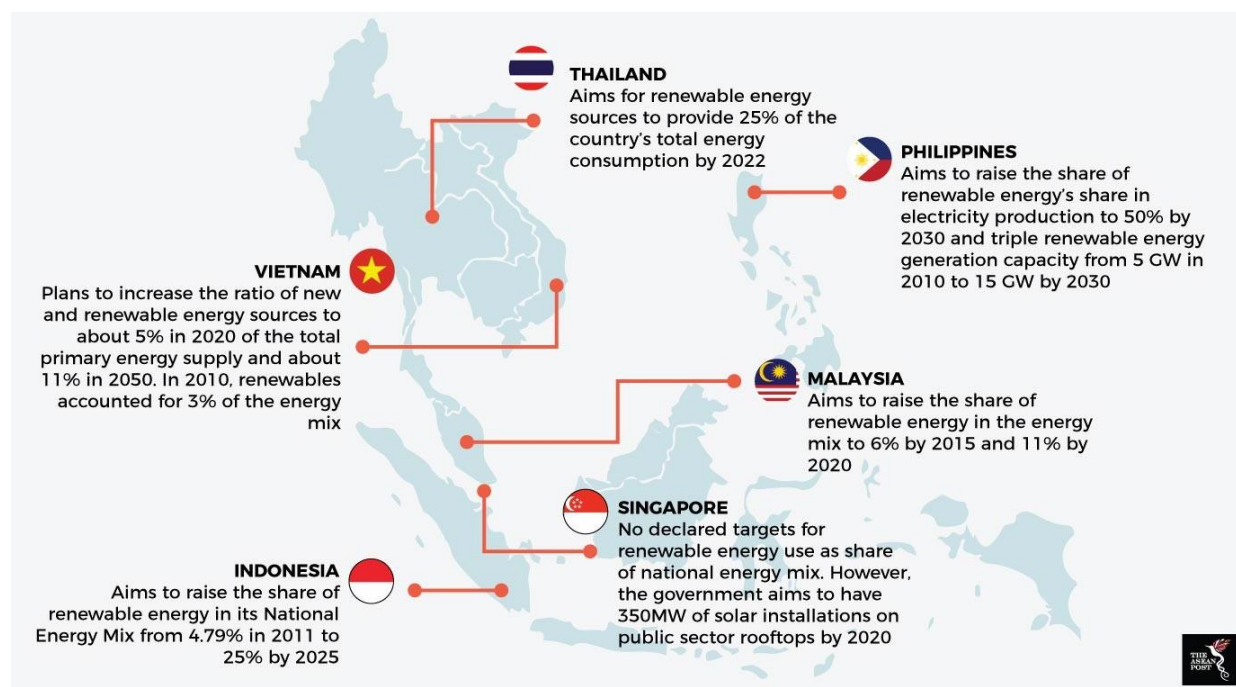
power and industry. Export opportunities for U.S. firms include engineering, procurement and construction projects, sales of cryogenic equipment, compressors, electric and instrumentation equipment, unloading equipment, safety equipment, and power generation equipment. In addition, we expect U.S. LNG exporters will participate in these markets, creating further opportunities for U.S. exports.

Renewable Energy

The main economies of Southeast Asia have a variety of renewable energy goals (Figure 88), both in the near term and longer-term. However, the abundance and low cost of coal in the region has dampened, somewhat, renewables developments.

The Government of India, promoting renewable energy heavily, is committed to increased use of clean energy sources and is already undertaking various large-scale, sustainable power projects. The Ministry of New and Renewable Energy (MNRE) has set an ambitious target to create renewable energy capacities of 175 GW by 2022. About 100 GW is planned for solar and 60 for wind, with the remaining capacity targeted for hydro, bio and others. The Government of India aims to achieve 225 GW of renewable energy capacity by 2022, ahead of its target of 175 GW as prescribed by the Paris Agreement. India's renewable energy sector is expected to attract investments of up to US\$ 80 billion over the next three to four years.

Figure 88: Renewable Energy Targets by Country¹¹¹



¹¹¹ Rewind.es

Solar Generation

Numerous solar projects are being developed in the region. The Philippines and Vietnam are improving tariffs, making it simpler to develop such projects. Indonesia appears to be lagging in this sector, though solar-based microgrid projects are a bright spot, despite being small and offering limited export potential.

Large-scale solar projects are difficult to source from the U.S. as most of the equipment required can be sourced at lower costs in the region. Many companies (including U.S. firms) operate solar module and inverter plants in Southeast Asia. India is a leader in new solar capacity and has some of the lowest tariffs in the world. Abundant solar intensity, coupled with business models favoring developers, have led to a plethora of projects.

Wind Generation

India is also a leader in wind power generation. The remaining Indo-Pacific countries lag India in generation growth for wind energy. Wind potential is mixed in the region, and, to date, regulations are not fully developed to assist in the growth of this sector.

Geothermal Generation

There are many active geothermal opportunities in South East Asia, especially in Indonesia and the Philippines. U.S. systems engineering, geosciences consulting, steam generation, and electrical systems infrastructure have potential for export for the projects.

Waste to Energy

The Philippines has begun to address its waste management capabilities and seeks alternatives to landfilling of wastes. Similar efforts are underway in Indonesia. India has a substantial waste-to-energy industry but has experienced difficulties due to limited access to high calorific wastes. A large portion of Indian waste is food-derived and has lower calorific values than other wastes, making them less productive for energy generation.

U.S. exports of combustion/gasification systems, pollution control, feed systems, and electrical infrastructure are possible in this sector. One U.S. consortium has been awarded a large project in the Philippines. Other waste to energy opportunities include a series of projects in Indonesia and a gasification co-firing project in Thailand.

Coal

Despite the global pressures to reduce carbon emissions and adopt more carbon-neutral energy generation, coal is likely to remain a major source of electricity in the Indo-Pacific region for decades to come. Coal-fired plants continue to be developed in the region to take advantage of abundant, low-cost coal across most of the region. Several regional developments seek to recover gas from coal beds.

Vietnam, the Philippines, India, and Indonesia are adding major coal projects but are also starting to accelerate the development of renewables and gas plants to replace older coal and oil-fired plants over the next decade. India has managed to accelerate its adoption of non-coal generation sources and may make faster strides than some of its neighbors given its government's assertive 2030 renewable energy goals.

Battery Storage

Battery storage, coupled with renewable energy generation, is beginning to be developed in the Indo-Pacific region. One solar-plus-storage project in Thailand is profiled in the Resource Guide.

Smart Grid

Grid integrity and load-shedding are issues in some areas in the Indo-Pacific region. With high power demand growth rates, there continues to be an opportunity within this sector. Battery storage systems suitable for grid management, as well as to support the implementation of inconsistent renewable energy solutions, are being developed. Smart grid projects, including Advanced Metering Infrastructure, transmission line management systems, and smart meter rollouts are included in this Resource Guide.

Oil and Gas

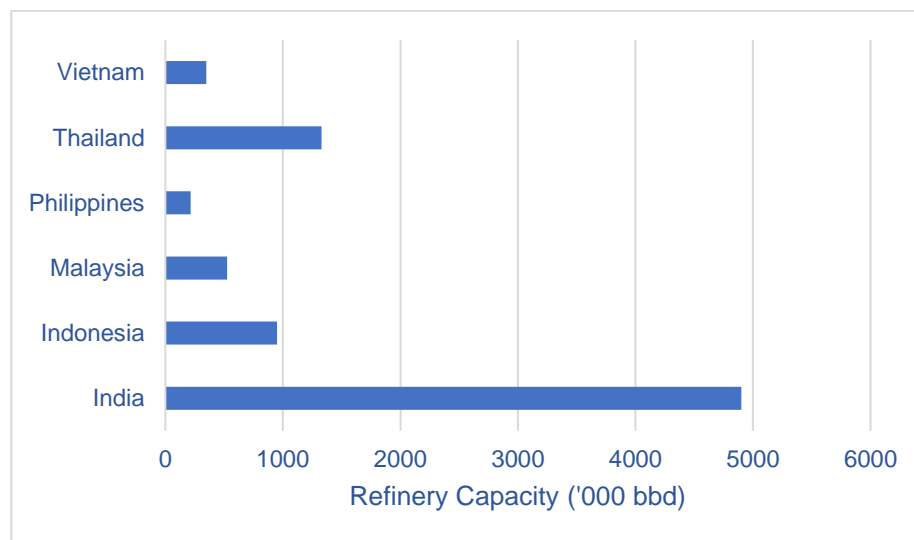
Oil and Gas Exploration

While this report does not focus on exploration and production projects for oil and gas, one project profiled is a well-decommissioning program executed by Petronas in Malaysia. Petronas is decommissioning wells at a rate of about 50 per year and seeking international expertise to assist. Well-decommissioning is a growing Indo-Pacific market both directly and as a contract service, with U.S. firms having strong technology and experience.

Petroleum Refining

While every country in the Indo-Pacific region operates oil refineries (Figure 89), India is by far the largest refiner in the region. India has many new refineries and has been upgrading several. PERTAMINA, the state oil and gas company of Indonesia, is also upgrading its refinery portfolio.

Figure 89: Indo-Pacific Region Refinery Capacity (000 bpd) ¹¹²



¹¹² Oil and Gas Journal

Natural Gas


Natural gas is an important component of the energy mix in the Indo-Pacific region. Over the next five years, developments will be focused on natural gas-fired power projects and the increasing, already substantial LNG importation in the region. (See Power Generation section above.)

Chemicals

A trend in the Indo-Pacific region is to seek opportunities to monetize stranded fossil-fuel assets to produce petrochemicals. This is an efficient way to capture the gas values while also advancing chemical industry development in the region. Production of ammonia-derived chemicals is growing in the region and elsewhere. Malaysia has two methanol projects in development, in Sabah and Sarawak, profiled following.

Summary

The Indo-Pacific Energy sector is exhibiting strong and continuing growth for both conventional and renewable energy sources and technologies. Numerous projects spanning capacity additions small to large exist for U.S. equipment, engineering and LNG suppliers.

Intra-State Transmission Strengthening System		
	SECTOR	Electricity
	SUBSECTOR	Transmission & Distribution
	LOCATION	Arunachal Pradesh and Sikkim, India
	PROJECT VALUE	\$679 Million

PROJECT SUMMARY

Power Grid Corporation of India Limited (PGCIL), an Indian state-owned electric utility company, has initiated a comprehensive program for strengthening the electric power transmission and distribution systems in Arunachal Pradesh and Sikkim (Intra-State Transmission Strengthening System). The project intends to improve electric power access and reliability with an investment of \$679 million. The government approved the project to accelerate the development of the North Eastern (NE) region.

PROJECT DESCRIPTION

The Government of India has announced several energy initiatives to build power generation capacity, promoting energy efficiency and increasing clean energy sources within the country's overall power mix. India is the fifth largest electric energy producer globally, with a total installed power generation capacity of 373 gigawatts (GW). India's energy demand grew by 5.2 percent in 2019, outpacing global growth of 2.3 percent.¹¹³ The private sector now represents 47 percent of India's electric power production, compared to 10 years ago when the Indian Government dominated the energy sector.

The roadmap for power sector development requires strengthening overall transmission, sub-transmission, and distribution systems, a challenge for the NE Region due to the region's hilly and rugged terrain. During its first Summit, the North Eastern Council, at Pasighat in Arunachal Pradesh, in Jan. 2007, articulated the magnitude of the challenge in the "Pasighat Proclamation on Power." According to the Pasighat summit recommendations, a comprehensive scheme for strengthening of transmission, sub-transmission, and distribution systems was developed by the Central Electricity Authority (CEA) in consultation with PGCIL and the states of the NE Region.

Given low population density over a geography of 84,000 square km, power demand in Arunachal Pradesh is scattered across a large area. The situation requires a 132 kilovolt (kV) transmission network for proper voltage management and lower distribution losses. Currently supported by a

¹¹³ International Energy Agency

33 kV backbone (Figure 90), only five of the 25 districts in the State connect to a 132/220 kV transmission network. Similarly, the distribution system in Sikkim relies primarily on a 66 kV network, which also requires substantial strengthening.

Figure 90: Representative Electric Power Infrastructure - North Eastern Region¹¹⁴



When completed, the project will benefit many of those living in the NE region who lack access to a reliable and secure power grid. The project will provide a backbone for the transmission of regional hydropower and a built-in optical-fiber cable. The latter will support both the utility's supervisory control and data acquisition (SCADA) system and local high-speed communications capability.

Project components for 15 districts in Arunachal Pradesh and four districts in Sikkim include:

- 4,240 km of a combination of 220, 132, 66, and 33 kV transmission lines.
- 129 new substations of 1,924 mega-volt ampere (MVA) transformation capacity.
- 134 transmission lines.

The Scope of Work in Sikkim

- Seven new 132/66 kV substations (590 MVA).
- Fourteen 66/11 kV substations (170 MVA).
- One 66/33 kV substation (10 MVA).
- Thirteen 6/11 kV substations (160 MVA).

¹¹⁴ LiveMint

- Eight 132 kV and 220 kV (initially charged at 132 kV) transmission lines spanning 118 km.
- 281 km of 66 kV line.

The Scope of Work in Arunachal Pradesh

- Twenty-four new 132 kV substations (529 MVA).
- Seventy 33/11 kV substations (465 MVA).
- Augmentation of 15 MVA capacities at Daporijo.
- 33 new transmission lines spanning 1917 km including seven 132 kV lines.
- Seventy 33 kV line feeders over 1,923 km.

Following construction, the State governments will operate and maintain the power systems. Due to delays in bidding and awarding contracts, which was further lengthened by the COVID-19 global pandemic, PGCIL does not expect the project's completion before 2023.

PGCIL will select individual engineering, procurement, and construction (EPC) contractors for various sections of the project. The EPC scopes of work include:

- Design and engineering.
- Manufacture, testing, and supply to the site, including transportation and insurance.
- Unloading, storage, erection.
- Testing and commissioning.

The EPC contractors will be responsible for procuring equipment and services from other national and international vendors for system components, including:

- Design.
- Transmission lines.
- Tower packages.
- Substation packages.
- Distribution packages.
- Optical Ground Wire (OPGW) packages.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

The Cabinet Committee on Economic Affairs (CCEA) approved this project in 2014. The initial completion target, which was originally 2018, was extended to 2021. However, the recent slowdown due to the COVID-19 global pandemic has further delayed the project. Though contracts and bidding have resumed, PGCIL expects the project's completion, at the earliest, will occur in 2023.

EPC contracts worth approximately \$521 million have been awarded to various parties. The EPC firms will initiate the procurement process for the system components' equipment and services

over the next three years of project implementation. Several parties have already secured primary contracts for grid sections (Table 30).

Table 30: EPC Contractor Awards to Date

Contractor	Award	Value (\$ Million)
Neccon Power & Infra Limited	Substation	15.87
Godrej & Boyce Manufacturing	Substation	34.20
Shyama Power Private Limited	Substation	23.33
KEC International	Turnkey tower & Substation	76.46
Larsen & Toubro Limited	Turnkey tower	68.85
EMC Limited	Tower & Substation	45.89
Technofab Engineering Limited	Distribution	32.54
Tata Projects Limited	Transmission, substation, Tower	81.51
Jiangsu Jinglce (China) & KEC International	Substation	17.81
Sterling and Wilson Limited	Substation	28.54
Angelique International Limited	Substation	21.89
Aster Private Limited & Kusk Construction	Tower	10.32
LS Cable India	Transmission Line	9.42
KEI Industries Limited	Substation	4.77
PLR Projects Private Limited & RCC Infrastructure	Tower	23.18
Aster Private Limited & Hitech Engineering	Tower	11.94
Reliance Elektrik Works	Substation	2.57
Simplex Infrastructures Limited (SIL)	Pile foundation	8.11
Transglobal Power Limited & Vishal Infrastructure	Tower	4.13

As of Sept. 2020, bids have been invited for the following:

- **Balance of Works Package:** for plant, equipment and associated works for ARP-DMS-04 in Arunachal Pradesh. The last date for bid submission was been extended from Oct. 7, 2020 to Oct. 19, 2020.

- **Tower Package TW-27:** for transmission line works. The last date for bid submission was Oct. 10, 2020.
- **Tower Packages TW29B and TW30B:** for transmission line works. The last date for bid submission is Nov. 4, 2020.

On December 14, 2020, Tata Projects Limited won a contract for the Balance of Works package (ARP-DMS-04). Contracts have yet to be awarded for the three tower packages (TW-27, 29B and 30B.)

PROJECT COST AND FINANCING

The project is divided between direct project capital investments (88 percent) and consultancy fees (12 percent). By geographic area, the budgetary split is approximately two-thirds for Arunachal Pradesh and one-third for Sikkim.

The Government of India will be funding the project through PGCIL, which will hold 100 percent equity. Once completed, PGCIL will turn the project over to Arunachal Pradesh's and Sikkim's state governments for operation and maintenance.

U.S. EXPORT OPPORTUNITIES

Over the next 36 months, the primary EPC contractors will begin the sub-contracting and procurement of equipment and services. U.S. energy sector equipment and services companies may participate as subcontractors and suppliers to the primary EPC contractors for supply of the following system components:

- Design services.
- Transmission lines system components.
- Tower packages.
- Substation packages.
- Distribution packages.
- Optical Ground Wire (OPGW) packages.


Specifically, the opportunities include:

- Electric transmission lines.
- Sub-stations.
- Towers and allied electrical equipment, including transformers.
- Fixed capacitors.
- Fuses for electrical apparatus.
- Lightning arrestors.
- Voltage limiters.
- Electric conductors.

- Microprocessors.
- Amplifiers.
- Electric/smart meters.
- Other smart communications technology.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S .Commercial Service
<p>Power Grid Corporation of India Saudamini, Plot No 2 Sector 29, Near IFFCO Chowk Gurgaon , Haryana India +91 125 2571700 tcsarmah@powergridindia.com https://www.powergridindia.com</p>	<p>Indo-Pacific Region 1101 Wilson Blvd. Suite 1100 Arlington, VA 22209 USA Ms. Tanvi Madhusudanan Country Manager tmadhusudanan@ustda.gov</p> <p>USTDA U.S. Embassy in Delhi Shantipath Chanakyapuri, New Delhi Delhi 110021 India Ms. Mehnaz Ansari Senior Regional Representative, South Asia mansari@ustda.gov IndoPacific@ustda.gov www.ustda.gov</p>	<p>U.S. Commercial Service The American Center 24 Kasturba Gandhi Marg New Delhi 100 001 91-11-2347-2000 India Ms. Aileen Crowe Nandi Minister Counselor for Commercial Affairs office.newdelhi@trade.gov www.trade.gov</p>

Kerala TransGrid 2.0		
	SECTOR	Energy
	SUBSECTOR	Electric Power
	LOCATION	Kerala
	PROJECT VALUE	\$1.4 Billion

PROJECT SUMMARY

TransGrid 2.0, a project sponsored by the Kerala State Electricity Board (KSEB), is intended to upgrade local electric power transmission and facilitate intrastate power distribution. Facing rising electric power consumption, KSEB is developing a transmission system capable of meeting demand in all parts of its network without overloads or other constraints, in compliance with the “24 X 7 Power for All” mandate of the Indian Government. TransGrid 2.0 is a two-phase project with a total cost estimated at \$1.4 billion. The first phase has a budgeted cost of \$387.35 million; the second phase has a budgeted cost of \$310.3 million. The balance of about \$700 million is allocated to land acquisition. The project will add five new 400 kilovolt (kV) substations, twenty-five 220 kV substations and associated transmission lines.

PROJECT DESCRIPTION

Kerala imports approximately 70 percent of its electric power from outside the state, necessitating an intricate intrastate power transmission network. Peak hour demand in the state will rise substantially over the next 15 years (Table 31). TransGrid 2.0 is the planned solution to manage both greater power deliveries imported from outside the state and its distribution across Kerala.

Table 31: Kerala Electric Power Demand/Supply Shortfalls, 2017-2032 (MW)¹¹⁵

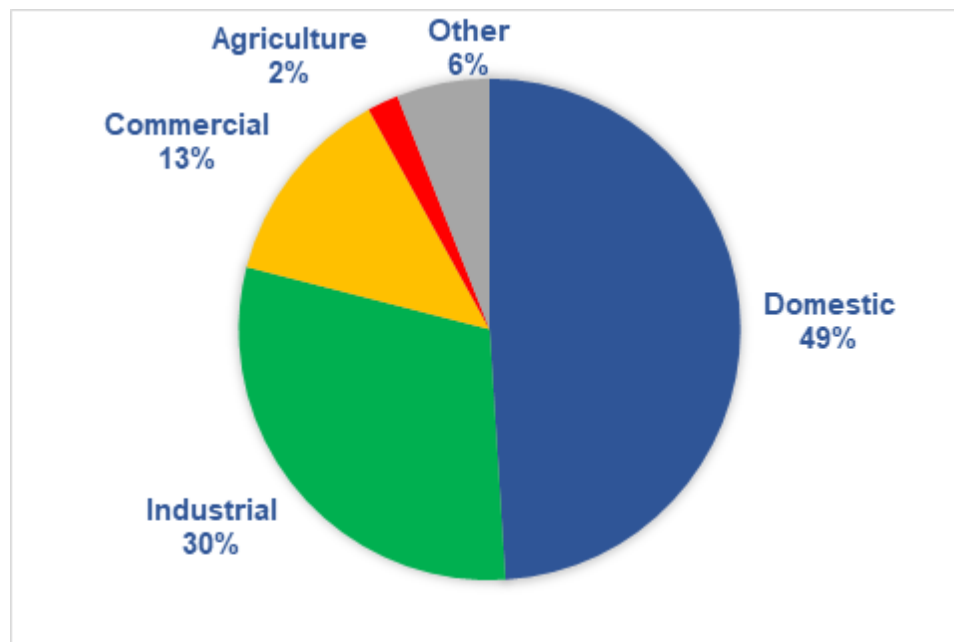
Period	Daily Peak Hour Demand	New Supply Required
2017-18	4,900	2,000
2022-23	6,398	4,000
2032	12,000	8,000

¹¹⁵ 18th Electric Power Survey of India

National policy, including the Electricity Act of 2003, focuses on the development of an Indian electric power transmission sector to be supported by adequate and timely investments. Indian regulations require efficient and coordinated action plans to ensure a robust and integrated power system. The regulations dictate a transmission system capable of meeting network demand without overloading or creating constraints, even under contingency conditions. The intent is to provide secure, reliable, efficient, and economic electricity in all circumstances.

Kerala is densely populated. The entire state can be considered an extended metropolitan area for the purposes of transmission planning. Kerala domestic power demand accounts for almost 50 percent of the state's electricity consumption (Figure 91).

Figure 91: Kerala Electric Power Demand Segmentation¹¹⁶



TransGrid 2.0 aims to:

- Improve power-carrying capacity.
- Address problems associated with sagging conductors.
- Reduce transmission line losses.

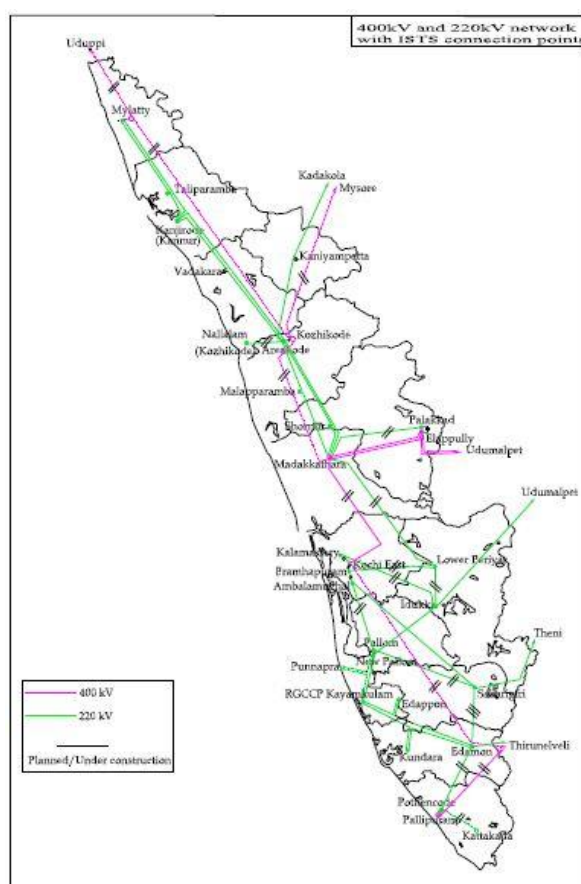
TransGrid 2.0 will result in upgrades of all lines and substations. The project will create a green corridor to tap wind and solar energy, with the eventual creation of a smart grid.

¹¹⁶ Electrical India

Kerala's demographics pose significant right-of-way (ROW) issues. Thus, TransGrid 2.0 has and will embrace innovative technologies, business models and alternative construction methods. Tower designs will be modified to carry high-power conductors using the existing way. Newer technologies (e.g., monopoles, sleek towers and digitization) will enhance system reliability and security, causing minimum disturbance to the public and the environment. TransGrid 2.0 provides a green vision for better energy management through a planned reduction in system losses.

The objective of TransGrid 2.0, initiated in 2016, was to efficiently add import capabilities of 2000 megawatts (MW) by 2018 and then to add 4000 MW by 2022 followed by 8000 MW by 2032 from the high-capacity Inter-State Transmission System (ISTS). The project plan has two phases (Figure 92). TransGrid 2.0 will install new 400 and 220 kV substations and several new transmission lines across 26 locations. The new infrastructure will scale and improve the intrastate power transmission network. The packages listed for each phase will be available for bid.

Figure 92: Kerala TransGrid 2.0 Planned Network¹¹⁷



¹¹⁷ Ministry of Power – 24x7 Power for ALL – Feb. 2016

Phase 1: 2016 – 2023 (\$387.35 million): 13 projects encompassing:

- **Ernad Special Line (ESL) Package** (\$74.43 million) (Partially executed).
 - Upgrade existing 220/220 kV SC line to 400/220 kV multi-circuit multi-voltage (MCMV) line.
 - Upgrade existing 110 kV DC line/220 kV SC line to 220/110 kV MCMV line to take 220 kV circuits to existing 220 kV substation.
 - Install MCMV narrow-base tower to connect several substations in the city and suburbs.
 - An award of \$54.35 million to L&T Construction Limited was made in 2018 to install advanced MCMV technology.
- **HTLS Northern Region Package** (\$11.86 million) (Recently completed).
 - Upgrade existing 66 kV line to 110 kV DC line using special poles, insulated cross arms and high temperature/low sag (HTLS) lines.
 - Awarded to Larsen & Toubro Limited.
- **Kolathunadu Lines Strengthening (KLS) Package** (48.46 million) (Work Started).
 - Upgrade 110 kV S/C line to 220/110 kV MCMV line.
 - Loop-In-Loop-Out line to 220 kV substation.
 - Awarded to Sterlite Transmission Limited.
- **Kochi Lines Package (KTL)** (\$54.21 million) (Work Started).
 - Upgrade of 66 kV S/C line to 220/110 kV MCMV.
 - Awarded to Larsen & Toubro Limited.
- **North Malabar Lines (NML) Package** (\$15.16 Million) (Work Started).
 - Upgrade 110 kV DC line to 220 kV MCMV and line in/line out to 220 kV at Kakkayam HEP substation.
 - Awarded to Sterlite Power Transmission Limited.
- **North-South Interlink (NSI) Package* Phase I**(\$28.55 million) (Work Started).
 - Upgrade 66 kV line to 220 kV MCMV line and construct 220 kV DC line.
 - Awarded to Larsen & Toubro Limited.
- **Thiru-Kochi 400 kV Lines Package (TKL400)** (\$ 40.71 million, to be tendered).
 - Construction of 400 kV line by upgrading 110 kV SC line to 400 kV using 400/110 kV MCMV towers.
 - 400 kV substation at Kottayam.
- **North Malabar Substation Package:** (\$25.63 million) (Work Started).
 - Upgrade 110 kV substations to 220 kV at Kunnamangalam & Chalakudy.
 - New 220 kV substation at Thalasseri.
- **Kochi Substation Package:** (\$45.47 million) (Work Started).
 - Upgrade of 10 kV substation to 220 kV at Aluva & Kaloor.
 - Upgrade 66 kV substation to 220 kV at Kothamangalam. New 220 kV Substation at Pallivasal.
- **Kottayam Lines Package:** (\$13.99 million) (Work Started).
 - 220 / 110 kV lines to 400 kV and 220 kV substations.
 - Awarded to Larsen & Toubro Limited.
- **AIS #1 Package** (\$6.93 million) (Work Started).
 - 220 kV substation at Manjeri.

- **Mallapuram Manjeri Upgrade Package:** (\$1.94 million) (Completed).
 - Upgrade 66 kV line to 110kV DC.
 - Awarded to Sterlite Power Transmission Limited.
- **GIS 4 Package:** (\$20.21 million) (Work Started).
 - 220 kV substations at Vizhinjam and Ettumanoor.

The Power System Development Fund (PSDF) has funded Ernad Lines and HTLS North. The Kerala Infrastructure Investment Fund Board (KIIFB) has funded the remainder.

Phase II: 2019- 2023 (\$ 310.3 million): 13 projects encompassing the following:

- **Sabari Sub Station Package:** (\$13.09 million) (Work Awarded).
 - 220 kV substations at Pathanamthitta & Kakkad.
- **Sabari Lines: Upgrade Package** (\$21.07 million) (Work Awarded).
 - Upgrade of 110 kV Koodal Pathanamthitta D/C to 220/110 kV MCMV line.
 - LILO of Sabagiri Edamon S/C Line Koodal.
 - LILO of 220 kV Sabagiri Pallom Line to Kakkad.
 - Interlinking of 220 kV Edappon and Pathanamthitta substations.
 - Awarded to Sterlite Power Transmission Limited.
- **Vengallur Substation & Thrissivaperur Lines II Package:** (\$29.16 million) (Work Awarded).
 - 220/110 kV substations at Vengallur.
 - 220/110 kV MCMV Line Vengallur to Kunnamkulam substations.
 - Awarded to Sterlite Power Transmission Limited.
- **Travancore Lines Package:** (\$4.64 million) (Under Evaluation).
 - Interlinking of 110 kV TRES and Medical College substations.
- **Quilon Lines Package:** (\$118.63 million) (Under Evaluation).
 - 220 kV GIS Substation at Sasthamkotta and connecting lines.
- **GIS 6 Package:** (\$17.43 million) (Under Evaluation).
 - 220 kV GIS substation at Iranjalakuda, Thuravur.
- **GIS 7 Package:** (\$8.57 million) (Under Evaluation).
 - 220 kV GIS substation at Panjal.
- **North South Interlink II Package:** (\$32.00 million) (Under Evaluation).
 - 220/110 kV MCMV Line Aluva – Edayar - North Parur – Kodungallur – Irinjalakudda.
 - 220 / 100 kV MCMV line Aluva – Athani – Chalakudy.
- **North Malabar Lines II Package:** (\$38.57 million) (Under Evaluation).
 - 220/110 kV lines Thalasseri – Kunnamangalam.
- **Thrissivaperur Lines II Package:** (\$28.57 million) (Work Awarded).
 - 220/110 kV MCMV Line Irinjalakudda – Pazhuvil – Kunnamkulam.
 - Awarded to Sterlite Power Transmission Limited.
- **Valluvanadu 220/110 kV Lines Package:** (\$27.65 million) (Under Evaluation).
 - 220 /110 kV line Mannarkad – Palakkad.
 - 220 kV LILO.to Palakkad from Madakathara.
 - 220kV GIS substation at Vennakara.

- **Kollam Package** (\$37.86 million) (Work Started).
 - 400 kV GIS substation at Edamon.
 - 11 kV underground Cabling from Kottayam substation to Kollam GIS.
 - Awarded to KSEB.
- **Travancore Lines II Package:** (\$15.00 million) (Under Evaluation).
 - 110 kV SC underground cabling between 220 kV substation Vizhinjam & 110 kV substations Mattathara.
 - Upgrade to 220 kV line Palode – Attingal – Parippaly – Kundara.
 - 110 kV SC underground cabling between 220 kV Substation Vizhinjam & 110 kV Substation Veli.

KIIFB is a primary source of project funding. Participants selected for the project will undertake the following, as required in the award(s) package(s):

- Design, engineering, manufacturing, construction, and erection of substations and multi-circuit lines.
- Testing and commissioning, as well as any necessary dismantling of existing conductor earth wire, towers, and accessories.
- Design, manufacture, erection, testing, and supply of towers and aluminum conductor steel reinforced (ACSR) conductor.
- Conversion of 220 kV DC line to multi-circuit and double circuit up to the proposed substation.
- Design, manufacture, testing, supply, and stringing of optical ground wire (OPGW) with all accessories.
- Design, manufacture, testing, and supply of high temperature/low sag (HTLS)/composite core (CC) conductor.
- Supply of spares per specification.
- Other allied works per the tower schedule/design provided by KSEB.
- Technical support and training for KSEB staff and officers for operations and maintenance (O&M) of the line.
- Emergency Restoration Service (ERS) as required.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

KSEB is currently implementing the Kerala TransGrid 2.0 project. All necessary government approvals and environmental clearances are in place. KSEB has awarded sections for most parts of Phase One and parts of Phase Two. Other sections are under evaluation and will be awarded shortly. KSEB expects the completion of the main works by 2023. The completion period for each package ranges from 18 to 24 months. The awarded parties will initiate procurement processes for equipment and services for the system components during project implementation.

Power Grid Corporation of India Limited (PGCIL) is the Project Management Agency for the implementation of TransGrid 2.0.

PROJECT COST AND FINANCING

The TransGrid 2.0 total project cost is \$1.4 billion, of which \$702 million is land cost. The balance of \$698 million is for system equipment and services. The Phase One outlay (excluding land) is \$387.35 million. The expenditure for Phase Two is \$310.3 million.

The Kerala Infrastructure Investment Fund Board (KIIFB) is funding \$764 million of the total. KIIFB is structured as a Special Purpose Vehicle (SPV). The Board will mobilize and channel funds to the various sub-projects, also structured as SPVs. The Power System Development Fund (PSDF) has funded two of the 26 projects under TransGrid 2.0.


U.S. EXPORT OPPORTUNITIES

Over the next 36 months, the primary contractors will be procuring equipment and services for the various packages. The procurement process will open opportunities for U.S. energy sector equipment and service suppliers. To participate in TransGrid 2.0, U.S. companies will work under the direction of the primary contractors. Opportunities exist to support design, equipment supply, testing, and operations and maintenance (O&M). Specific opportunities include:

- Design, manufacture, testing, and supply of:
 - Substation packages.
 - HTLS/Composite Core-type conductors for 110kV or higher voltage level.
- Supply and installation of:
 - Tele-protection and optical networking equipment for 400/220/110 kV substations.
 - Stringing and tensioning equipment, including re-stringing/stringing works.
- Civil survey and measuring/testing equipment.
- Operations and maintenance contracts.
- Provision of componentry.
 - Electric transmission lines.
 - Towers and allied electrical equipment, including transformers.
 - Fixed capacitors.
 - Fuses for electrical apparatus.
 - Lightning arrestors.
 - Voltage limiters.
 - Electric conductors.
 - Microprocessors.
 - Amplifiers.
 - Electric/smart meters.
 - Other smart communications technology.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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Western Region Strengthening Scheme WRSS XXI		
	SECTOR	Energy
	SUBSECTOR	Electricity Transmission and Distribution
	LOCATION	Gujarat and Maharashtra
	PROJECT VALUE	\$811 Million

PROJECT SUMMARY

The Western Region Strengthening Scheme (WRSS) XXI project is an electric power transmission system for the 10.5 gigawatts (GW) of renewable energy generated from new solar (7.5GW) and wind (3GW) energy zones in the states of Gujarat and Maharashtra.

- **Gujarat**
 - Wind: Bhuj II (2,000 MW); Lakadia (2,000 MW); Dwarka (1,500 MW).
 - Solar: Lakadia (2,000 MW).
- **Maharashtra**
 - Wind: Osmanabad (2,000 MW).
 - Solar: Solapur (1,000 MW).

In addition to transmitting new renewable energy, the transmission lines will also help transmit power from the existing 6 GW of wind power projects in Gujarat (Bhuj/Bhachau), bringing the total transmission capacity to 16.5 GW.

The Ministry of Power (MoP) has appointed bid process coordinators (BPC) for the selection of transmission service providers (TSP). The total project cost is estimated to be \$811 million.

PROJECT DESCRIPTION

The Government of India (GoI) has announced several energy initiatives to build power generation capacity, promote energy efficiency, and increase clean energy sources in the overall power mix. India is the fifth largest electric energy producer globally, with a total installed power generation capacity of 373 gigawatts (GW). India's energy demand grew by 5.2 percent in 2019, outpacing global growth of 2.3 percent.¹¹⁸

¹¹⁸ International Energy Agency

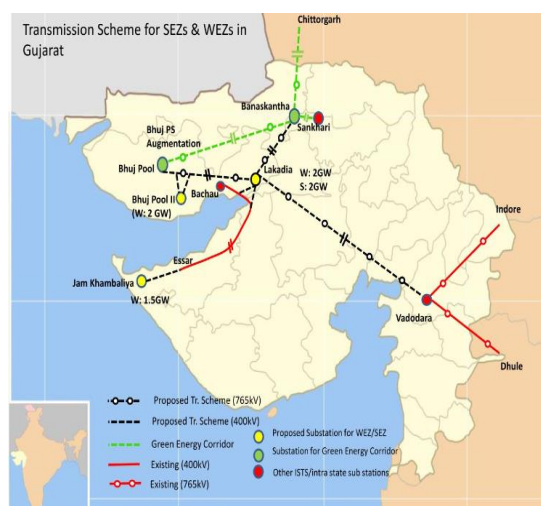
The GoI has set a target for developing 175 GW of renewable energy (RE) capacity by 2022. Of this target, 83 GW are commissioned, approximately 29 GW are under installation and about 30 GW remain to be tendered.

On June 8, 2018, the Ministry of Renewable Energy (MNRE) established a sub-committee to identify approximately 50 GW of Inter-State Transmission System (ISTS) renewable energy projects in identified Solar-Energy-Rich Zones (SEZs) and Wind-Energy-Rich Zones (WEZs). Since then, the Solar Energy Corporation of India (SECI), in association with the MNRE and renewable energy power developers, have identified SEZs and WEZs in seven renewable energy-rich states:

- Andhra Pradesh.
- Gujarat.
- Karnataka.
- Maharashtra.
- Madhya Pradesh.
- Rajasthan.
- Tamil Nadu.

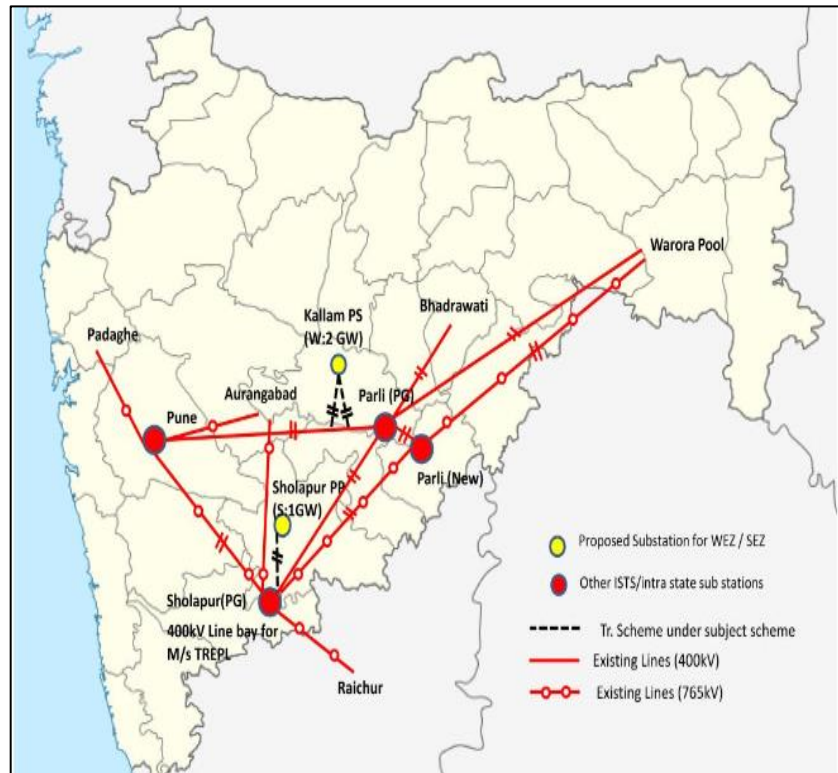
New generation capacity must be supported by transmission infrastructure to economically and safely deliver power to consumers. In Gujarat and Maharashtra, a project is under development in the Western Region Strengthening Scheme (WRSS) XXI. Designed to help meet India's long-range energy security, sustainability and climate goals at affordable prices, the project's estimated cost is \$811 million. The resulting projected annual transmission charges are \$134 million, paid to the Transmission Service Provider (TSP). The reach of the SEZ and WEZ transmission schemes for Gujarat and Maharashtra under WRSS XXI have already been mapped (Figures 93 and 94).

Figure 93: Gujarat SEZ and WEZ Transmission Scheme¹¹⁹



¹¹⁹ Government of India Ministry of Power

Figure 94: Maharashtra SEZ and WEZ Transmission Scheme¹²⁰



The scope of work for the Transmission Service Provider (TSP) involves the following:

- Establish, operate and maintain the project and complete all activities for the project, including survey and detailed project report (DPR) formulation.
- Arrange financing.
- Provide project management.
- Obtain necessary consents, clearances, and permits (e.g., wayleave, environment and forest, civil aviation, railway/road/river/canal/power crossing and Power and Telecommunication Coordination Committee (PTCC)).
- Manage design and engineering services.
- Procure equipment and material supplies.
- Oversee construction, erection, testing, and commissioning.

Key components of the project include the development of the following:

- Pooling Stations.
- Transmission Lines.
- Sub Stations.

¹²⁰ Ibid.

The project has been divided into 11 Parts (Table 32):

Table 32: Electricity Transmission and Distribution Project Parts

Part	Purpose	Cost (\$ million)
A	Additional 1x500 MVA 400/220 kV (9th) ICT, for injection from any additional RE project (beyond 4000 MW) at Bhuj PS.	8.04
B	Transmission System strengthening for relieving over loads in the Gujarat Intrastate system due to RE injections in Bhuj PS.	122.3
C (WRSS 21) Part A	Conversion of Existing lines at Bhachau end.	2.71
D (WRSS-21) Part B	Transmission System strengthening for relieving overloads in Gujarat Intrastate system due to RE injections in Bhuj PS.	266.43
E	Transmission system associated with RE generations at Bhuj II, Dwarka and Lakadia.	153.57
F	Transmission System for providing connectivity to RE projects at Bhuj II (2000 MW) in Gujarat.	92.14
G	Jam Khambhaliya PS for providing connectivity to RE projects (1500 MW) in Dwarka (Gujarat), Interconnection of Jam Khambhaliya PS for providing connectivity to RE projects (1500 MW) in Dwarka (Gujarat).	62.14
H	400 kV line bay at Solapur PS for St-II connectivity to M/s Toramba Renewable Energy Pvt. Ltd.	1.43
I	Transmission System for providing connectivity to RE projects in Gujarat [Lakadia (2000MW)].	28.00
J	Transmission system associated with RE generation from potential wind energy zones in Osmanabad area of Maharashtra.	43.00
K	Transmission system associated with RE generations from potential Solar Energy Zone in Maharashtra (1000 MW under Phase-I).	31.43

PROJECT STATUS AND IMPLEMENTATION TIMELINE

WRSS XXI is a greenfield project. The National Committee on Transmission (NCT) has recommended the use of tariff-based competitive bidding (TBCB) on a build-own-operate-maintain (BOOM) platform for the project. Successful Transmission Service Provider (TSP) bidders will incorporate special purpose vehicles (SPVs) for project implementation.

The Western Region Standing Committee on Transmission (WRSCT) approved the two-phase project in Sept. 2018. WRSCT has completed technical surveys and feasibility studies for Phase One, Parts A-G and covering Parts H-K for Phase Two. WRSCT expects Phase One to be completed by June 2021 (Table 33).

Table 33: Phase One Implementation Timing

Part	Completion	Oversight
A	Dec. 2020	RTM*
B	Dec. 2020	TBCB**
C	Dec. 2020	RTM*
D	June 2021	TBCB
E	Dec. 2020	TBCB
F	June 2020	TBCB
G	Dec. 2020	RTM

*RTM: regulated tariff management

**TBCB: tariff-based competitive bidding

Phase Two, Parts H-K, are on hold pending clarifications from the State Governments. Requests for Qualifications (RFQs) for these portions are expected during 2021.

Bids for Phase Two, Parts A and C, were awarded in Jan. 2019 to the Power Grid Corporation of India. Parts B and D were awarded to Sterlite Power Transmission in Nov. 2019, with Part B to Sterlite Grid 18 Limited under an SPV structure.

Due to the COVID-19 global pandemic and the subsequent lockdown, the Ministry of Power has extended, by five months, the scheduled commercial operation date of all interstate power transmission projects under construction at the time of the lockdown.

PROJECT COST AND FINANCING

The total project cost is \$811 million. The project will be implemented through tariff-based competitive bidding (TBCB) or a regulated-tariff-management (RTM) process on a build-own-operate-maintain (BOOM) basis.


U.S. EXPORT OPPORTUNITIES

The project is being awarded on a bid basis to various Transmission Service Provider (TSP)/implementation parties. U.S. companies wishing to participate are required to work with primary contractors in supporting design, equipment supply, testing, and operations and management. Specific opportunities include:

- Technical know-how:
 - Design and application development for wind and solar integration systems.
 - Frequency regulation systems.
 - Peak management systems.
 - Transmission and distribution deferral systems.
- Supply of equipment and componentry:
 - Electric transmission lines.
 - Pooling stations and substations.
 - Towers.
 - Electrical equipment including:
 - Transformers.
 - Fixed capacitors.
 - Fuses for electrical apparatus.
 - Lightning arrestors.
 - Voltage limiters.
 - Electric conductors.
 - Microprocessors.
 - Amplifiers.
 - Electric/smart meters.
 - Other smart communication technology.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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Bina Panki Petroleum Product Pipeline		
	SECTOR	Energy
	SUBSECTOR	Oil and Gas Development
	LOCATION	Bina, Madhya Pradesh Panki, Uttar Pradesh
	PROJECT VALUE	\$227 Million

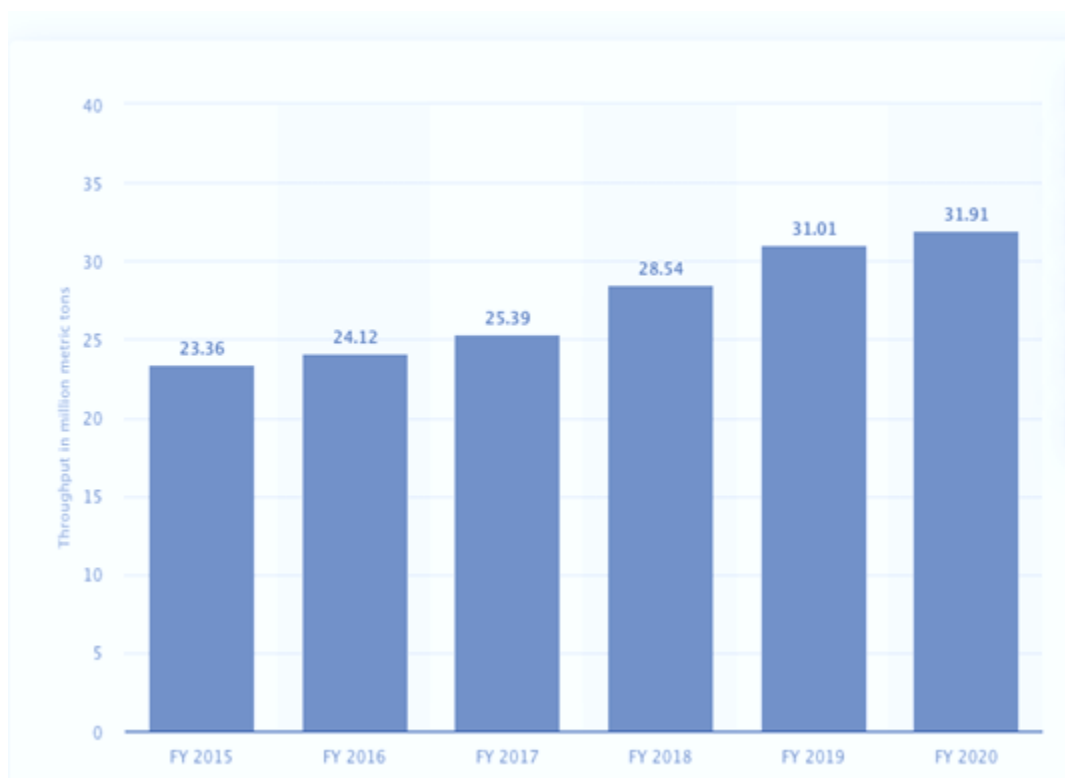
PROJECT SUMMARY

Bharat Petroleum Corporation Limited (BPCL) is implementing a \$227 million project to lay a multiproduct, cross-country pipeline connecting the Bina dispatch terminal (Madhya Pradesh) to the existing BPCL Panki terminal in Kanpur, Uttar Pradesh. Intermediate sectionalizing valve stations, an intermediate pigging station and a receipt terminal at Panki are also parts of the project. The pipeline will run 360 km and will employ 18-inch diameter pipe. The initial thirteen years' system capacity will be 3.45 million metric tons per annum (mmtpa), ultimately expanding to six mmtpa. Worley Parsons, India (WPIL), has been appointed as the engineering project management consultant (EPMC).

PROJECT DESCRIPTION

BPCL is a public oil and gas (O&G) sector enterprise established in 1976 after the Indian government took over Burmah Shell. Headquartered in Mumbai, BPCL managed the first refinery to process indigenous Bombay high crude oil. The company currently produces a broad range of petroleum and gas products at its refineries and has a 2,300-kilometer pipeline network. BPCL's refinery throughput has grown steadily from 2015 and 2020 (Figure 95).

Figure 95: BPCL Refinery Throughput, Million Metric Tons¹²¹



The proposed Bina-Panki pipeline will optimize product movement from the Bina refinery (Figure 96) to the Panki depot to meet market demand in Uttar Pradesh and Bihar. The pipeline will replace existing rail transport. As a result, BPCL foresees investment returns of more than 12 percent. The proposed 18-inch, multi-product pipeline will carry a range of petroleum products, including motor spirit (MS), high-speed diesel (HSD), superior kerosene oil (SKO) and aviation turbine fuel. The pipeline will pass through the Sagar and Tikamgarh districts in Madhya Pradesh and through the Lalitpur, Jhansi, Jalaun, and Kanpur districts in Uttar Pradesh, avoiding environmentally sensitive areas.

¹²¹ BPCL

Figure 96: Bina Refinery¹²²



The Project (pipeline) battery limits are defined as follows:

1. Dispatch station at Bina, including booster pumps (one operational and one standby), mainline pumps (one operational and one standby), basket filter, metering, corrosion inhibitor dosing and scraper launcher, along with associated facilities.
2. Intermediate pigging station (IPS), including scraper receiver/launcher, filter, metering, corrosion inhibitor dosing and associated facilities.
3. 355 km cross-country pipeline from Bina to Panki.
4. Receipt terminal at Panki, including scraper receiver, filtering, metering and related facilities.
5. Sectionalizing valve stations (SVS) per code and profile requirements.
6. SCADA (Supervisory Control & Data Acquisition), LDS (Leak Detection System), CP (Cathodic Protection), ESD (Emergency Shut Down) system, telecommunications and instrumentation systems.

The scope of work for the contractor installing the pipeline is divided in three parts:

¹²² Ibid

Part A: Basic Engineering

1. Process package consisting of all Process & Engineering design, conducting optimization studies for the entire pipeline, review/update layout of facilities, process flow diagrams, piping and instrumentation diagrams, process/equipment datasheets and electrical/instrumentation datasheets.
2. Pipeline system operation and control philosophy & manuals.
3. Conceptual designs, telecommunication and SCADA, inclusive of leak detection systems and turnkey instrumentation.
4. Pipeline optimization studies and modify pipeline design as per throughput specifications.
5. Analyses and detailed route survey/survey alignment sheets/cadastral survey and soil investigations.

Part B: Detailed Engineering, Inspecting, Monitoring and Project Management

This element will include all activities after basic engineering, including:

- Detailed engineering.
- Finalization of specifications for procurement of equipment/materials and works packages.
- Preparation of RFQs.
- Detailed estimates.
- Floating of open and limited tenders for equipment and works.
- Tender evaluations.
- Issuance letter of intent/purchase orders.
- Approval of construction (AFC) drawings, all vendor documents, the quality assurance plan and inspections.
- Expediting and both project management and project risk management until commissioning of the project.

Part C: Construction Supervision - Site Construction, Supervision Services through Mechanical Completion, Pre-Commissioning and Commissioning

The contractor will comply with the provisions under the Petroleum and Natural Gas Regulatory Board (PNGRB) Regulations including the service obligations specified in Schedule J to PNGRB (Authorizing Entities to Lay, Build, Operate or Expand Petroleum and Petroleum Products Pipelines), Regulations 2010 and other relevant rules for the technical standards and specifications, including safety standards and any other regulations that may be applicable, and the provisions of the PNGRB Act, 2006.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

In 2018, BPCL completed a Detailed Feasibility Report (DFR) and studies for environmental clearance. In Dec. 2018, the Petroleum and Natural Gas Regulatory Board (PNGRB) granted BPCL the authorization to lay, build and operate the pipeline.

In the third quarter of 2019, BPCL invited bids to install 29 km of 18-inch, API 5L grade X-70 pipeline through horizontal directional drilling (HDD) at various crossings for the project, a relatively small portion of the 360 km pipeline project. BPCL issued bids to supply multiple types of pipes, including coated, submerged arc pipes, longitudinal welded/submerged arc pipes, and helical welded/high-frequency electric welded carbon steel line pipes.

The concession authority for this project is PNGRB. Several consultants are also involved with the development of the project:

Consultant	Contact Details	Scope of Work
N.K. Buildcon Private Limited	B-62, “UGANTA”, University Marg, Bapu Nagar, Jaipur Rajasthan, India Ph: S+91 141- 2710841 http://www.nkbuildcon.com/	Survey works
Worley Parsons India Private Limited	B Wing, 5th Floor, i-Think Lodha Techno Campus Off Pokhran Road No. 2, Thane (West), Mumbai Maharashtra, India Ph: +91 22 6781 8000 https://www.worleyparsons.com/	Project Consultant
Projects & Development India Limited (PDIL)	PDIL Bhawan, A-14, Sector 1, Noida, Uttar Pradesh India Ph: +91 120 2529842 www.pdilin.com	Pre-feasibility report
Engineers India Limited	Engineers India Bhawan, 1, Bhikaiji Cama Place, RK Puram Delhi, India Ph: +91 11 26762121 http://www.engineersindia.com/	DFR of 327 km pipeline

With authorization by the PNGRB, BPCL expects the pipeline to be commissioned by Dec. 2021. However, beginning in April 2020, most BPCL projects, including this one, were placed on hold due to the COVID-19 global pandemic and economic shutdown. Work on the project resumed in Aug. 2020. The completion date has been extended to 2022.

PROJECT COST AND FINANCING


The estimated cost of the project is \$227 million. The project will be funded by BPCL (a public sector, state-owned undertaking controlled by the Government of India) through their internal resources, including reserve funds and debt financing. Of the total \$227 million project cost, BPCL has spent \$45 million to date.

U.S. EXPORT OPPORTUNITIES

U.S. firms will have opportunities to subcontract to the EPMC. U.S. exporters will also have opportunities to provide equipment and services per the project description above. While BPCL is required to adhere to local content (LC) regulations for upstream EPC projects, the import content for the off-shore specified pipeline will be approximately 65 percent of the project, as defined by the PNRGB. For tubulars, the import content will be 40 to 50 percent. For drilling services, pumping units, and wetheads, the import content will be 70 to 80 percent, including downhole tools, logging services, premium bits, machine and equipment, and associated components.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
Bharat Petroleum Corporation Limited (BPCL) Bharat Bhavan, 4&6 Currinbhoy Road Ballard Estate, Mumbai Maharashtra, India Mr. Samir Banerjee, Senior GM, Procurement Amol.gosavi@worleyparsons.com visalpaliwal@bharatpetroleum.in www.bharatpetroleum.com	Indo-Pacific Region 1101 Wilson Blvd. Suite 1100 Arlington, VA 22209 USA Ms. Tanvi Madhusudanan Country Manager tmadhusudanan@ustda.gov U.S. Trade and Development Agency U.S. Embassy in Delhi Shantipath Chanakyapuri, New Delhi Delhi 110021 India Ms. Mehnaz Ansari Senior Regional Representative, South Asia mansari@ustda.gov IndoPacific@ustda.gov www.ustda.gov	U.S. Commercial Service The American Center 24 Kasturba Gandhi Marg New Delhi 100 001 India Ms. Aileen Crowe Nandi Minister Counselor for Commercial Affairs office.newdelhi@trade.gov www.trade.gov

Mumbai Harbor FSRU LNG Terminal		
	SECTOR	Energy
	SUBSECTOR	Oil and Gas
	LOCATION	Mumbai
	PROJECT VALUE	\$395 Million

PROJECT SUMMARY

Mumbai Port Trust (MbPT) is planning a five million metric ton per annum (mmtpa) floating storage and regasification (FSRU) LNG terminal in Mumbai Harbor (Maharashtra State), within seven kilometers (km) of the Gas Authority of India Limited (GAIL) natural gas pipeline grid. The \$395 million project (excluding vessel costs) will be a public-private partnership (PPP) with a concession period of 30 years.

PROJECT DESCRIPTION

The Government of India has announced plans to increase the share of natural gas in India's energy mix from six percent in 2016 to 15 percent by 2022. Currently, half of India's natural gas supply is from domestic production, while the other half is from LNG imports. Rising demand indicates a 30 percent domestic/70 percent imported LNG supply mix by 2025. Anticipating future demand, India has broadened its international supply base and negotiated long-term LNG supply contracts.

A challenge in meeting the 2025 supply goal is building sufficient gas infrastructure to receive LNG shipments, re-gasify and then, distribute the gas across a wide geographic area. India has four operating LNG terminals located on its west coast, with several more coming on-stream. LNG terminals can be either land or water-based, floating LNG (FLNG) terminals.

The components of an FLNG project are:

- Gas production facilities.
- Baseload liquefaction plant with storage and export facilities.
- LNG tanker ships (transportation).
- Import terminal with storage regasification unit(s) (SRU).

The Indian Ministry of Shipping has issued guidelines for receiving liquefied natural gas (LNG) cargo in floating storage regasification units (FSRU) at its major ports. The policy defines investment structure options incentivizing private investors while creating a private-sector engine to help India shift its focus to offshore terminals, which are half as expensive and take much less

time to build and reach operability. Part of the offshore efficiency is that land-based LNG port terminals require leasing waterfront property, with associated costs and regulatory issues. Simultaneously, offshore storage ships (Figure 97) with onboard regasification plants can be moored and linked directly to a gas pipeline network, a faster, more cost-efficient way of increasing total LNG storage capacity.

Figure 97: Floating LNG Storage¹²³

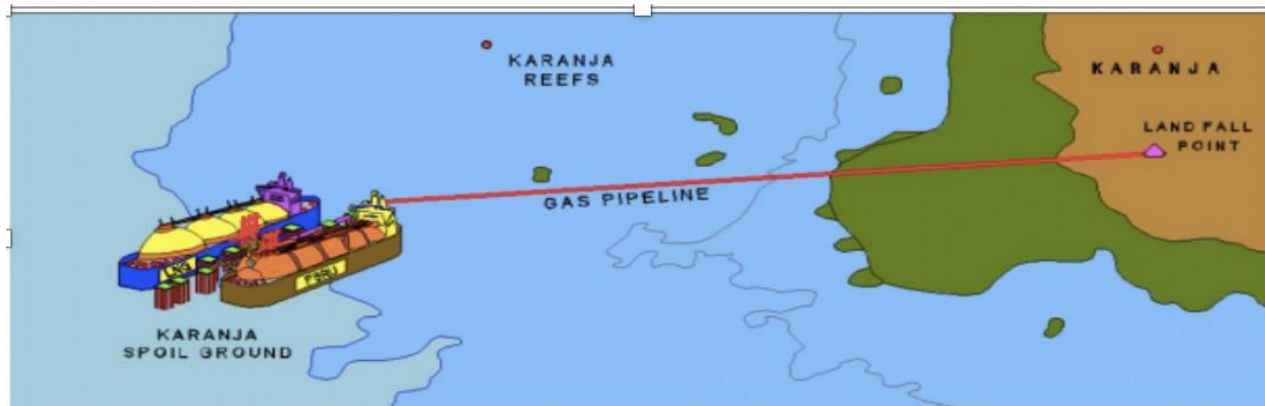


LNG storage-building speed is critical to India meeting its target of increasing natural gas use to 15 percent of the country's energy consumption. An LNG storage capacity of 47.5 million tons is required to meet the estimated volume, almost double India's current storage capacity.

The growing demand for natural gas along India's western coast drives the Mumbai Harbor LNG storage project. Specifically, MbPT is planning a FSRU with an LNG capacity of 5 mmtpa to be located in the Mumbai Harbor area (Figure 98).

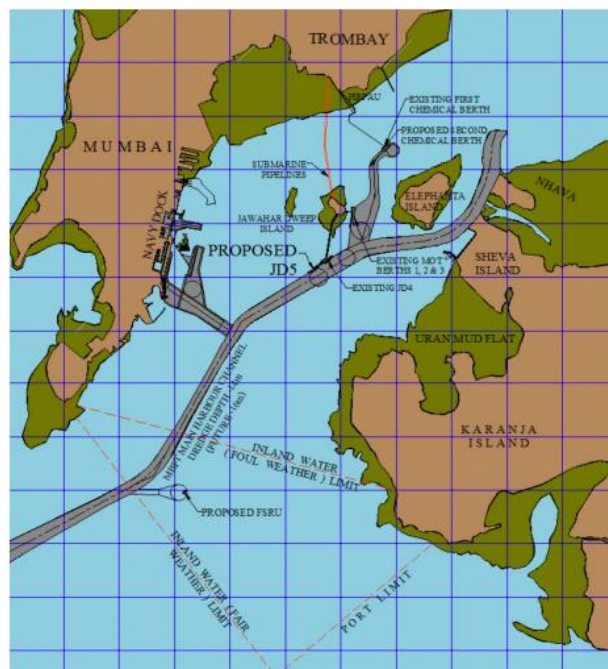
¹²³ Vancouverobserver.com

Figure 98: FSRU Terminal with Submarine Pipeline to Landfall¹²⁴



The project will be a public-private partnership (PPP) with a 30-year concession period. The terminal will be connected to the national pipeline grid, enabling natural gas transportation as far away as Panipat in Haryana. The project location (Figure 99), was selected reflecting environmental considerations and the proximity of the GAIL natural gas pipeline grid (within 7 km of the terminal), which, importantly, already meets FSRU project safety guidelines.

Figure 99: Location and Map of Mumbai Port¹²⁵



¹²⁴ Master Plan for Mumbai Port by AECOM

¹²⁵ Sagarmala.gov.in

The scope of the MbPT FSRU project includes the discharge of LNG, regasification and storage for the required period, as described below:

- **Berthing Structure:** Overall length of 348 m and width of 69 m; shipside water depth of 15.0 meters and an approach channel depth of 13.5 meters with six mooring dolphins, eight berthing dolphins and one service platform resting on cast-in-situ piles.
- **Berth Segments:** Each fixed with fenders, quick release mooring hooks, and other necessary fixtures required for berthing and mooring the LNG carrier and FSRU vessel.
- **Superstructure:** Monolithic beam-slab framed structure with piles to support the berth.
- **Advanced Communication/Security & Surveillance/Firefighting System:** To ensure efficient operation and management, as well as safety.
- **LNG Carrier Vessel:** Capacity of 216,000 cubic meters to berthed at one side of the jetty.
- **FSRU Vessel:** Storage capacity of 176,000 cubic meters to be moored on the other side of the jetty; located approximately 7 km from landfall point.
- **Dedicated Marine Loading Arms:** Number of arms matched to unloading capacity; located on the unloading platform of the jetty to pump refrigerated LNG from carrier (shuttle tanker).
- **LNG Storage:** LNG received at the FSRU stored in the tanks within the FSRU.
- **LNG Transit:** Stored LNG passed through the regasification facility, then through the conditioning and metering section, and finally through the dedicated loading arm to the unloading platform; from there, a dedicated riser will take the gas through the submarine pipeline.
- **Sub-sea Pipeline:** Connected to existing concession (ONGC/Gail) at a landfall point (7 km).
- **Dredging:** To cater to Q-max vessels (12.5 meters draft).
- **Land-fall point facilities:** For metering stations.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

The MbPT developed the project Terms of Reference (ToR) in 2015, but did not receive Coastal Regulation Zone (CRZ) and other environmental clearances until 2017. MbPT issued Requests for Proposal (RFPs) for project implementation, with submission dates extended several times, and finalized on July 6, 2020. MbPT shortlisted Shapoorji Pallonji Oil and Gas Private Limited as technically qualified, with the financial bids under evaluation. MbPT will complete the financial bid review in the next several months and issue award(s); nonetheless, the shutdown resulting from the COVID-19 global pandemic has delayed the assessment. By mid-2021, the process of subcontracting and issuing equipment and services supply contracts will begin. The project is likely to be fast-tracked once the bid closes, as all clearances are in place. The project is scheduled for completion within 36 months after the contract award.

PROJECT COST AND FINANCING

The estimated cost of the project is \$395 million, excluding the vessel's value. Of this amount, MbPT is likely to provide \$100 million. MbPT will enter into a 30-year concession arrangement with the private partner. This partner will be responsible for the design, engineering, financing, procurement, implementation, commissioning, operations and maintenance of the facilities throughout the concession period. The private partner will be the prime contractor for all subcontracts and vendor management.

According to Indian guidelines, the privately-funded project will follow a Land License model with a single-stage e-tender for constructing the FSRUs. Per the guidelines, the project will not have minimum guaranteed throughput (MGT) requirements until five years after the Commercial Operations Date (COD). After this initial period, there will be an MGT equal to 30 percent of capacity.


U.S. EXPORT OPPORTUNITIES

Opportunities for U.S. firms will exist during the detailed design, construction and operation phases of the project. These will include:

- Systems and detailed engineering design services.
- Condensing equipment and feed.
- Uploading and return arm design and equipment.
- LNG regasification facilities (onshore and offshore).
- Tanks and floater vessels design and supply.
- Containment systems and storage tanks architecture.
- Vaporizers.
- High precision metering and associated equipment.
- Berthing and unloading design and equipment.
- Facilities design.
- Operation and Maintenance (O&M) services.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
<p>Mumbai Port Trust (MbPT) Port House, SV Marg Mumbai Maharashtra India Mr. Shri Sanjay Bhatia chairman@mumbairport.gov.in www.mumbaiairport.gov.in</p>	<p>Indo-Pacific Region 1101 Wilson Blvd., Suite 1100 Arlington, VA 22209 USA Ms. Tanvi Madhusudanan Country Manager tmadhusudanan@ustda.gov U.S. Embassy in Delhi Shantipath Chanakyapuri, New Delhi Delhi 110021 India Ms. Mehnaz Ansari Senior Regional Representative, South Asia mansari@ustda.gov IndoPacific@ustda.gov www.ustda.gov</p>	<p>U.S. Commercial Service The American Center 24 Kasturba Gandhi Marg New Delhi 100 001 91-11-2347-2000 India Ms. Brenda VanHorn Senior Commercial Officer office.mumbai@trade.gov www.trade.gov</p>

Paradip-Somnathpur (Balasore)-Haldia Pipeline		
	SECTOR	Energy
	SUBSECTOR	Oil & Gas Development
	LOCATION	Paradip and Balasore (Odisha), Haldia (West Bengal)
	PROJECT VALUE	\$196 Million

PROJECT SUMMARY

The Indian Oil Corporation (IOCL) Paradip-Somnathpur-Haldia Pipeline (PSHPL) project spans several east Indian states. The pipeline will service the 15 million metric tons per annum (mmta) high-sulfur heavy crude oil Paradip refinery, commissioned in 2016. The plan is to lay an 18-inch 344-km pipeline from Paradip (Odisha) to Haldia (West Bengal) via Somnathpur (in Balasore, Orissa).

PROJECT DESCRIPTION

India's refining capacity was 249.4 mmta at the end of 2018-19, the second-largest in Asia. India's petroleum products demand in 2018-2019 was 211.6 mmta. Gasoline, diesel and LPG demand grew by 8.1 percent, 5 percent, and 6.8 percent, respectively during the period.

IOCL is a Government of India public sector undertaking (PSU). It is a global Fortune 500 company engaged in the refining, transportation, and marketing of petroleum products across India. IOCL's Pipelines Division owns and operates more than 14,500 km of pipeline networks.

Paradip is IOCL's eleventh and most modern refinery with a complexity factor of 10.7, based on the Nelson Index. The refinery uses domestically-sourced INDMAX technology developed by IOCL's R&D Center. INDMAX can produce 44.15 percent LPG, the highest yield achievable from a refinery of this type. Paradip is a technological benchmark for Indian refining and positions IOCL as a global technology licensor.

The refinery has a designed capacity of 4.17 mmta and can process 100 percent high-sulfur heavy crude oils to produce various petroleum products, including:

- Petrol and diesel of BS-IV quality.
- Kerosene.
- Aviation turbine fuel.
- Propylene.

- Sulfur.
- Petroleum coke.

The Paradip refinery is also designed to produce Euro-V premium-quality motor spirit and other green auto fuel variants for export.

To service the Paradip refinery, as a part of a proposed pipeline system, IOCL is building a new 344 km LPG and product cross-country pipeline. (Figure 100) from Paradip (pump station) to Haldia via the Somnathpur terminal. IOCL plans to construct the pipeline via horizontal directional drilling (HDD) to cross rivers, where necessary. The PSHPL product pipeline will transport HSD (high-speed diesel), motor spirits and kerosene. The pipeline will incorporate various pumping and delivery stations, operating and control systems, cathodic protection, and other typical pipeline system features.

Figure 100: Paradip Refinery and Pipeline Rendering¹²⁶



The project will require civil, mechanical and electrical engineering, services and equipment for telecommunications, and instrumentation at sectionalizing valve (SV) stations. Work is segmented into three regional project groups (Table 34). Bidders may choose to bid for one or all of the groups.

¹²⁶ IOCL

Table 34: PSHPL Project Groups¹²⁷

Group	Mainline Stretch (From/To)	State	Associated Stations	Mainline Length, Km (approx.)
A	Paradip to Kansana Bansa River Crossing (~ Ch.123km)	Odisha	Paradip Pumping Existing SV Stations of PHDPL/PHCPL (2 No.) New SV Station (8 No.)	123
B	Kansana Bansa River Crossing (Ch. 123km) to Odisha, West Bengal Border (Ch. 248 km)	Odisha	Existing SV Stations of PHDPL/PHCPL (1 No.) New SV Station (3 No.) Somnathpur Delivery Station	125
C	Odisha, West Bengal Border (Ch. 248km) to Haldia (Ch.344 km)	West Bengal	Existing SV Stations of PHDPL/PHCPL (2 No.) New SV Stations (2 No.) Haldia Station	96

The scope of work includes:

- **Basic Engineering**
 - Preparation of process package & optimization studies.
 - Development of equipment and electrical/instrumentation data sheets.
 - Pipeline system operation and control manuals.
 - Preparation of conceptual designs for Supervisory Control and Data Acquisition (SCADA).
 - Conducting detailed route surveys.
- **Detailed Engineering, Inspecting, Monitoring and Project Construction Supervision**
 - Site construction supervision services up to mechanical completion.
 - Pre-commissioning and commissioning assistance.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

The project received approval in April 2018. Subsequently, IOCL conducted financial studies, environmental impact assessments (EIA), and risk assessments (RA). The IOCL board approved a project investment of \$196 million. The company expects the pipeline's commissioning by the end of 2021. IOCL invited project bids in Sept. 2019 and has already awarded bids for 24 percent of the project:

¹²⁷ Ibid

- **Group A:**
 - Awarded to Likhitha Infrastructure Private Limited for \$ 16.4 million:
 - Laying American Petroleum Institute (API) specification 5L-grade X-70 pipelines from Paradip to Kansana Bansa River crossing (approximately 123 km).
 - Installation of 18" Outside Diameter (OD) pipeline across major rivers via horizontal directional drilling (HDD), in addition to other supporting project requirements.
 - Awarded to Mansi Ganga Builders and Engineers Private Limited for \$1.4 million;
 - Laying 60 km of pipeline from Paradip through the Mahanadi River, Nuna River, Gobri River, Brahmani River and Kharsua River.
- **Group B:**
 - Awarded to Nandini Impex Private Limited for \$ 11 million:
 - Laying 125 km of API 5L grade X-70 pipelines from the Kansana Bansa River and crossing to Odisha/West Bengal border.
 - Awarded to Punj Lloyd Limited (PLL) for \$ 1.1 million:
 - Laying pipeline from chainage 60 km ex-Paradip to chainage 248 km ex-Paradip (Odisha/West Bengal) through the Baitarani River.
- **Group C**
 - Awarded to Kalpataru Power Transmission Limited for \$ 16.3 million;
 - Laying 96 km of API 5L grade X-70 pipelines from Odisha/West Bengal border to Haldia.

IOCL will be involved in selecting/approving the sub-contractors and vendors for equipment and services.

PROJECT COST AND FINANCING

The expected project cost is \$196 million. IOCL is sponsoring the project and will retain 100 percent equity ownership. The Ministry of Petroleum and Natural Gas requires contractors to meet local content (LC) requirements aligned with the “Make in India” campaign, which is designed to drive economic growth through local content production. IOCL also specifies rate schedules for specific items and services with which contractors must comply.

U.S. EXPORT OPPORTUNITIES


While IOCL will follow local content regulations for upstream EPC projects, opportunities will exist for contractors to import machinery, equipment and components at a specified import percentage, including:

- Tubulars and drilling services: 40-50 percent.
- Machinery and equipment, premium bits, wet-heads, logging services: 70-80 percent.

This project is one of the many new planned pipelines by IOCL. Entry into this project and becoming a registered supplier to IOCL may lead to additional opportunities.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
<p>Indian Oil Corporation Ltd. 3079/3 Josip Broz Tito Marg New Delhi India Dy. General Manager (PJ- Contract anilkumar@indianoil.in www.indianoil.in</p>	<p>Indo-Pacific Region 1101 Wilson Blvd. Suite 1100 Arlington, VA 22209 USA Ms. Tanvi Madhusudanan Country Manager Tmadhusudanan@ustda.gov USTDA U.S. Embassy in Delhi Shantipath Chanakyapuri, New Delhi Delhi 110021 India Ms. Mehnaz Ansari Senior Regional Representative, South Asia mansari@ustda.gov IndoPacific@ustda.gov www.ustda.gov</p>	<p>U.S. Commercial Service The American Center 24 Kasturba Gandhi Marg New Delhi 100 001 India Ms. Aileen Crowe Nandi Minister Counselor for Commercial Affairs office.newdelhi@trade.gov www.trade.gov</p>

Raniganj (South) CBM Block Expansion		
	SECTOR	Energy
	SUBSECTOR	Oil & Gas
	LOCATION	Raniganj, West Bengal, India
	PROJECT VALUE	\$3.97 Billion

PROJECT SUMMARY

The Raniganj South Block, in West Bengal, India, has estimated in-place shale gas reserves of 6.13 trillion cubic feet (tcf), of which about 1.7 tcf can be recovered. The block expansion project involves drilling 400 shale and 150 coal bed methane (CBM) wells to depths of 3,000 meters and 1,500 meters, respectively. The project also requires the construction of five gas-gathering stations (GGS) and five central gas stations (CGS) with associated infrastructure. Great Eastern Energy Corporation Limited (GEECL) is undertaking the project.

PROJECT DESCRIPTION

In 2016, India's government implemented a new Hydrocarbon Exploration and Licensing Policy (HELP). HELP provides more straightforward rules, tax breaks, and pricing and marketing freedom, along with a revenue-sharing model. Under the revenue sharing model, the government receives a share of the gross revenue from oil and gas sales independent of costs or margins. HELP will also enable faster coverage of targeted geographic areas.

CBM, an unconventional source of natural gas, is now considered an important means of enhancing India's domestic energy resource base and is aligned with the Government of India's policy to double oil and gas output by 2022-2023. However, this target date will likely be postponed due to the COVID-19 global-pandemic-induced recession. India has the fifth-largest proven coal reserves globally, making Indian CBM, with its 92 tcf of retrievable gas across twelve states, a significant energy resource.

To exploit the full potential of CBM in India, the Directorate General of Hydrocarbons (DGH), in close interaction with the Ministry of Coal (MoC) and the Central Mine Planning and Design Institute (CMPDI), has carved out CBM blocks. The parties involved awarded select blocks through Open Acreage Licensing Policy (OALP) bid rounds (Table 35).

Table 35: Indian CBM Blocks¹²⁸

S. No.	Particulars	Details
1	Land Area	195,867.9 m ² (19.58 hectares)
2	Built-up Area	Proposed Built-Up Area: 716, 856 m ² Existing Built-Up Area: 158,696 m ²
3	Water Consumption	3,062 thousand liters per day
4	Power Requirement	27,360 KVA
5	Connectivity	Ashok Rajpath
6	Parking	193,370 m ²
7	Green Area	39,175 m ²

Commercial production of CBM at CBM Block Raniganj (South) began in July 2007, under the operations of GEECL. In 2017, a policy framework was issued, allowing for domestic arm's length pricing and marketing freedom, thereby enhancing producers' ability to monetize and realize a return on their investments. Currently, three blocks are producing CBM in Raniganj:

- Raniganj (South) operated by Great Eastern Corporation Ltd (GEECL).
- Raniganj (East) operated by Essar Oil & Gas Exploration & Production Limited (EOGEPL).
- Sohagpur (West) operated by Reliance India Ltd. (RIL).

In addition, there is incidental CBM gas produced in the following two testing wells:

- Jharia block operated by the Oil and Natural Gas Company Limited (ONGC).
- Sohagpur (East) operated by RIL.

London-listed Indian CBM producer, GEECL, proposed expanding its exploration and production activities at its flagship Raniganj (South) Coal Bed Methane (CBM) block in West Bengal with a project cost estimated at \$3.97 billion. This project will include both new CBM and shale gas production.

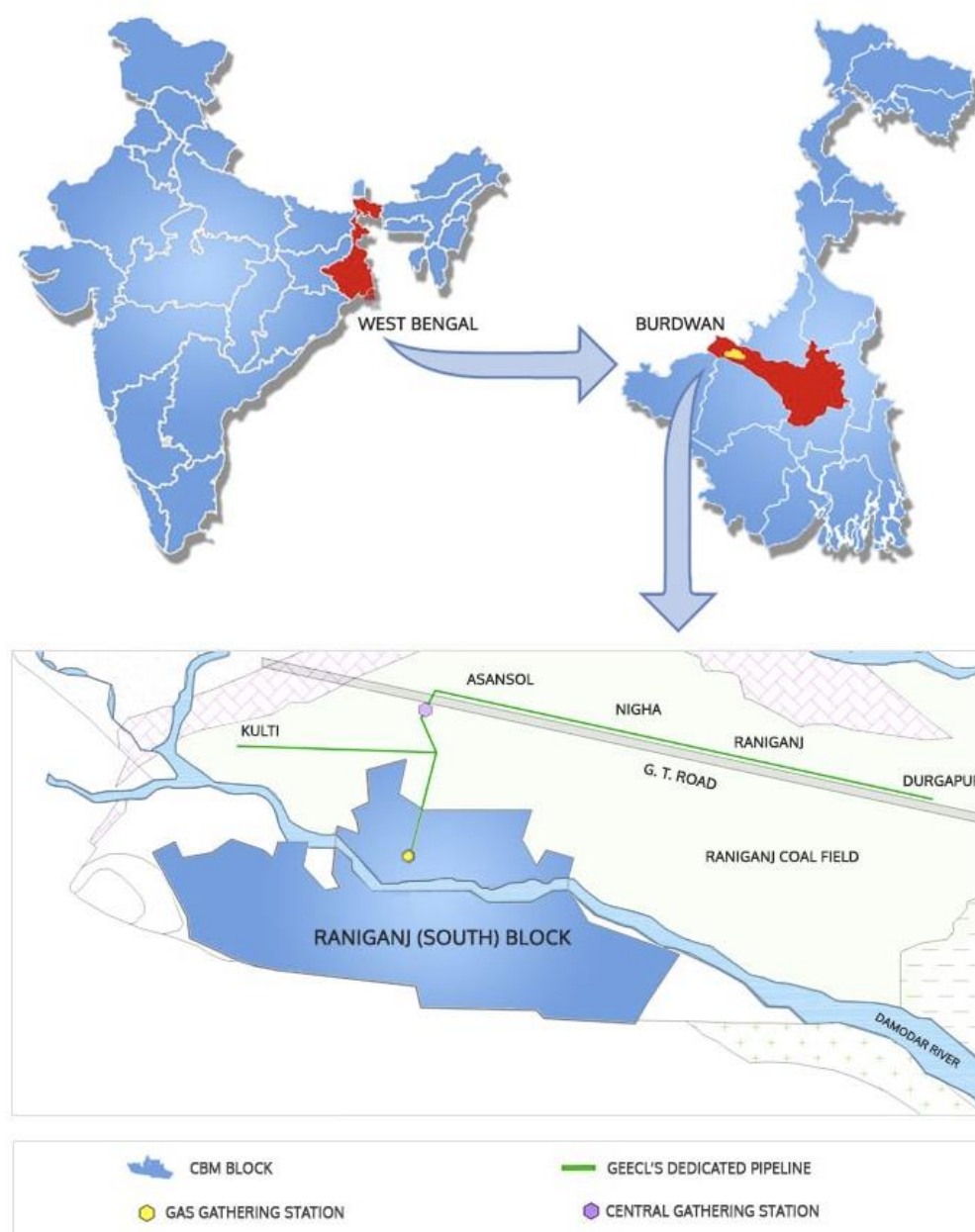
New investments planned under this project include the following:

- Drilling 400 shale wells.
- Drilling 150 CBM wells.
- Constructing as many as five Gas Gathering Stations (GGS).
- Constructing as many as five Central Gas Stations (CGS).
- Development of allied infrastructure at its block in West Bengal.

¹²⁸ Directorate General of Hydrocarbons

GEECL's Raniganj (South) block license (Figure 101) covers 210 square km, with wells drilled in a 5-well cluster pattern. An internal, medium-density polyethylene (MDPE) pipeline network connects the wells to the Gas Gathering Station, which, in turn, feeds gas into the dedicated external steel pipeline network. GEECL intends to drill CBM wells 1,500 meters deep and shale wells to a depth of up to 3,000 meters. Typically, drilling CBM wells requires 8-10 days while drilling shale gas wells needs twice that time.

Figure 101: Raniganj (South) Block



Specific elements of the GEECL project include:

- Drilling vertical and inclined wells.
- Casing and cementation.
- Logging.
- Sand jet perforation.
- Hydro-fracturing.
- Well completion with appropriate lift pumps.
- Creation of GGSs.
- Installation of an Early Production System (EPS).
- Laying of comingled CS/HDPE pipelines for gas and HDPE pipelines for water.
- Bringing wells to production following Good International Petroleum Industry Practices (GIPIP) and sound health, safety, and environment (HSE) practices.

GEECL's Raniganj (South) block has similarities to the Black-Warrior basin in the United States; namely multiple coal seams with significant gas content and favorable permeability, which account for its high productivity. CBM wells are not significantly different from other gas wells except that conventional wells typically begin production with high gas/water ratios (GWR) decreasing with time. In contrast, CBM wells start with low GWRs increasing with time.

This project is an expansion of GEECL's 156 successfully drilled wells. Upstream and midstream assets are located at the block site, with downstream activities aided by proximity to West Bengal's large and growing industrial center. GEECL enjoys multiple contracts with large and medium industrial customers.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

On May 22, 2019, a proposal to approve GEECL's project Terms of Reference (ToR) (consistent with policy frameworks already in place for its wells operating in the area) was submitted to the Ministry of Environment, Forest and Climate Change (MoEFCC). Approved in June 2019, GEECL started its expansion planning, including drilling core wells, followed by drilling pilot production wells. GEECL completed the initial drilling work during this period, and then the project stalled in April 2020 as a result of the country-wide lockdown resulting from the COVID-19 global pandemic. GEECL expects to detail the field development plan by the end of 2020 and develop the overall project through the next decade.

Despite the lock-down, GEECL had only a marginal drop in its FY 2020 revenues from \$40.33 million to \$36.25 million and profit after taxes, from \$7.3 million to \$6.9 million. As a result, GEECL remains bullish on these initiatives and expects to resume this project by first quarter 2021.

PROJECT COST AND FINANCING

The estimated project cost is \$3.97 billion. GEECL, the 100 percent equity shareholder in the project, will be the prime contractor and manage all sub-contracts, securing services and supplies during the construction and operational phases. Investments in drilling, extraction and transportation will be phased-in over a decade.

U.S. EXPORT OPPORTUNITIES

U.S. export opportunities include:

- Design and engineering services.
- Supply of equipment related to gas estimations.
- Drilling.
- Safety and maintenance services.

Technology-specific export opportunities exist as well, including:

- Coring system design.
- Manifold and flowline design/definition.
- Cleat system design.
- Stimulation design and modeling.


Equipment and material supply opportunities will exist for:

- Water-based drilling fluids.
- Air/gas drilling chemical.
- Variable-depth drilling rigs and associated equipment (e.g., rotary drilling rigs, mining rigs, coiled-tubing drilling units, modified completion rigs).
- Air compressors and boosters.
- Blowout preventers.
- Rotating heads.
- Drill pipes.
- Wireline-coring equipment.
- High-end pressure coring equipment.
- Hydraulics.
- Componentry, including pipe, bridge plugs, Frac baffles, sealers.
- Fluid entry survey equipment.

With two allocated blocks, one in Raniganj in West Bengal and another at Mannargudi in Tamil Nadu, GEECL has played an essential role in producing CBM gas in India. The Raniganj project alone is extensive and long-term, with numerous supply needs. GEECL also has plans for CBM exploration in other regions. As a result, a reliable service or equipment supplier may have access to multiple additional opportunities both near and long term.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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New Indonesian Capital – Green City Development		
	SECTOR	Energy/Transportation/ICT
	SUBSECTOR	Renewables; EVs
	LOCATION	East Kalimantan, Indonesia
	PROJECT VALUE	Up to \$34 Billion (Phase One)

PROJECT SUMMARY

Indonesia's new capital city, yet unnamed, will be a greenfield construction project, using environmentally friendly technologies and products as a way to maintain the existing eco-system as much as possible. The city plan envisions a smart, green, and sustainable urban area. The government plans to incorporate renewable energy (primarily large hydro and rooftop solar), waste-to-energy, electric vehicles, and Leadership in Energy and Environmental Design (LEED) certifications. The first phase of the capital's relocation will occur in 2024.

PROJECT DESCRIPTION

In August 2019, Indonesia's President, Joko Widodo, announced the country would move its capital from Jakarta, located on Java, to an as-yet-unnamed city in East Kalimantan, on the island of Borneo (Figure 102). The new city is located on 180,000 hectares of government-owned land, between the cities of Balikpapan and Samarinda. Indonesia projects the overall Phase One cost for moving the capital to be approximately \$34 billion. The city will accommodate a population of 1.5 million people.

The core of the city will occupy 6,000 to 10,000 hectares and serve as the seat of government (Figure 103). Indonesia plans to develop housing for many of the federal employees and their families. The core city center, to be developed under Phase One, will accommodate 150,000 to 200,000 inhabitants initially. After completing the core central zone, the remaining metropolitan area will be developed across 40,000 hectares.

Indonesia's national government is committed to making its new capital a green city, using environmentally friendly technologies and designs wherever possible. The tag line for the new city promotes it as smart, green, beautiful, and sustainable. The government has plans to use renewable energy (primarily large hydro and rooftop solar) to provide a significant portion of the energy required to power the city and use technologies such as waste-to-energy technologies to dispose of the city's waste. Other tools, such as low emissions or electric vehicles, will be used to limit pollutants. Many buildings will be constructed to meet Leadership in Energy and Environmental Design (LEED) certifications to reduce energy consumption.

Figure 102: Location of the New Indonesian Capital¹²⁹



Figure 103: Rendering of the New Indonesian Capital City¹³⁰



One of the significant challenges facing the city developers is managing the environmental impacts of establishing a large population center. Currently, forests occupy a portion of the land where the

¹²⁹ The BBC

¹³⁰ Bappenas

city is planned. While the planners aim to make the new capital city both a smart and a forest city, clearing of trees and other natural habitats must occur. A thorough environmental impact mitigation plan will be necessary to ensure the success of the city.

The national government has also expressed a desire to keep the city compact to limit the environmental impacts associated with new development. Half of the city's area will be "green spaces" (Figure 104). Protected/conservation areas will stay untouched. Additionally, each project within the new capital will be required to undertake an environmental impact assessment.

Figure 104: Close-Up Rendering of the New Indonesian Capital City¹³¹



At present, the country's Ministry of National Development Planning (Bappenas) is the lead organization for the new capital's planning and development. Bappenas is working in coordination with all line ministries, particularly the Ministry of Public Works, to ensure the city is effectively planned, functional, and environmentally focused. Once Indonesia's new Cabinet ministers are appointed, they will establish a new Agency or Board, at the national level, to be the primary decision-maker for advancements in the new capital.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

A consortium of international firms completed the master plan for the central government zone in December 2020. These firms include engineering company AECOM, consulting firm McKinsey & Company, and architecture and engineering firm Nikken Sekkei. In December 2020, the Minister of National Development Planning approved the project to assist in economic recovery.

¹³¹ Bappenas

Phase One of the project has begun, with a projected end date of 2024. However, the project has been delayed due to COVID-19. The government postponed a "soft" groundbreaking planned for August 2020 to focus on the pandemic and recovery. The pandemic has delayed work on new laws required to allow for the project's execution and the government's transition to the new capital.

The first phase of construction will focus on the central core area of the capital, including government offices and supporting facilities. The government expects to complete Phase One within three years. Construction is now scheduled to begin in 2021, but start-timing will depend on whether the government must divert further resources to pandemic recovery efforts. The 5,000 ha of land required for the first phase is wholly government-owned. The government plans to move to the new capital city and begin operations in 2024 (Figure 3), coinciding with the conclusion of President Jokowi's term in office.

PROJECT COST AND FINANCING

Indonesia projects the Phase One costs, for the construction and government move, to be approximately \$34 billion.

A variety of mechanisms will support project financing, including government resources, private investment, and public-private-partnerships (PPP). The state will provide a fifth of the budget amount. The United Arab Emirates (UAE) government and the United States International Development Finance Corporation (DFC) will provide \$22 billion for infrastructure development broadly in Indonesia, including for the new capital city, through a sovereign wealth fund.¹³²

U.S. EXPORT OPPORTUNITIES

Significant opportunities exist for U.S. firms offering green technology solutions as a way to drive the country's plan for a smart, green, and sustainable city. To meet the government's desired goal of at least half of the city being composed of "green spaces," critical planning will need to be done at an early stage to integrate green technologies, limit the city's impact on the environment and reduce overall emissions. U.S. firms are well placed to provide the necessary goods and services to aid the Indonesian government with this effort.

Possible opportunities for U.S. firms operating in this space include:


- Electric Vehicles and charging stations
- Waste to energy solutions.
- Integrated battery storage solutions.
- Water and wastewater technologies.
- Public transportation.
- Emissions control systems.

¹³² <https://www.archpaper.com/2020/03/capital-city-indonesia-master-plan-aecom-mckinsey-company-nikken-sekkei/>

- Air and water monitoring solutions.
- Renewable energy technologies and supporting devices.
- Energy-saving appliances.
- Run of river hydropower solutions.
- Biogas and biomass technologies.
- LEED design services.
- Green building materials.
- Recycling technologies.
- Control systems and ICT solutions
- Urban Planning services.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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Indonesia Waste to Energy Priority Projects		
	SECTOR	Energy/Environment
	SUBSECTOR	Waste to Energy
	LOCATION	Indonesia – Multiple Locations
	PROJECT VALUE	\$2.5+ Billion

PROJECT SUMMARY

Indonesia is in the process of accelerating the use of waste-to-energy (WTE) technologies to manage its growing waste challenges. Twelve cities or provinces have been targeted for new facilities, representing more than \$1 billion of investment. The Government of Indonesia expects these plants to be operational by 2025.

PROJECT DESCRIPTION

In 2018, Indonesia's President, Joko Widodo, issued a Presidential Decree to promote waste-to-energy (WTE) technology projects to combat the growing amount of waste accumulating across the country. Indonesia has a growing problem, as landfills are increasing in size and can leak into rivers and the surrounding environment. WTE projects are being accelerated to limit this pollution and reduce the footprint of waste across the country. The WTE policy has the added benefit of generating electricity, expected to be approximately 234 MW from burning up to 16,000 tons of waste per day. President Widodo noted that these projects' driving force was to take care of the trash rather than generate electricity.

The National Strategic Project list, as developed by the Coordinating Ministry of Economic Affairs, line Ministries, and the Committee for Acceleration of Priority Infrastructure Delivery (KPPIP), lists the WTE projects as Priority Projects. The Government determined the Priority Projects as those aligned with the National Medium-Term Development Plan and a Presidential or Ministerial Decree, their strategic role for economic development, and the overall investment value. When selecting projects for this classification, the KPPIP emphasized projects with a high economic internal rate of return (EIRR).

As part of the Presidential Decree, 12 cities and provinces will implement waste to energy facilities (Figure 105). The Decree specified the electricity tariff for these projects. The tariffs depend on the capacity of the project:

- For projects less than 20 MW, the tariff is U.S. 13.35 cents/kWh.
- For projects greater than 20 MW, the tariff is U.S. 14.54 cents/kWh – [0.076 x capacity in MW].

- The maximum value allowed for the tipping fee is Rp 500,000/ton (approximately \$35/ton).

Figure 105: Location of WTE Projects¹³³



Indonesia is developing seven initial projects using a public-private-partnership (PPP) model (Table 36). The structure requires the cities to:

- Use an outside transaction advisor to Structure the project before selecting the investor.
- Receive approval from the Ministry of Energy and Mineral Resources to sign a power purchasing agreement (PPA) with PT Perusahaan Listrik Negara (PLN).

Once the PLN signs the PPA, the construction of the facility will begin. However, in the summer of 2020, the Ministry of Finance put a hold on all investment decisions pending a review of the tariff amount and the split of payments of the tariff between the Central Government and the local Government. This decision is only the case for PPP projects.

For those projects not being developed under a PPP, the local investor will manage the process, including preparing documents for tender, rather than use an outside transaction advisor. For example, a 1.5 MW portion of the Bekasi facility is being developed as a non-PPP model, while an additional 20 MW will be a PPP.

New regulations enacted in Feb. 2020 by the Minister of Energy and Mineral Resources will provide a more consistent and coordinated regulatory approach, making project opportunities more attractive to international developers. These reforms include ensuring that PLN, the distribution utility, prioritize electricity acquisition from renewable independent power producers (IPPs). The

¹³³ KPPIP

new regulations also simplify procurement of electricity from IPPs by PLN, without ownership transfer requirements to PLPN at a future date, which is different from the prior regulations.

Table 36: Initial PPP Projects¹³⁴

Location	Capacity (ton/day)	Estimated Investment Value (\$ million)	Estimated Start of Investment Tender
Legok Nangka, West Java (Jawa Barat)	1,845	\$265	On hold pending MoF review
Sarbagita, Bali (Denpasar)	1,345	\$160	On hold pending MoF review
Cipeucang, South Tangerang (Tangerang Selatan)	800	\$120	On hold pending MoF review
Jatibarang, Semarang	1,000	\$130	On hold pending MoF review
Tamangapa, Makassar	890	\$120	On hold pending MoF review
Ilo-Ilo, North Sulawesi (Sulawesi Utara)	1,000	\$130	On hold pending MoF review
Sumur Batu, Bekasi	1,800	\$260	On hold pending MoF review

PROJECT STATUS AND IMPLEMENTATION TIMELINE

Table 37 describes the progress of the projects identified. Several additional projects under later time schedules are included. The projects have been delayed by the COVID-19 global pandemic and the Ministry of Finance's review of tariffs. The Government plans for these projects to initiate construction in 2021 and 2022.

The projects being developed under the PPP scheme are using international organizations to prepare the associated documentation, including:

- The outside business case (OBC).
- The final business case (FBC).
- Tender documents.
- Transaction advisory materials.

¹³⁴ KPPIP

Table 37: Project Status¹³⁵

No	Project Name	Scheme	Target Construction Start	Target Operating Date	Estimated Capacity (MW)	Estimated Investment (Rp billion)
1	PSEL Kota Surabaya*	Private	2016	starting	9	718
2	PSEL Kota Surakarta	Private	2019	delayed	5	336
3	FPSA (DKI Jakarta)	Private	2021	2024	43	6.700
3.a	ITF Sunter	PPP	2021	2024	35	5.000
3.b	Wilayah Layanan Barat	PPP	2022	2025	35	6.000
3.c	Wilayah Layanan Timur	PPP	2021	2024	20	2.000
3.d	Wilayah Layanan Selatan	PPP	2021	2024	20	2.000
4	PSEL Kota Tangerang	PPP	2022	2024	31	2.586
5	PSEL Kota Palembang	Private	2021	2023	20	1.725
6	PSEL Regional Jawa Barat	PPP	stopped	stopped	25	4.000
7	PSEL Regional Bali	PPP	2021	2023	20	2.300
8	PSEL Kota Semarang	PPP	2022	2024	19	1.700
9	PSEL Kota Makassar	PPP	2022	2024	15	1.508
10	PSEL Kota Tangerang Selatan	PPP	2022	2024	12	1.816
11	PSEL Kota Bekasi	PPP	2022	2024	19	2.200
12	PSEL Regional Sulawesi Utara	PPP	2022	2024	20	1.740

¹³⁵ KPPIP Jan. 2021

The international organizations developing PPP documentation include the:

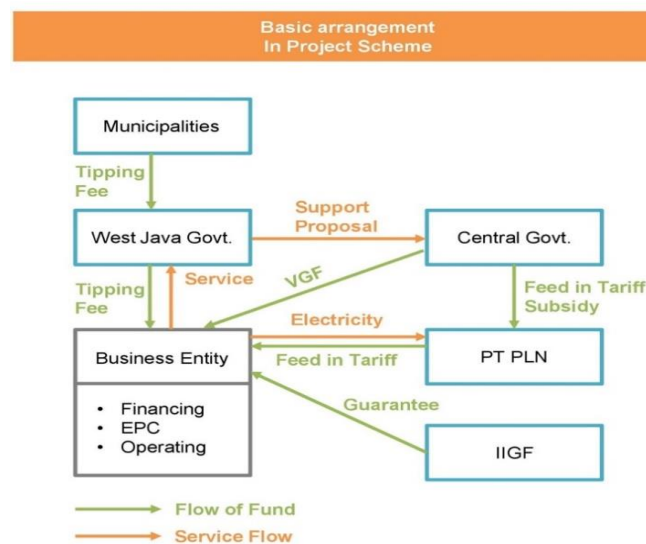
- Millennium Challenge Account (USA/Indonesia).
- Japan International Cooperation Agency.
- Indonesia-Australia Partnership for Infrastructure.
- Korea Environmental & Technology Institute.
- Asian Development Bank.
- Indonesia China Business Council.

PROJECT COST AND FINANCING

The total estimated cost of the WTE facilities exceeds \$2 billion.

For the PPP projects, which are encouraged by the Government, the operator receives the tipping fee and tariff as detailed in the Presidential Decree. Additionally, the Indonesian Government provides a viability gap fund (VGF), an equity portion of 30-40 percent, and free land use. The Indonesia Infrastructure Guarantee Fund also provides a government guarantee for the project. However, this structure is under review by the Ministry of Finance. Figure 106 provides a template of the PPP structure operation. Projects not developed under the PPP scheme will only receive the tipping fee and tariffs included in the Presidential Decree.

Figure 106: PPP Operating Structure¹³⁶



¹³⁶ KPPIP

U.S. EXPORT OPPORTUNITIES

Several international entities have already shown interest in supporting the development of the WTE PPP projects and are involved with their preparation, including the following:


- West Java: USA (Outline Business Case (OBC)); Japan (Full Business Case (FBC)).
- South Tangerang: Korea (OBC, FBC); ADB (Transaction Advisor).
- Makassar: Korea (OBC, FBC).
- North Sulawesi: China (OBC).
- Semarang: Australia (OBC, FBC, Transaction Advisor).

The construction of the WTE sites provides ample opportunity for U.S. firms to become involved. Desired services and technologies include:

- Construction services and supervision.
- Incinerators/Boilers.
- Sorting technology.
- Drying technology.
- Emissions controls.
- Turbines/Generators.
- Recycling technologies.
- Design services.
- Hauling equipment.
- Control systems.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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Pertamina – Balikpapan Refinery Upgrade		
	SECTOR	Energy
	SUBSECTOR	Refining
	LOCATION	Balikpapan, East Kalimantan, Indonesia
	PROJECT VALUE	\$4 Billion

PROJECT SUMMARY

Pertamina, the Indonesian state-owned oil and gas company, is in the process of upgrading four of its refineries and constructing a new refinery as part of its Refinery Development Master Plan (RDMP). Pertamina's 10-year, \$30-billion plan to revitalize and expand the operational capabilities of its Indonesian refineries proposes to double existing processing capacity to 2 million barrels per day by 2026 to meet the country's growing demand for cleaner petroleum-derived products and reduce dependence on imports.

The Balikpapan refinery upgrade will increase this refinery's crude processing capacity to 360,000 barrels per stream day. Pertamina awarded the engineering, procurement and construction (EPC) contract for this upgrade to Hyundai Engineering Co, Ltd., SK Engineering & Construction Co. Ltd., and two domestic EPC firms. The planned completion is 2023.

PROJECT DESCRIPTION

In 2016, Pertamina formed the Department of Refinery and Petrochemicals Mega Projects to manage the revitalization of existing refineries and the construction of two new refineries. The Department is currently overseeing the implementation of the Refinery Development Master Plan (RDMP). The RDMP's end goal is to increase Pertamina's overall refinery production capacity, produce cleaner fuels, and ultimately support an energy security policy reducing dependence on energy imports.

Without the RDMP, Indonesia would need to import approximately 62 percent of its fuel for domestic consumption by 2025. In 2017, imported fuel accounted for nearly one-third of domestic fuel consumption in the country. The goal of the RDMP is to double the domestic refining capacity to 2 million barrels of oil per day by 2025, up from the current level of 1 million barrels per day. The project will also increase the overall Nelson Complexity Index factor for Pertamina's facilities (Figure 107) from 5.4 to 8.9. At the same time, Pertamina will have a more flexible production capability to meet the country's growing need for fuel.

In 2019, Indonesia's combined domestic refinery capacity was 1.1 million barrels per stream day, with crude oil refinery production reaching 364.1 million barrels of fuels, non-fuels, and lubricants

(Table 38). Production was on an upward trend from 2015 to 2018, but with a significant drop in 2019 to 272 million barrels. Refined product imports over the same period have fluctuated from a high of 177 million barrels in 2017 to a low of 75 million barrels in 2019. However, exports of refined products have been much lower, from a high of 25 million in 2019 to a low of 12 million in 2018. Net imports of refined products were 50 million barrels in 2019.

Figure 107: Pertamina's Refineries¹³⁷



Table 38: Indonesia Refined Products – Produced and Traded¹³⁸

	2015	2016	2017	2018	2019
Crude Oil Refinery Production (Thousand Barrels)	329,581	340,289	352,182	364,135	272,025
Exports of Refined Products (Thousand Barrels)	23,755	12,858	14,822	11,801	25,716
Import of Refined Products (Thousand Barrels)	175,473	143,628	177,498	175,825	75,296

¹³⁷ KPPIP

¹³⁸ <https://www.esdm.go.id/id/publikasi/handbook-of-energy-economic-statistics-of-indonesia>

Balikpapan is Pertamina's oldest refinery (Figure 108). Having begun operations in 1922, Balikpapan supplies up to 26 percent of Indonesia's fuel needs. The current refinery has a crude processing capacity of 260,000 barrels per stream day (bpsd). The refinery has seven integrated components:

- Crude distillation unit (CDU).
- High vacuum distillation unit (HVD).
- Hydrocracker unit.
- Platformer.
- Naphtha treater.
- Gasoil treater.
- LPG recovery.

Pertamina is expanding the refinery's crude processing capacity by 100,000 bpsd to 360,000 bpsd. The Balikpapan RDMP proposed overhaul also includes the construction of units to equip the refinery to produce fuels meeting Euro 5-quality standards, including:

- A new 90,000-bpsd residual fluid catalytic cracker (RFCC).
- An 80,000-bpsd middle distillate hydrotreater.
- An LPG sulfur removal unit.
- A propylene recovery unit.

The upgrade process will increase diesel production by 30,000 barrels per day. After completion of the upgrade process, the refinery will also produce 230,000 tons of polypropylene per year.

Figure 108: Balikpapan Refinery¹³⁹



¹³⁹ Pertamina, via Jakarta Post

To meet the RDMP targets, the EPC contractors' scope of work includes converting the existing refinery to:

- Permit processing residues into high-quality fuel.
- Reduce the sulfur content of diesel and gasoline to improve quality and reduce environmental impacts.
- Produce high-octane fuel.

After Phase One of the upgrade, the Balikpapan refinery will produce fuel that conforms to the quality specifications for Euro-2.

Phase Two of this project will produce fuels to meet Euro-5 specifications. The output of Phase Two at Balikpapan will ultimately supply the feedstock to the planned greenfield petrochemical facility in Balongan. Phase Two will provide the refinery considerable flexibility to process a much wider slate of crudes than previously. After the RDMP process, the Nelson Compatibility Index for the Balikpapan facility will be nine.

Previous upgrades to the Balikpapan facility include work by Honeywell UOP in 2017 to provide technology licensing and engineering design for a 33,000 barrels per day continuous catalyst regeneration unit and a 47,000 barrels per day hydrocracking unit.

PROJECT STATUS AND IMPLEMENTATION TIMELINE¹⁴⁰

Progress on the refinery upgrades has been subject to considerable delays throughout the planning process, primarily due to funding and policy considerations. Increasing oil prices globally and the government's decision not to raise fuel prices have put a strain on Pertamina's resources, slowing the overall RDMP process. The Balikpapan refinery cleared those hurdles, attracted outside financing, and the project continues. The operating company for the refinery, PT Kilang Pertamina Balikpapan, was officially formed in May 2019.

Pertamina awarded the EPC contract to upgrade the Balikpapan Refinery Phase One to a joint venture of Hyundai Engineering Co, Ltd., SK Engineering & Construction Co. Ltd., and two local Indonesian EPCs, PT Rekayasa Industri and PT Pembangunan Perumahan. Overall EPC progress is estimated at 35 percent completion as of Feb. 2021. Major equipment deliveries to the refinery began in late 2020 and continued into early 2021. The expansion's completion will be by mid-2023.

For Phase 2, Pertamina completed the basic engineering design in late 2020. The Hyundai team will complete the FEED study effort by Oct. 2021. The EPC contract is scheduled for award in Nov. 2021. Construction will start in mid-2022, with the expansion operational in late 2025.

¹⁴⁰ Source: Triharyo Soesilo (Hengki), Special Advisor to Minister for Acceleration of Infrastructure Development & Investment at Ministry of Energy and Minerals

The current target for the overall completion of the RDMP is 2026.

PROJECT COST AND FINANCING

Pertamina has arranged the project financing for this upgrade at Balikpapan through export credit financing with the Government of South Korea. Pertamina has been in discussions with Mubadala Investments (Abu Dhabi) about taking a partnership stake in the refinery. Additional investments are also being sought to support the upgrade process and ease the financial cost that Pertamina is assuming. The overall cost of the Balikpapan refinery upgrade is estimated at \$5.5 billion.


U.S. EXPORT OPPORTUNITIES

Throughout its history with refinery development, Pertamina has had a strong relationship with U.S. suppliers. Firms such as Honeywell UOP and Fluor are well-positioned to continue their relationship with Pertamina. However, significant competition exists from East Asian firms, particularly given Korean firms' roles in the JV Company. Additional competition will come from European firms active in this space. Refinery upgrade opportunities for U.S. firms include:

- Engineering services.
- Construction supervision.
- Design services.
- Process equipment.
- Vessels.
- Quenching towers.
- Heat exchangers.
- Compressors.
- Condensers.
- Distillation towers.
- Pumps.
- Safety and fire protection equipment.
- Catalysts.
- Instrumentation and controls.
- Electrical equipment.
- Turbines.
- Water treatment systems.
- Storage tanks.
- Air pollution control systems.

CONTACTS

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Pertamina – Balongan Refinery Upgrade		
	SECTOR	Energy
	SUBSECTOR	Refining
	LOCATION	Balongan, West Java, Indonesia
	PROJECT VALUE	\$100 Million (Phase One); Up to \$6.5 Billion

PROJECT SUMMARY

Pertamina, the Indonesian state-owned oil and gas company, is in the process of upgrading four of its refineries as part of its Refinery Development Master Plan (RDMP) and constructing a new refinery. The Balongan refinery upgrade will increase naphtha production and increase crude processing capacity to 240,000 barrels per stream day. Pertamina has decided to undertake this upgrade process alone, without a foreign partner. The estimated completion date for Phase One of the upgrade process is 2023.

PROJECT DESCRIPTION

In 2016, Pertamina formed the Department of Refinery and Petrochemicals Mega Projects to manage the revitalization of existing refineries and the construction of two new refineries. The Department is currently overseeing the implementation of the Refinery Development Master Plan (RDMP). The end goal of the RDMP is to increase the overall production capacity, produce cleaner fuel, and ultimately support an energy security policy that reduces dependence on energy imports.

Without the RDMP, Indonesia would need to import approximately 62 percent of its fuel for domestic consumption by 2025. In 2017, imported fuel accounted for nearly one-third of domestic fuel consumption in the country. The goal of the RDMP is to double the domestic refining capacity to two million barrels of oil per day by 2025, up from the current level of one million barrels per day. While the Phase One expansion of the Balongan refinery is part of the RDMP, the petrochemical facility is not considered part of this plan but rather a separate development that will be sited next to the existing refinery (Figure 109).

In 2019, Indonesia's combined domestic refinery capacity was 1.1 million barrels per stream day, with crude oil refinery production reaching 364.1 million barrels of fuels, non-fuels, and lubricants (Table 39). Production was on an upward trend from 2015 to 2018, but with a significant drop in 2019 to 272 million barrels. Refined product imports over the same period have fluctuated from a high of 177 million barrels in 2017 to a low of 75 million barrels in 2019. However, exports of refined products have been much lower, from a high of 25 million in 2019 to a low of 12 million in 2018. Net imports of refined products were 50 million barrels in 2019.

Figure 109: Pertamina's Refineries¹⁴¹



Table 39: Indonesia Refined Products - Produced and Traded¹⁴²

	2015	2016	2017	2018	2019
Crude Oil Refinery Production (Thousand Barrels)	329,581	340,289	352,182	364,135	272,025
Exports of Refined Products (Thousand Barrels)	23,755	12,858	14,822	11,801	25,716
Import of Refined Products (Thousand Barrels)	175,473	143,628	177,498	175,825	75,296

The existing Balongan refinery, commissioned in 1994 in West Java, has a current refining capacity of 125,000 barrels per stream day of crude throughput. Through this project, Pertamina will upgrade about 11 percent of the country's total refining capacity over two phases. Currently, the Balongan refinery comprises the following units:

- Crude distillation unit (CDU).
- Atmospheric hydrodemetallization Unit (ARHDM).

¹⁴¹ KPPIP

¹⁴² <https://www.esdm.go.id/id/publikasi/handbook-of-energy-economic-statistics-of-indonesia>

- Residual catalytic cracking (RCC).
- Catalytic condensation unit.
- Penex.
- Kero treater.
- Naphtha treater.
- Gasoil treater.
- Olefins conversion unit (OCU).
- Propylene recovery unit (PRU).

As of 2017, Balongan can produce fuel that is compliant with Euro-4 standards. In late 2018, Pertamina issued a tender sourcing additional crudes for the Balongan refinery (Figure 110). New grades were added to include more options for West Africa-sourced crudes.

Figure 110: Balongan Refinery¹⁴³



The Balongan refinery will be augmented with an estimated \$6.5 billion investment and include integrating a greenfield petrochemical complex. The complex will provide the ability to process sour crude, produce at least one million tons of ethylene and other refinery derivative products annually, and become more competitive on costs. The petrochemical project is being developed with CPC Corporation, Taiwan.

There will not be any need to acquire new land for the Phase One upgrade of the refinery, though the greenfield petrochemical facility will require additional land/land reclamation. Some of Pertamina's Balikpapan refinery output will be feedstock for the Pertamina/CPC petrochemical facility processes. After the RDMP process, the Nelson Compatibility Index for the Balongan facility will be nine.

¹⁴³ Antara via Jakarta Post

Earlier upgrades to the Balongan facility were conducted by Toyo Engineering Corporation in 2003 and 2008.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

Phase One is currently under construction, with expected completion in early 2022.

Phase Two is currently in basic engineering design, with an expected completion date for this work of May 2021. A FEED study competition of two finalists will be conducted from July 2021 to April 2022, with the EPC contract scheduled for July 2022. The project is expected to be on stream in 2025.

Phase Three is planned for completion in 2027. In 2020, land appraisal and acquisition occurred. Also, the preliminary feasibility study and market study were completed. EPC is expected to start in late 2023, with completion by late 2027.

A large fire at the refinery on March 28, 2021 mainly in the storage areas, may impact the project schedule.

PROJECT COST AND FINANCING

Pertamina has decided to undertake the Phase One refinery upgrade without a foreign partner. Initially, the company had signed an agreement with Saudi Aramco to undertake the upgrade jointly, but that agreement expired in 2016. The \$100 million for Phase One will be financed through export credit financing Pertamina is currently exploring. Pertamina is financing Phase Two without a partner. The petrochemical facility being developed in conjunction with CPC, with financing arranged by CPC.

U.S. EXPORT OPPORTUNITIES


There are numerous export opportunities for U.S. companies associated with this refinery upgrade project and new petrochemical facility. The existing Balongan refinery already contains significant content from the U.S., including both equipment and services.

- Engineering services.
- Construction supervision.
- Design services.
- Process equipment.
- Vessels.
- Quenching towers.
- Heat exchangers.
- Compressors.

- Condensers.
- Distillation towers.
- Pumps.
- Safety and fire protection equipment.
- Catalysts.
- Instrumentation and controls.
- Electrical equipment.
- Turbines.
- Water treatment systems.
- Storage tanks.
- Air pollution control systems.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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Pertamina – Tuban Refinery		
	SECTOR	Energy
	SUBSECTOR	Refining
	LOCATION	Tuban, East Java, Indonesia
	PROJECT VALUE	\$15.7 Billion

PROJECT SUMMARY

Pertamina, the Indonesian state-owned oil and gas company, is in the process of upgrading four of its refineries as part of its Refinery Development Master Plan (RDMP) and constructing a new refinery. The greenfield Tuban refinery will have a crude processing capacity of 300,000 barrels per stream day (bpsd). Pertamina plans to begin construction of this refinery in 2022, with operations beginning in late 2026.

PROJECT DESCRIPTION

In 2016, Pertamina formed the Department of Refinery and Petrochemicals Mega Projects to manage the revitalization of existing refineries and construct this new refinery at Tuban in East Java. The end goal of this Refinery Development Master Plan (RDMP) is to increase the overall production capacity, produce cleaner fuel, and ultimately support an energy security policy that reduces dependence on energy imports.

Without the RDMP, Indonesia would need to import approximately 62 percent of its fuel for domestic consumption by 2025. In 2017, imported fuel accounted for nearly one-third of domestic fuel consumption in the country. The goal of the RDMP is to double the domestic refining capacity to two million barrels of oil per day by 2025, up from the current level of just over one million barrels per day. It will increase the overall Nelson Complexity Index factor for Pertamina's facilities (Figure 111) from 5.4 to 8.9. At the same time, Pertamina will have a more flexible production capability to meet the country's growing need for fuel.

In 2019, Indonesia's combined domestic refinery capacity was 1.1 million barrels per stream day, with crude oil refinery production reaching 364.1 million barrels of fuels, non-fuels, and lubricants (Table 40). This represents an upward trend from 2015 to 2018, but with a significant drop in 2019 to 272 million barrels. Refined product imports over the same period have fluctuated from a high of 177 million barrels in 2017 to a low of 75 million barrels in 2019. However, exports of refined products have been much lower, from a high of 25 million in 2019 to a low of 12 million in 2018. Net imports of refined products were 50 million barrels in 2019.

Figure 111: Pertamina's Refineries¹⁴⁴



Table 40: Indonesia Refined Products - Produced and Traded¹⁴⁵

	2015	2016	2017	2018	2019
Crude Oil Refinery Production (Thousand Barrels)	329,581	340,289	352,182	364,135	272,025
Exports of Refined Products (Thousand Barrels)	23,755	12,858	14,822	11,801	25,716
Import of Refined Products (Thousand Barrels)	175,473	143,628	177,498	175,825	75,296

In late 2017, Pertamina and Rosneft established a joint venture, PT Pertamina Rosneft Pengolahan dan Petrokimia, to construct and operate an integrated greenfield refinery and petrochemical facility in Tuban, East Java. This facility will have the ability to process 300,000 barrels/stream day, producing various refined products and chemicals. The chemicals include 1.2 million tpy of polypropylene products, 1.3 million tpy of paraxylene, and 650,000 tpy of polyethylene. Like the other greenfield refinery Pertamina is constructing, Tuban's outputs will be used to help meet domestic demand for fuel and raise Indonesia's domestic refining capacity by nearly 30 percent. The refinery configuration will allow processing Russian ESPO and Iraqi Basrah imports, as well as other crudes as feedstocks for the integrated petrochemical facility. These outputs will meet Euro-5 standards, resulting in a refinery that improves domestic energy security and provides more environmentally friendly fuels.

¹⁴⁴ KPPIP

¹⁴⁵ <https://www.esdm.go.id/id/publikasi/handbook-of-energy-economic-statistics-of-indonesia>

The President of Indonesia and the Ministry of Finance have approved the use of land owned by the Ministry of Forestry for the new refinery. When completed and operational, the Nelson Compatibility Index for the Tuban facility will be greater than nine.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

Progress on all of Pertamina's refinery projects has been subject to considerable delays throughout the planning process, primarily due to funding and policy considerations. Increasing oil prices globally and the government's decision not to raise fuel prices put a strain on Pertamina's resources, slowing the overall RDMP implementation. Also, the Tuban refinery had faced some challenges at a local level concerning land acquisition which are now resolved. Work has begun on the site and negotiations are ongoing.

The land clearing, basic engineering design, and environmental assessment are complete. The consortium has signed a contract with Lummus Technology LLC and Chevron Lummus Global (CLG) to license process technologies. Pertamina awarded W. R. Grace & Co. a contract to provide licensing and technology for the complex's polypropylene plant.

Basic engineering design is expected to be completed in March 2021. The front-end engineering design (FEED) study is expected to be completed in early 2022. After the completion of the FEED study, Pertamina will issue an EPC tender in early 2021. Pertamina will award the EPC contract in late 2022, with the project completed in late 2026.

There has been limited impact on the project schedule due to Covid-19 as the project has been mainly in the design stage during the last year.

PROJECT COST AND FINANCING

The overall cost of this new refinery is expected to be \$15.7 billion. The joint venture company that will operate the refinery is 55 percent owned by Pertamina, with Rosneft holding 45 percent.

U.S. EXPORT OPPORTUNITIES


There are numerous export opportunities for U.S. companies associated with this multi-billion-dollar refinery project, particularly given the historical relationship Pertamina has had with U.S. suppliers to upgrade their existing refining facilities. U.S. technology licenses have already been awarded to Chevron and WR Grace. Also, Fluor and Honeywell UOP have had a solid track record of working with Pertamina. However, firms based out of Europe and Asia, including Korea, Singapore, and Japan, will be strong competitors to U.S. firms operating in this area.

Opportunities for U.S. firms to support the construction and operation of the Tuban refinery include:

- Construction Supervision.
- Design Services.
- Engineering Services.
- Power plant.
- Piping.
- Fabrication.
- Technology Licensing.
- Process equipment.
- Vessels.
- Quenching towers.
- Heat exchangers.
- Compressors.
- Condensers.
- Distillation towers.
- Pumps.
- Safety equipment.
- Catalysts.
- Instrumentation and controls.
- Electrical equipment.
- Turbines.
- Water treatment systems.
- Storage tanks.
- Air pollution control systems.
- Fire Protection Equipment.
- IT solutions.
- Access control solutions.
- Communications equipment.
- Water treatment technologies.
- Power systems

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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PETRONAS Well Management		
	SECTOR	Energy
	SUBSECTOR	Oil & Gas
	LOCATION	Malaysia
	PROJECT VALUE	>\$200 Million

PROJECT SUMMARY

A staged oil and gas well abandonment and upstream decommissioning program by Petroliaam Nasional Bhd (PETRONAS), the Malaysian Nasional Oil Company, is in process in tranches. PETRONAS has scheduled 54 and 22 wells for decommissioning in 2021 and 2022, respectively. PETRONAS is proactively seeking offshore providers with specific technology and experience to support this group of projects.

In addition to its own asset portfolio, PETRONAS sees decommissioning as a new, high-growth business opportunity to service Indo-Pacific region oil and gas projects over the next many years. More than 200 Indo-Pacific offshore oilfields are likely to stop producing by 2030, comprising over 7,000 wells requiring decommissioning.¹⁴⁶

PROJECT DESCRIPTION

Petroliaam Nasional Bhd (PETRONAS) is the integrated national oil company of Malaysia. The company's operations span: oil and gas exploration and production (Figure 112); refining and marketing; and petrochemicals and specialty chemicals. The company was founded in 1974, during an oil crisis, in part to decrease the nation's dependence on foreign energy. The founding also came after settling disputes over territorial waters with Indonesia. Malaysia's first oil discovery occurred at the end of the 19th century, and in 1910, Royal Dutch Shell first drilled in Sarawak, then a British colony. In 2019, the company posted revenues of approximately \$58 billion.

Over the last few years, PETRONAS has undertaken an assertive new procurement and vendor management program to clarify and extend supplier relationships to support strategic projects in the company's portfolio. Also, the company has focused on the digitization of its procurement and contract management processes.

¹⁴⁶ JDSupra, <https://www.jdsupra.com/legalnews/the-coming-decommissioning-wave-in-44775/>

Figure 112: Representative PETRONAS Oil Rig/Well¹⁴⁷



Among the company's strategic projects is well-related asset management on the upstream side of the business. These projects include both well completion and decommissioning, as many of PETRONAS's own assets have been operating for more than 40 years. (Table 41).

Table 41: PETRONAS Upstream Aging Assets¹⁴⁸

PETRONAS Upstream Assets	Percent Older Than 40 Years
>300 Platforms	11
>10,000 km of pipelines	8
>3900 well strings in >200 wells	11

For PETRONAS's portfolio, asset decommissioning is necessary both for economic reasons and environmental stewardship. PETRONAS decommissioned 38 wells in 2019 and has identified 106 wells for decommissioning from 2020-2022.

PETRONAS does not release specific budget numbers for internal projects. While decommissioning costs vary widely depending on asset location and associated complexity, at a typical cost of between \$2 and \$10+ million per well, PETRONAS's capital expenditure for the 2020-2022 project portfolio will be greater than \$200 million.

¹⁴⁷ Source: Petronas

¹⁴⁸

Beyond its own portfolio, PETRONAS sees decommissioning as a high-growth business opportunity in the region because the Indo-Pacific region is relatively early in its life cycle for this type of infrastructure management. Over the next decade, Wood McKenzie projects over \$100 billion of decommissioning jobs across the Asia-Pacific region¹⁴⁹. These opportunities extend to nearly 2,600 platforms and over 3,500 wells in more than 200 fields projected to cease production in that timeframe. The U.S. is well-positioned to participate in this growth because some of its hydrocarbon extraction assets have already faced depletion and decommissioning.

PETRONAS is actively seeking to expand its foreign supply base to support its decommissioning program. This ongoing, internal-to-PETRONAS project includes management of:

- Well abandonment – permanent closure of wells when insufficient hydrocarbons can be extracted or the reservoir has been drained.
- Upstream facilities decommissioning – management of wellhead platforms, floating production storage and offloading (FPSO/FSO) and vent platforms at the ends of the oil and gas production lifecycle, including ensuring optimized cost management, full exploitation of asset re-use and repurposing and environmental stewardship.

PETRONAS seeks new business partners who offer technologies, services, experience for innovative removal, and value engineering and stakeholder management in the following categories (Table 42):

Table 42: Required Business Partner/Supplier Experience¹⁵⁰

Well Abandonment	Upstream Facilities Decommissioning
Drilling rigs	Engineering services
Hydraulic workover units (HWUs)	Decommissioning yard/facility
Offshore support vessels (OSVs)	Transport and lifting services
Lifting Services	Decommissioning cutting services. (diamond wire cutting, abrasive water jet cutting, etc.)
Third-party drilling services (slickline, cementing, fishing, perforation-wash-cement, etc.)	Other services (underwater, decontamination, remediation, etc.)

Of particular interest are innovative suppliers who can offer cost-effective and creative business models uniquely. Other requirements include:

- Own decommissioning yard and facility with:
 - Sea access.
 - Area for dismantling and storage.

¹⁴⁹ Wood Mackenzie

¹⁵⁰ Petronas

- Deep draft quay proximity to supply chain partners.
 - Waste treatment.
 - Smelting.
- Availability of:
 - Lifting cranes.
 - Cutting tools.
 - Liquid pumps.
 - Weighing stations.
 - Self-Propelled Modular Trailers (SPMT).
- Compliance with relevant Acts, Regulations and Guidelines applicable to the work.
- Technically suitable for decommissioning activities.
- Company Health, Safety and Environment program and management systems including:
 - Occupational health.
 - Environmental management.
 - Management of contaminated steel and equipment.
 - Pollution prevention.
 - Wastewater management.
 - Liabilities management.
 - Cumulative impact of activities and risk assessment.
 - Quality management.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

PETRONAS had originally targeted the decommissioning of approximately 50 wells in 2019 and 30 wells in 2020. The company completed 38 2019 projects due to shifts in activity priorities and has not disclosed completions for 2020, where progress has been slowed by the COVID-19 global pandemic. PETRONAS has outlined a steady stream of future well-decommissioning projects in respect of the 44 percent of facilities in Malaysian waters currently operating beyond their design lifetimes and projects the following decommissionings:

- 54 wells in 2021.
- 22 wells in 2022.

PETRONAS expects its decommissioning process in Malaysia to continue beyond 2022. Given the associated experience, PETRONAS is also exploring decommissioning as a business growth opportunity across Asia, as numerous oil and gas assets are mature across the region.

The PETRONAS Procurement function manages supplier relations and contract awards.

PROJECT COST AND FINANCING

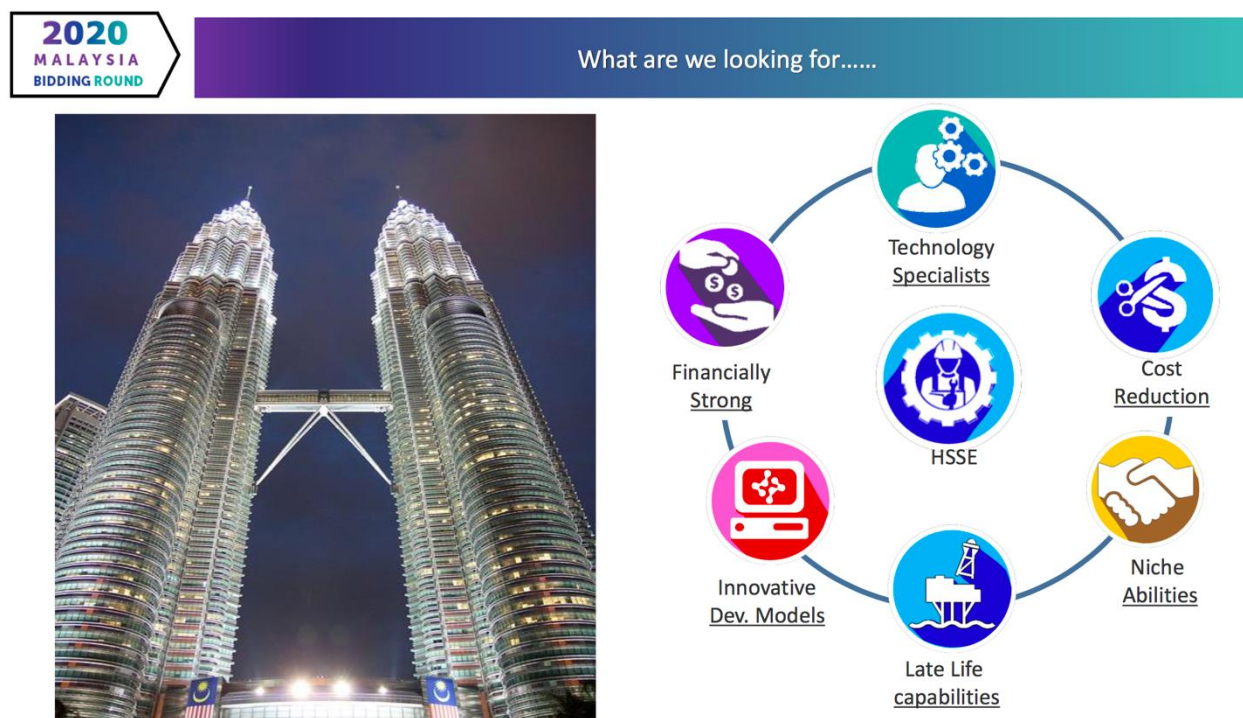
PETRONAS internal well-decommissioning project costs for 2021 and 2022 will exceed \$200 million. Contract well decommissioning revenues in the region may substantially expand the size of the opportunity.

The costs for the management of individual assets vary widely. The decommissioning of a typical well requires an investment of approximately \$2 to \$10 million. Generally, PETRONAS includes well decommissioning projects in its annual budget.

U.S. EXPORT OPPORTUNITIES

Established U.S. companies are well-positioned for this project, as decommissioning is a well-developed industry in North America and Europe. In the Indo-Pacific region, decommissioning experience is more nascent. PETRONAS seeks several areas of supplier expertise (Figure 113).

Figure 113: Desired PETRONAS Supplier Capabilities



In addition to the well-decommissioning projects and associated capabilities offered in the Project Description section, PETRONAS has an ongoing program to attract suppliers for well completion services, onshore and offshore maintenance, and for a variety of specific oilfield technologies and components for its upstream business, including:

- Distributed control systems.

- Control valves.
- Centrifugal pumps.
- Electrical – switchgear, transformers, induction motors.
- Wellhead control panels.
- Directional drilling technologies.


One or more well completion contracts will open in late 2020 or early 2021, for 2021 and 2022 projects.

Additionally, PETRONAS seeks “fresh and innovative ideas from all our partners through Technology Challenge, Technology Marketplace and Biddings in order to develop marginal and matured fields for continued operations against the backdrop of today’s challenging environment.”¹⁵¹

CONTACTS

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¹⁵¹ PETRONAS Activity Outlook, 2020-2022, <https://www.petronas.com/sit3es/default/files/downloads/PETRONAS-Activity-Outlook-2020-2022.pdf>

Sarawak (and Sabah) Methanol and Derivatives		
	SECTOR	Energy
	SUBSECTOR	Petrochemicals
	LOCATION	Sarawak and Sabah, Malaysia
	PROJECT VALUE	\$2+ Billion

PROJECT SUMMARY

The State of Sarawak is developing a methanol and derivatives complex in Bintulu. The complex is a two-phase project, with the initial phase comprising a methanol plant with an announced capacity of approximately 1.7 million metric tons per year. The project aligns with other energy investments in the State, providing Sarawak's first added-value oil-and-gas downstream value chain. The State of Sabah has completed a Master Plan for a similar complex.

PROJECT DESCRIPTION

The Malaysian States of Sarawak and Sabah, located on the island of Borneo, are each undertaking development of methanol and derivatives complexes at Tanjung Kidurong, Bintulu and Sipitang, respectively. Both projects take advantage of their states' natural gas resources on the upstream side and local agriculture markets, for at least a portion of plant output, downstream. The Sarawak plant, which is 100 percent state-owned, is administered through Sarawak Petchem. The state-owned Sabah project is overseen as Sabah Oil and Gas Industrial Park (SOGIP). Sabah Oil and Gas Development Corporation (SOGDC) administers SOGIP. Figure 114 depicts a representative methanol ammonia plant.

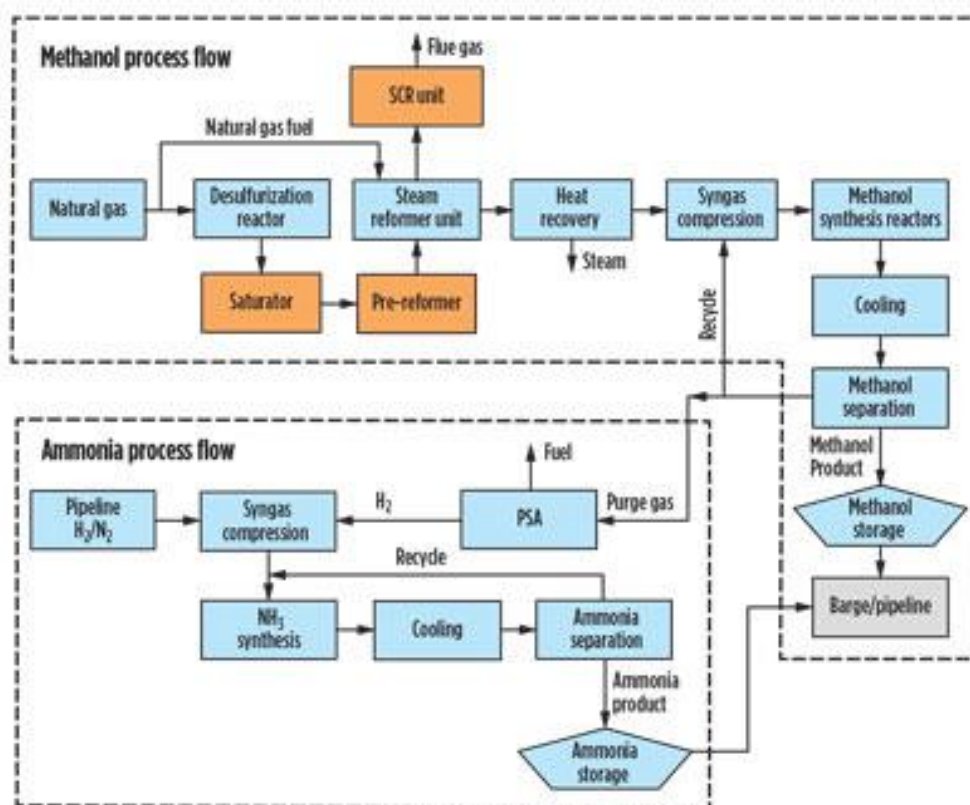
Related processes are typically used to produce methanol and ammonia from natural gas; thus, it is common to co-site manufacturing (Figure 115). The two States are importing technology and engineering services for co-producing the two chemicals. Typical large-scale derivatives from methanol-ammonia complexes are agricultural fertilizers. Methanol, particularly, is a precursor to various other derivative industrial chemicals, resins and polymers (Figure 116).

Both projects have access to regional ports. The Sarawak site is near the Port of Bintulu. The Sabah site is near the Port of Sabah and has a jetty with a conveyor installed.

Figure 114: Representative Methanol Ammonia Facility¹⁵²



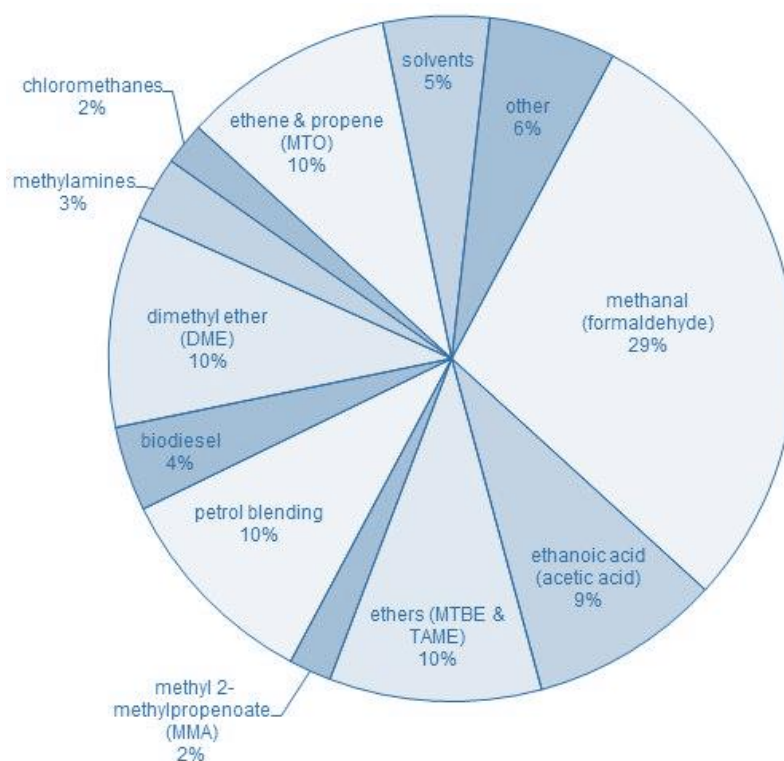
Figure 115: Relatedness of Methanol and Ammonia Processes¹⁵³



¹⁵² Chemarc

¹⁵³ Gas Processing News

Figure 116: Uses of Methanol¹⁵⁴



Sarawak

The Sarawak complex will be 100 percent owned by the State of Sarawak via the Sarawak Economic Development Corporation (SEDC) using Sarawak Petchem, a special purpose vehicle-specific to the project, formed in 2017. The project's objectives are to:

- Add value to hydrocarbons produced in Sarawak.
- Form the basis for creating an integrated petrochemical hub in the region.
- Provide high quality/value employment to attract and return technical talent to the region.

Sarawak holds the largest share (54 percent) of Malaysian natural gas reserves, the complex's prime feedstock. The area is already home to:

- Three Malaysian liquefied natural gas (LNG) plants.
- Nine LNG trains.
- The world's first gas-to-liquids facility, Shell's MDS (middle distillate synthesis) plant, which produces gasoline, kerosene, distillate fuel oil and lubricants, completed in 1993.

The plant will be located on an 80.9-hectare site and supplied with approximately 4.5 million cubic meters per day (MMSCFD) of natural gas feedstock from PETRONAS. PETRONAS has agreed to a 20-year purchase and sale agreement for methanol sales and marketing. PETRONAS operates

¹⁵⁴ IHS Markit

the only other Malaysian methanol plant, a similar-scale facility at Labuan, an island off Sabah's coast.

The methanol plant is one of two chemical projects by the State of Sarawak to bring manufacturing and associated wealth and employment into the developing area. The second is the planned co-sited ammonia/derivatives complex. The plant will employ 320 to 360 people when complete, of whom over 200 will be degreed professionals.

The project's initial phase is a 5,000 metric tons per day (circa 1.7 million metric tons per year) methanol plant. This methanol plant represents the first petrochemical investment in Sarawak. Sarawak Petchem expects the plant to begin operations in 2023.

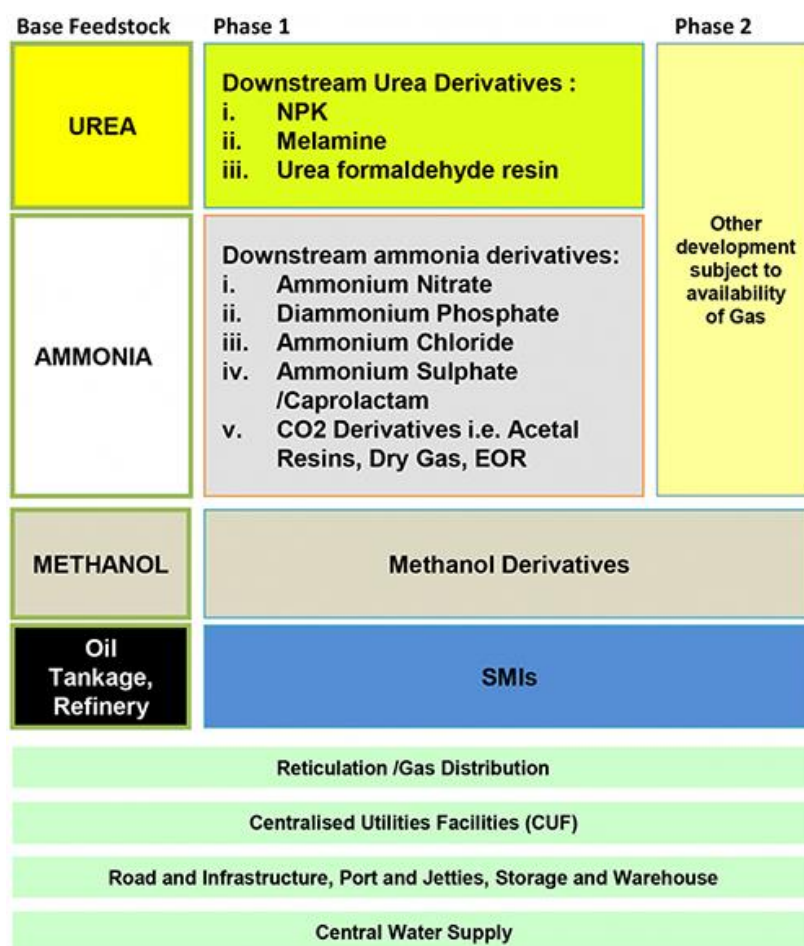
The second phase of the project is constructing two additional plants: 1) ammonia and 2) methanol derivatives. Sarawak is also encouraging all feasible proposals to further extend the State's nascent petrochemical sector with the ultimate intent to turn the area into a petrochemical center. Under consideration for future development at the site are choline chloride, ethylene and propylene. The Sarawak Economic Development Corporation (SEDC), as the owner of the land, will develop and manage the petrochemicals hub and its common areas, including centralized utility facilities, to facilitate participation by potential investors.

Sabah

Sabah has dedicated a 1,600-hectare site near the sea (and Labuan) for the Sabah Oil and Gas Industrial Park (SOGIP). Sabah Oil and Gas Development Corporation Sdn Bhd (SOGDC) is a wholly-owned company of the State of Sabah designated as the vehicle to own, manage and market SOGIP.

A Master Plan has been completed (Figure 117) with an expected first project phase to include methanol, ammonia and urea. The goal is to house a world-scale (at least 5,000 metric tons per day), single train ammonia-urea plant, ideally the largest in South East Asia.

Figure 117: Sabah SOGIP Plan¹⁵⁵



SEDIA cites several advantages of the project:

1. Natural gas is available at the doorstep.
2. Sabah State and PETRONAS have a partnership in the development.
3. Sufficient development land is available: 1600 hectares.
4. Location is strategic: near shipping lane with proximity to Labuan and Brunei.
5. Sheltered bay: sufficient water depth (16m – 25m) and availability of vessel anchorage.
6. Customized tax incentives for SOGIP tenants.
7. Minimal socioeconomic impact (relatively unpopulated/little population relocation).
8. Gas within the industrial park, tap from the Sabah Sarawak Gas Pipeline.
9. Proximity to trunk road connecting Sabah to Sarawak and Brunei.
10. PETRONAS SOGIP fertilizer hub -- opportunities to create downstream opportunities to produce a variety of fertilizer product.
11. The agriculture industry in Sabah offers demand for fertilizer locally.

¹⁵⁵ SOGIP <https://sogip.com.my>

Site features include:

- 1600 hectares total (736 hectares developed and 142 hectares occupied).
- Basic infrastructure including worker quarters and office.
- Fiber optics 100 Mbps.
- Receives 180 MMSCFD gas.
- Land Sub-Lease only 30 years plus renewable for 30 years.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

A project feasibility study for the Sarawak methanol plant is complete. Samsung Engineering signed a front-end engineering and design (FEED) contract with Sarawak Petchem in April 2019. The facility's groundbreaking occurred in Sept. 2019, with an Early Work Phase One contract awarded in Nov. 2019. Site development works have been ongoing through 2020 (Figure 118)

Figure 118: Tanjung Kidurong, Bintulu, Sarawak Methanol Plant Site Preparation, July 2020



In July 2020, South Korea's Samsung Group disclosed securing an additional contract from Sarawak Petchem to complete the project's second Early Work Phase. The second phase spans 11 months and covers placing equipment orders, planning design, and executing early-stage construction.

Sarawak Petchem expects plant operations to begin in 2023. Samsung Engineering Co. Ltd. is the probable engineering, procurement, and construction (EPC) contractor. Sarawak Petchem will roll over future activities with a Licensor, Engineering, Procurement, Construction and Commissioning (LEPCC) contract at the end of the FEED and Early Work contracts.

A Master Plan for the Sabah site has been completed and envisions methanol, ammonia and urea as the first phase. A second phase would consider additional petrochemicals, subject to natural gas availability. Timing is not firm, and the State is proactively seeking a foreign investor who can bring technology and experience to ensure the project's success.

PROJECT COST AND FINANCING

The Sarawak Phase One methanol plant has a budget of \$800 million. The entire project, Phase One Methanol, and Phase Two Ammonia and Derivatives, is estimated at \$2.0 billion. Financing is unannounced pending completion of the Phase Two feasibility work. During 2019, the total contract value for the FEED and Early Work Phase One contracts was \$81.1 million. In 2020, Sarawak Petchem awarded a \$55.5 million Early Work Phase Two contract.

The Sabah plant's estimated budget is \$2.5 to \$12 billion depending on plant scale and the ultimate product slate. A first phase methanol plant likely will be similar in scale and cost to the Sarawak world-scale facility. The State has not yet arranged financing. Incentives, including a ten-year tax holiday, are available.

U.S. EXPORT OPPORTUNITIES


U.S. export opportunities include:

- EPC contracting (Sabah).
- Design services.
- Financing.
- Technology providers and licensing.
- Catalysts.
- Towers.
- Compressors.
- Pumps.
- Valves.
- Control systems.
- Safety equipment.
- Security solutions.
- Emissions controls.
- Construction supervision and management.

That State of Sabah is desirous of parties participating with financing/creative business models and/or development of other chemical production.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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SURE Waste-to-Worth Energy Projects		
	SECTOR	Energy
	SUBSECTOR	Waste to Energy
	LOCATION	The Philippines (3 Locations)
	PROJECT VALUE	\$210 Million

PROJECT SUMMARY

SURE Global Waste to Worth Innovations is developing a portfolio of waste-to-energy projects in the Philippines. The company includes four projects in its current portfolio, with three currently under construction. SURE has completed front-end engineering design efforts for the three projects at Angeles City, Cabuyao, and Dagupan. Dagupan, the smallest, is furthest along, but all three are progressing. Angeles City and Cabuyao involve source separation, anaerobic digestion, and gasification, producing 8MW and 22 MW of power, respectively. Cabuyao also involves pyrolysis and the production of marine fuel. SURE plans to develop the fourth project at Bacolod later.

PROJECT DESCRIPTION

SURE is currently developing three projects as part of its waste-to-energy portfolio (Figure 119). The company is negotiating financing and entered detailed engineering in early 2020. U.S. engineering firm AECOM prepared feasibility studies for Angeles City and Cabuyao. Additional detailed engineering was done by Brightwave Energy, which worked closely with the combustion equipment suppliers ICM and Regen under a USTDA grant completed in 2019.

Waste-to-energy projects provide a sustainable waste disposal method, generating a stream of recycled materials and power. The Philippines still has many unregulated methods of waste disposal and litter. While waste-to-energy plants do not solve all the problems, they offer some incentive to manage the waste more sustainably while generating energy.

Unregulated landfills, some adjacent to communities, waterways and the Pacific Ocean, have brought refuse management issues to many communities' and local officials' attention. Besides the projects described here, major waste-to-energy projects are being developed throughout the Philippines, including in Quezon City, Davao City, and Puerto Princessa City.

Figure 119: Locations of SURE Waste-to-Worth Projects



Angeles City

The Angeles City project is a 230 ton-per-day municipal solid waste (MSW) facility. The project is a joint venture with the local municipal government of Angeles City. Angeles City will supply the land and guarantee the minimum waste delivery to the joint venture. The city is responsible for managing the hauling contracts (as they do today) and delivering a minimum of 230 tons/day of MSW on average. SURE will supply, develop, and operate the project under a 20-year contract.

The project involves waste separation, preparation of refuse-derived fuel, anaerobic digestion of the liquid waste stream, and gasification of the solids waste stream, which will produce gas for combustion and power generation. This project will generate approximately 8 MW of net power.

The ownership of the project is via Sure Global Philippines W2Wi Inc. The project will be managed by a special project vehicle (SPV, named Angeles W2W), which has already been registered with the SEC. The city is not an equity partner.

The project has been delayed due to the COVID-19 shutdown. Pending legislation concerning the power offtake agreement has delayed the project's financing as the effort cannot move ahead without it. Financial institutions have pledged the funding, but they require in-place power purchase agreements to provide the financial close.

Dagupan

The second SURE project is with the City of Dagupan. Dagupan is a small coastal community with an unsecured waste dump that must be closed. The City has agreed to work with SURE to

implement a waste-to-energy facility using Regen technology. The project will convert 30 tons per day of MSW into marine diesel oil and biogas. The marine diesel oil will be blended with other diesel and sold to the local fishing industry. The municipality will serve as the waste supplier and landowner.

Due to the delays at Dagupan, SURE decided to install the pyrolysis process at the Cabuyao project instead.

Cabuyao

SURE's third project is a private development with SB Hain in the City of Cabuyao. SB Hain is a major waste management firm operating in the Philippines. SB Hain's contracts include waste collection for several cities, including Cabuyao, and landfill operations. Cabuyao is the largest of the SURE projects at 650 tons per day. In this project, SURE will own and operate the facility. SB Hain will supply the waste for a fee under a guarantee arrangement. SB Hain will receive a percentage of SPV's revenues based on a formula tied to the amount of waste they deliver to the project.

A large investor has approached SURE to participate in the Cabuyao project.

The pyrolysis equipment ordered for the Dagupan site will now be redirected to the Cabuyao site. The pyrolysis equipment has already been fabricated. SB Hain has agreed to purchase the synthetic diesel produced by the plant. The larger processing plant will still be installed at the site but at a later date.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

SURE has completed the engineering design for the three projects. Concessions were negotiated for the three projects. However, the concessions have been rescinded due to the new National Energy Policy and Regulatory Framework which will require new concession frameworks to be negotiated. All have received the required environmental permits. The Angeles City and Cabuyao projects are scheduled to enter a two-year procurement and construction phase within the next six months.

The Dagupan project had received approval from the municipality to begin construction. However, due to a change in the local government, Dagupan municipality then rescinded the permission. SURE appealed the decision. Upon appeal, the approval was reinstated, but it delayed the project. The construction period is expected to be approximately one year. Due to the COVID 19 global pandemic, construction in the Philippines in 2020 was significantly curtailed. All three projects have been delayed as a result.

A new Senate bill concerning waste to energy has further slowed the projects. Philippine Senate Bill 1789: Establishing a National Energy Policy and Regulatory Framework for Facilities Utilizing Waste-to-Energy Technologies, filed August 25, 2020, has resulted in delays as the roles and responsibilities of certain government agencies will change. The principal changes involve the support of waste-to-energy facility utilization to attain sustainable energy and energy security.

Also, the definitions of the Department of Energy, Department of Health, Department of Environment and Natural Resources, and local authorities' roles and responsibilities have changed. The role of the DoE includes issuing permits to WTE facilities based on the energy output and determining the standards, criteria, and requirements applicable for each kind of WTE facility.

PROJECT COST AND FINANCING

Sure Waste to Worth estimates the CAPEX to be \$135 million for the three projects currently being developed:

- The Angeles City project is estimated to have a capital expenditure of approximately \$38 million, with an all-in cost of approximately \$45 million.
- The Cabuyao project is expected to require an investment of \$75 million.
- Dagupan is estimated to cost \$15 million. The developer is seeking an additional \$2 million in equity. Dow Chemical has agreed to be an equity participant. The Development Bank of the Philippines will be providing project debt.

The company is seeking equity investors for each of the projects.

Procter and Gamble has been an early supporter and has provided funding for project development. The USTDA and the Asian Development Bank have provided grant funding for the projects.

The feed-in tariff for waste to energy has been canceled. Based on the outcome of the new legislation, new concessions will be negotiated. SURE is planning for a Php 6.0 per kWh (approximately \$0.12/kWh) electricity price.

U.S. EXPORT OPPORTUNITIES

SURE has selected the major equipment suppliers. Two principal U.S. suppliers of the plants' thermal section are ICM Inc. and Regen Fuels and Energy. ICM will manufacture the process units in Kansas.


Further U.S. export opportunities for the projects include:

- Engineering and Construction Management Services.
- Waste Separation Press.
- Anaerobic Digester.
- Pumps.
- Gas Cleaning System.
- Conventional Incinerator.
- Emissions control technologies.
- Electrical Systems.

- SCADA controls and automation.
- Magnets and scales.
- Turbines.
- Air Handling and Combustion Systems.
- Steam Generators/Boilers.
- Loaders and Trucks.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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Batangas Integrated LNG to Power		
	SECTOR	Energy
	SUBSECTOR	LNG and Power
	LOCATION	Batangas Province, Philippines
	PROJECT VALUE	\$1.6 Billion

PROJECT SUMMARY

The Batangas Integrated LNG Terminal and Power Project is located in Batangas Province, Luzon Island, in the Philippines. The Project will have an initial capacity of 3 million metric tons per year of liquefied natural gas (LNG) and an integrated combined-cycle power generation unit with approximately 1,100 MW capacity. Future phases will double the LNG regasification capacity. Gen-X Energy, a portfolio company of the Blackstone Group, and LCT Energy and Resources, Inc. are co-developing the Project.

PROJECT DESCRIPTION

The project site (Figure 120) is an existing 38.5-hectare industrial complex located on the east coast of Batangas Bay, at Barangay Pinamucan, Batangas Province. The site is approximately 100 kilometers (by road) south of Metro Manila. The project site is located close to existing gas-fired power plants (3,200 MW), existing gas distribution infrastructure, a grid interconnection point, oil refineries, and a petrochemical plant.

The project comprises an LNG import and regasification terminal and a natural gas-fired, combined-cycle power plant. The Project will supplement and ultimately replace part of the Malampaya gas field production of natural gas.

The LNG terminal comprises the following components:

- A jetty with the capacity to unload LNG tankers.
- One 180,000 cubic meter full containment LNG storage tank.
- Regasification facilities with a throughput of up to 3.0 million tons annually.

The combined-cycle power plant will use the natural gas from the LNG terminal as fuel and will have a nominal gross installed capacity of approximately 1,100 MW. The facility will deliver the power to the 500 kilovolt (kV) system of the Philippines' National Grid Corporation.

Figure 120: Batangas Integrated LNG Terminal and Power Project Location



Gen-X Energy, a portfolio company of The Blackstone Group and LCT Energy and Resources, Inc., are the developers of the Project.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

Development milestones achieved to date include:

- Entered into commercial arrangements with LCT Energy & Resources, Inc. to develop the Project jointly.
- Secured the use of the project site for the development, construction, and operation of the Project.
- Commenced various project site activities, including field surveys, geotechnical investigations, and technical studies.
- Completed early-stage engineering and design work for the Project.
- Submitted the project application for obtaining a Notice to Proceed with the Philippine Department of Energy. The Project has been certified as a significant energy project.

- Filed a permit application to the Department of Environment and Natural Resources after AECOM completed the environmental and social impact assessment (ESIA). A public hearing is scheduled for December 2020 to review the Project application. Gen-X expects the hearing will result in issuance of an Environmental Compliance Certificate during the first quarter of 2021.

Near-term activities include:

- The system impact study for transmission interconnection will be completed in February 2021.
- Gen-X energy is preparing to submit a bid to Meralco for a power purchase agreement (PPA) due January 25, 2021. Since Meralco needs 3400MW in its Power Supply Procurement Plan, Gen-X expects to be in a strong position to be awarded a contract.

The project schedule spans 2019-2024:

- Development: Q4 2019 to Q3 2021.
- Financial Close and Construction Start: June 2021.
- Commercial Operation Date: December 2024 -1200MW, May 2025 – 600 MW.

PROJECT COST AND FINANCING

The total estimated project cost is \$1.6 billion.

The Project will be financed with a combination of equity and non-recourse project debt. The invested capital will be mobilized from Gen X Energy and LCT Energy & Resources. Debt financing will be secured from local commercial banks, international lenders, development finance institutions such as the United States International Development Finance Corporation, and other multilateral and/or export credit agencies.

U.S. EXPORT OPPORTUNITIES

The Project will require substantial quantities of LNG, providing significant export opportunities for U.S. LNG suppliers.

Gen X Energy will provide the management, planning, finance, project structuring, construction, and commissioning, and operations and maintenance services.


U.S. export opportunities include:

- Large gas turbine generators.
- Steam generators.
- Cryogenic pipes and valve.
- Specialized steel alloys for LNG service.
- Engineering services.

- Legal services.
- Banking and financial services.
- Inspection and quality control services.
- Operations and maintenance services.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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Red Core Geothermal		
	SECTOR	Energy
	SUBSECTOR	Geothermal Power Generation
	LOCATION	The Philippines (4 Locations)
	PROJECT VALUE	Up to \$200 Million

PROJECT SUMMARY

Red Core is developing several geothermal projects under a Geothermal Renewable Energy Service Contract (GRESK) granted by the Philippines Department of Energy (DOE). This section will primarily focus on the Tabayas project. Red Core estimates the Tayabas property in Southern Luzon has the potential for at least 60 MW of geothermal-based power generation.

PROJECT DESCRIPTION

Red Core is developing four geothermal projects on Luzon (Figure 121):

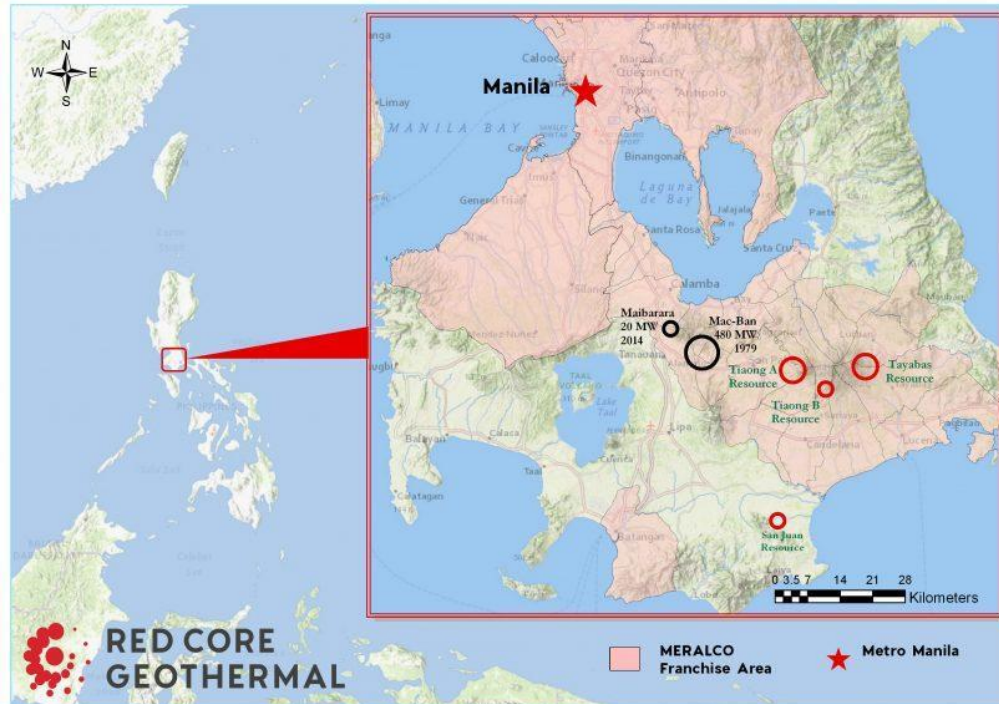
- Tayabas-Lucban.
- Tiaong-Dolores, including two sub-prospects, one on the west flank of Mount San Cristobal and the other on the southwest flank of Mount Banahaw.
- San Juan.
- Talim Island.

This section's focus will be the Tayabas project, where Red Core will explore the geothermal prospect areas to identify and prove commercially viable resources to develop into operating power plants. The Tayabas-Lucban geothermal project occupies 75,000 hectares in the province of Quezon. The site straddles the municipalities of Liliw, Luisiana, Majayjay, and Nagcarlan in Laguna and Lucban, Lucena, Mauban, Pagbilao, Sampaloc, Sariaya, and Tayabas in Quezon.

The project area is east of the Tiaong-Dolores geothermal project, across the Mount Banahaw Volcanic complex. Like Tiaong-Dolores, the Tayabas-Lucban project is within the Manila Electric Company's (Meralco's) franchise area. A Meralco transmission line crosses the property.

Several hot springs, including Bakia, Cagsiay, Mainit, Pablo-Tiaong, and Sampaloc, are located within the Tayabas-Lucban area, a good indicator of geothermal potential. This potential is further validated by the magnetotelluric (MT) surveys, resource assessment data, and 3D resource modeling studies completed in late 2015 by Red Core's geothermal consultants.

Figure 121: The Tayabas-Lucban and Other Red Core Projects¹⁵⁶



Geologic Setting

The contract area is within a geologic setting strongly suggestive of a shallow magmatic heat source, which should be capable of supporting a significant geothermal system. Geothermal fluids from the Banahaw Volcanic Complex (which includes Mount Banahaw, Mount San Cristobal, and Mount Banahaw de Lucban) supply the area's geothermal reservoirs.

Proximity to the Luzon Grid

The network of the interconnected transmission towers and substations of the National Grid Corp. of the Philippines (NGCP) passes through the contract area. Also, a significant substation of NGCP's South Eastern Tagalog Grid, which services Laguna and Quezon, is located in the town of Tayabas. This substation connects the contract area to the NGCP's South Luzon grid, which serves three districts, Bicol, South Eastern Tagalog, and South Western Tagalog, and to the North Luzon grid, which services additional districts.

Tayabas Geothermal Power Inc. (TGPI), a special purpose vehicle (SPV), is the Tayabas-Lucban geothermal project developer. The Philippines Department of Energy has granted TGPI a Geothermal Renewable Energy Service Contract (GRES-C). TGPI is a wholly-owned subsidiary of Manila-based Red Core Investments Corp.

¹⁵⁶ Red Core

PROJECT STATUS AND IMPLEMENTATION TIMELINE

Red Core is preparing to conduct thermal-gradient testing of the Tabayas resource. After thermal gradient testing, resource definition, and pre-production and drilling will commence.

Red Core experienced some delays with obtaining access to the site as the site's road was not suitable for transporting the drilling rig. A new access road to the site is in place, and drilling will commence soon.

In the meantime, Red Core has been focusing on moving towards modular geothermal plants and away from larger-scale, stick-built plants. Red Core now plans to install wells and reinjection wells at five sites with modular geothermal plants. The modular units require a lower temperature gradient.

Red Core expects to be injecting power into the grid by the end of 2022, implementing the geothermal modules as the wells are completed. The company expects to have three 20-megawatt (MW) plants in place within two years.

PROJECT COST AND FINANCING

Red Core has received initial funding from private Philippine firms Altura and Associates and the Alberto Soriano Corporation. The company seeks further investment for resource definition. Red Core is in negotiations with other investors and debt providers. The company plans to install a geothermal demonstration module and then seek additional investment for additional wells and plants across its sites.

U.S. EXPORT OPPORTUNITIES

Projects like Red Core require considerable capital equipment to extract the value of the geothermal resource. The equipment to support the development of the resource, capture, and direct the resource to the power plant, as well as the power plant itself, are quite complex, making the opportunity attractive to U.S. suppliers with allied technologies.


U.S. export opportunities include:

- Drilling materials and equipment (e.g., muds, casings, valves, blow out preventer, safety equipment).
- Pipes and valves.
- Drilling contract services.
- Drill casings and gathering pipe.
- Geothermal power plant modules including:
 - Pumps, valves, and fittings.
 - Steam and turbo generators.
 - Heat exchangers.

- Power electronics and transformers.
- Instrumentation and controls.
- Substations.
- Transmission lines.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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EGAT Floating Storage and Regasification Unit (FSRU)		
	SECTOR	Energy
	SUBSECTOR	LNG
	LOCATION	Offshore, Gulf of Thailand
	PROJECT VALUE	\$1.3 Billion

PROJECT SUMMARY

The Electricity Generating Authority of Thailand (EGAT) is in the Project and Environmental Impact Assessment (EIA) approval stages prior to constructing a five million tons per annum (MTPA) LNG floating storage and regasification unit (FSRU). The FSRU will be located approximately 20 kilometers offshore in the upper Gulf of Thailand and supply natural gas to the two EGAT power plants, South Bangkok and North Bangkok. The Project includes the FSRU, an islanding double berth and jetty, and offshore and onshore gas pipelines, spanning multiple provinces, to the power plants. EGAT expects the engineering, procurement and construction (EPC) contract to be in place by 2021, with commercial operation in 2024.

PROJECT DESCRIPTION

In 2019, within the EGAT system, natural gas was the fuel source for almost 60 percent of Thailand's generated power (Figure 122). Thailand's updated Power Development Plan (PDP), which extends through 2037, calls for gas generation capacity to increase by 19.5 GW (Figure 123). Despite overall gas-generated-power capacity increasing, market share will decrease due to a projected increase in renewable energy generation and associated retirements of assets.

To support the gas demand, Thailand plans to expand its use of (and storage capacity for) liquefied natural gas (LNG) and become a regional LNG hub. Presently, Thailand has one LNG receiving terminal with 11.5 MTPA capacity, located in the Map Ta Phut Port in Rayong, on the Gulf of Thailand. Of the total existing Thai LNG storage capacity, 10 MTPA is allocated to PTT Public Company limited (PTT, the Thai state oil and gas company). The remaining 1.5 MTPA LNG is available for use by EGAT.

Figure 122: Thailand's Total Electricity Generation by Fuel Type, January 2019¹⁵⁷

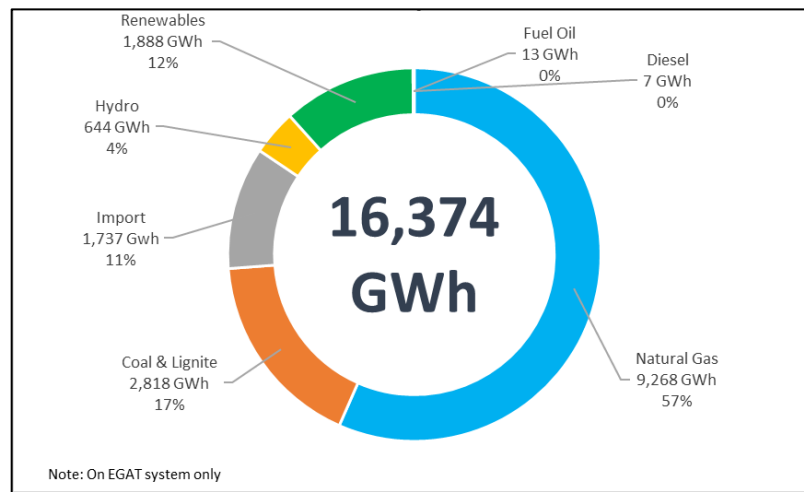
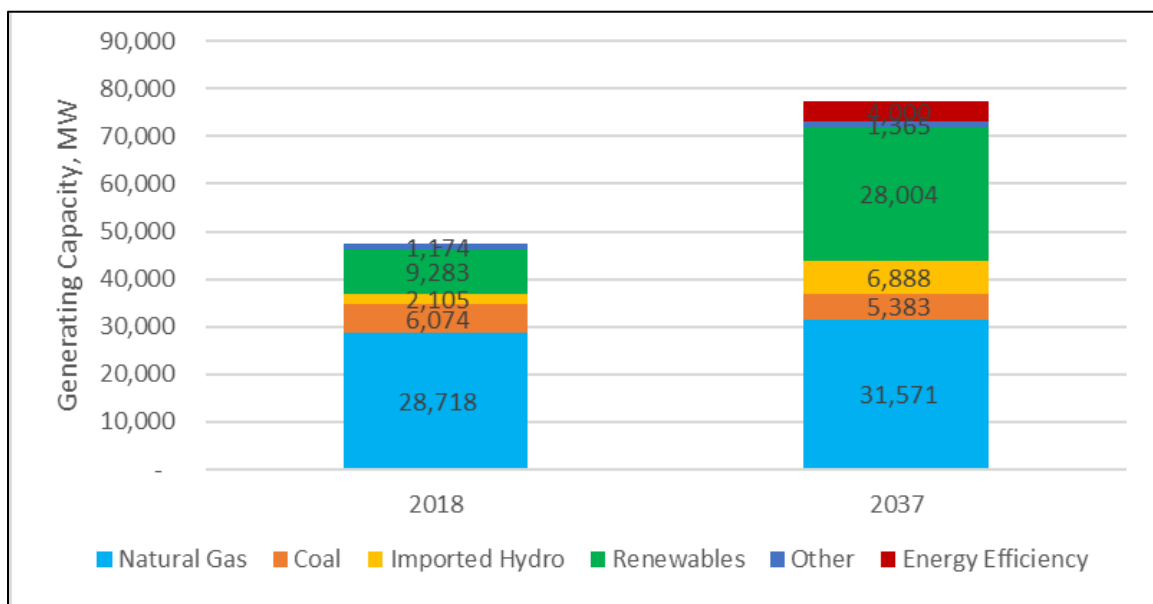


Figure 123: Thailand – Projected Power Generation Capacity by Fuel Source, 2018-2037¹⁵⁸



The Map Ta Phut LNG hub is undergoing expansion. A new 7.5 MTPA LNG Terminal at Nong Fab is under construction and is planned to be ready for operation by 2022. The Nong Fab LNG terminal can be extended up to 15 MTPA if required in the future. A third onshore LNG terminal is planned as part of the Thailand Eastern Economic Corridor Project (EEC Project). This new terminal will add another 10.8 MTPA of LNG storage capacity to the area and be operational by 2027.

¹⁵⁷ EGAT

¹⁵⁸ EGAT and EPPO

EGAT's project will add to this total and is currently in the government Project and EIA approval stages. Upon approvals, EGAT will construct and implement a 5.0 MTPA FSRU located offshore in the upper Gulf of Thailand (Figure 124). By 2024, the unit will store the necessary LNG for EGAT's South Bangkok and North Bangkok power plants. When completed, the EGAT FSRU will bring Thailand's total LNG terminal capacity to 34.8 MMTPA.

EGAT will locate the FSRU offshore in the Gulf of Thailand under the Marine Department's jurisdiction, the Ministry of Transport. The FSRU will link to a new 20 km, 30-inch offshore pipeline and a new 38 km, 30-inch onshore pipeline to EGAT's South Bangkok Power Plant. The facility will also connect to the existing PTT pipeline connected between EGAT's South Bangkok and North Bangkok power plants. Together, these plants provide about 7 GW to help supply the Bangkok metropolitan area's power needs.

Figure 124: Typical FSRU



Fluor Daniel Eastern, Inc., of the United States, undertook a front-end engineering design (FEED) study to develop plans for the FSRU vessel, the offshore berth and jetty, and onshore and offshore pipelines and the onshore facilities. Fluor completed the study in 2020. EGAT is considering Build Own Operate and Transfer (BOOT) options for the vessel. For the islanding double berth jetty and pipelines, EGAT will own all, which will later operate under the supervision of a TSO (Transmission System Operator).

To liberalize the Thai LNG market, EGAT was granted a license from the Energy Regulatory Commission (ERC) to import LNG, making it the second permitted LNG importer for the country (the other being PTT). EGAT is required to import LNG at a price less than the lowest long-term

contracted price to PTT. At present, EGAT has no contract with an international supplier to import LNG. EGAT had sought 0.8 to 1.2 million tons of LNG to be stored at the Map Ta Phut location.

The Thai Government put a deal on hold, citing the possibility of LNG oversupply in the market. Nonetheless, EGAT has successfully imported two spot LNG cargoes during 2019 and 2020 of about 200,000 metric tons for its power plants, as part of exercising a third-party access regime for terminals and pipelines. The current utilization of the Map Ta Phut Terminal is approximately half of the installed capacity. However, LNG import demand and usage will increase significantly in the coming years as the country depletes the domestic gas available in the Gulf of Thailand.

EGAT plans to import approximately 5.5 MTPA of LNG for its power plants over the next three years; however, the actual imported quantity of LNG by EGAT must be approved by Government.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

EGAT completed the FEED study for the FSRU during 2020. EGAT submitted environmental impact assessments (EIA) for each of the three elements of the project (pipelines, berth and jetty and FSRU) to the government for approval and is responding to comments. EGAT expects final EIA approval in the first quarter and Project Approval from the Government in the second quarter of 2021. Following approval of the Project and its EIA, EGAT will move to proceed with two tenders: one for the construction of the offshore and onshore pipelines, the offshore berth and jetty and the onshore facilities; the second for constructing the FSRU itself. The tenders will be by international competitive bid and the contracts will be awarded during 2021, with the Terminal to be completed and operational by year 2024.

PROJECT COST AND FINANCING

The project's estimated cost, including offshore berth and jetty, FSRU, offshore and onshore pipelines and the onshore facilities, is approximately \$1.3 billion. The final cost of the project will be subject to change based on the actual bidding process. The project will be financed through the EGAT Fund and bonds or loans from financial institutions.

US EXPORT OPPORTUNITIES

EGAT's tender for EPC contracts will occur via international competitive bidding. Tender news may be obtained on EGAT's internet website under the tab "News/Announcement-Procurement" at www.egat.co.th.


This project does not include LNG procurement. LNG will be imported by the permitted LNG importers only. The decision on the number of permitted LNG importers for this project will be considered and approved by Government, and the origin of the gas for this project will depend on price, among other factors.

Opportunities for U.S. companies to participate in this project include:

- Survey, Engineering and Construction
- Project Management Contracts
- Civil Works
- Marine works and berth & jetty
- Moorings
- LNG and NG loading/unloading arms
- FSRU provider
- Electrical Works, IT systems, SCADA and controls, and instrumentation
- LNG and NG pipeline materials
- Block valve and metering stations
- Safety systems
- LNG (via the permitted LNG importers)

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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SCG Pyrolysis Project		
	SECTOR	Energy
	SUBSECTOR	Waste to Energy
	LOCATION	SCG Cement Plant Saraburi Province, Thailand
	PROJECT VALUE	\$3 Million (Pilot Phase) TBD (Systemwide Implementation)

PROJECT SUMMARY

Siam Cement Group (SCG), as one of the largest companies in Thailand, has begun developing a pyrolysis project as part of its focus on the circular economy and greenhouse gas emission reduction. The project supports the reduction of carbon dioxide (CO₂) in the cement business unit by converting plastic waste and used tires to fuel oil and carbon black, later used as an alternative fuel in the cement manufacturing process.

PROJECT DESCRIPTION

In SCG's cement business line, combustion consumes significant amounts of energy to produce clinker. Clinker is a nodular material produced in the kiln stage of cement manufacture, which serves as the binder in many cement products. The primary fuel for this combustion process is coal. However, SCG is committed to reducing the amount of coal used in its facilities and is pursuing a "zero coal" policy. Within three to four years, the company expects to reduce its coal inputs to cement kilns by approximately 50 percent (Figure 125).

To address the coal reduction policy and reduce CO₂ emissions, alternative fuels like biomass and plastic waste, replace coal in the rotary kiln (Figure 126). However, due to the poor combustion quality and chloride content of plastic waste, coal replacement is currently limited to approximately 10 to 20 percent.

To increase the replacement percentage of coal consumption by alternative fuels, SCG is studying pyrolysis. Pyrolysis converts solid wastes like plastics or waste tires to liquid, solid, and gaseous fuels (called pyrolysis oil, carbon black, and syngas, respectively) in a separate process. The resulting fuels have higher energy and lower chloride content than the original solid waste. A pyrolysis reactor may be incorporated into a cement plant (Figure 127).

Figure 125: SCG Cement Kiln¹⁵⁹



Figure 126: Location and Heat Portion of Fuel Usage for Clinker Production in Cement Plant

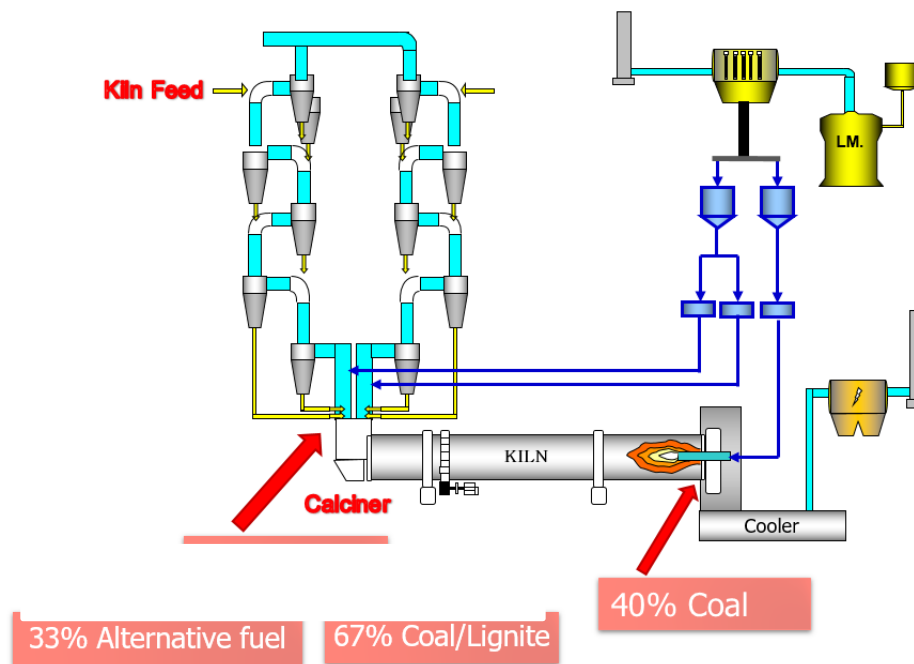
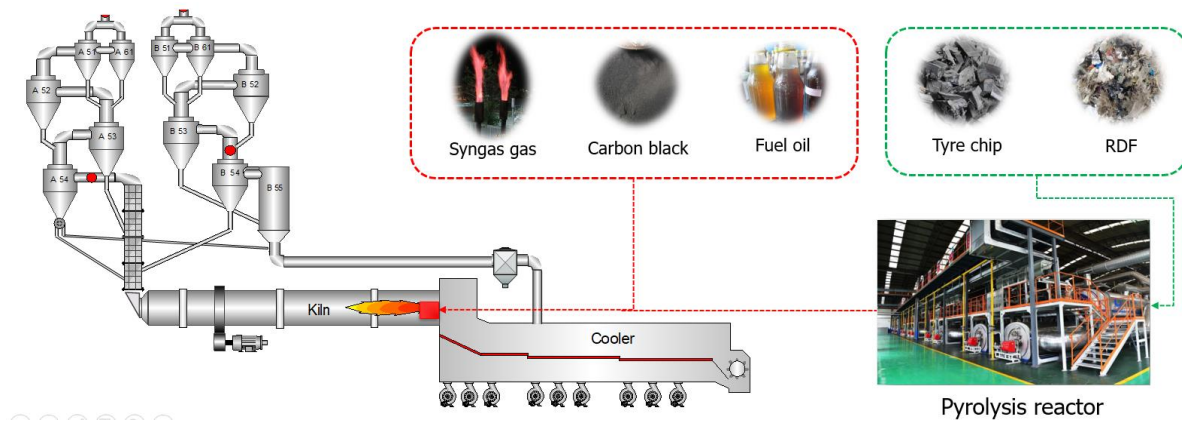


Figure 127: Pyrolysis Feedstock and Fuel Output for Cement Plant¹⁶⁰



SGG plans to use Refuse-Derived Fuel-2 (RDF-2), a plastic waste mix (Figure 128, Tables 43 and 44) or waste tires (Figure 129, Table 45) as feedstock for the pyrolysis plant. The RDF-2 and waste tires will be sourced from Bangkok and combined with existing recycled material from one of SCG's Saraburi cement production facilities. A supply of RDF-2 or waste tire fuel of more than 80,000 tons/year is available.

Figure 128: Plastic Waste RDF-2



¹⁶⁰ Ibid

Table 43: Composition of Plastic Waste RDF-2¹⁶¹

Material Composition	Percent
Plastic	84.8
Fabric	10.1
Wood	3.5
High strength plastic	1.4
Plastic foam	0.1
Rubber	0.1
Total	100%

SCG plans a pilot project to replace five percent of coal inputs on one production line at its cement plant in Saraburi, Thailand. The replacement fuel will be made from the pyrolysis of waste tires or RDF-2 and then burned in the cement kilns. Should the pilot program be successful and economical, it will be replicated, at a coal replacement factor greater than five percent, across SCG's cement facilities in the region. These sites include 11 production lines at five locations in Thailand, two in Vietnam, and one each in Laos, Cambodia, and Myanmar. By replacing the coal with RDF and waste tires, SCG expects to reduce overall emissions, including CO₂.

Table 44: Proximate/Ulimate Analysis of Plastic Waste RDF-2¹⁶²

Feedstock Waste Tire			AVG
Analysis Result	LHV	kcal/kg	4,825
	Chloride	%	0.34
	Bulk density	Kg/L	0.075
Ultimate Analysis	C	%	44.7
	H	%	10.9
	O	%	36.8
	N	%	0.4
	S	%	0.1
	Total		100%
Proximate Analysis	Moisture	%	32.5
	Ash	%	6.6
	Volatile	%	60.4
	Fixed carbon	%	0
	Total		100%

¹⁶¹ Ibid

¹⁶² Ibid

Figure 129: Waste Tires and Rubber Chips¹⁶³

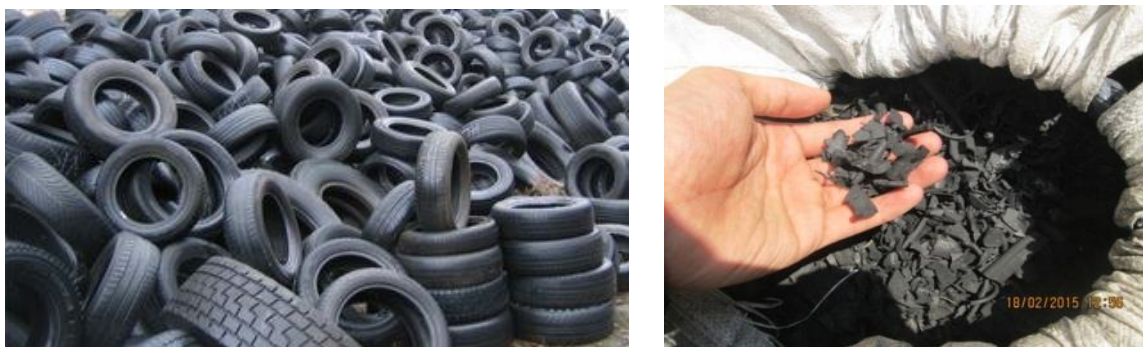


Table 45: Proximate and Ultimate Analysis of Waste Tires¹⁶⁴

Proximate Analysis (As Received)	Percent
Fixed carbon	8
Volatile matter	74
Ash	17
Moisture content	1
Total	100

Ultimate Analysis	Percent
C	56
H	7
O	17
N	0
S	1
Total	100
LHV (kcal/kg)	6,500

PROJECT STATUS AND IMPLEMENTATION TIMELINE

SCG is studying various pyrolysis technologies and expects to review and select the most appropriate option during 2020. Immediately following technology selection, SCG plans to build a pilot pyrolysis plant with a capacity of 20 to 40 tons per day. A pilot plant was installed as scheduled in 2020. However, the results of the testing were not promising, due to both technology

¹⁶³ Ibid

¹⁶⁴ Ibid

and residual moisture in the RDF-2 feedstock according to SCG. SCG is actively seeking alternative technology.

SCG has begun the application process for permitting and licensing to incorporate the pyrolysis process and use of its outputs at their facility in Saraburi. No additional environmental impact assessment is required.

PROJECT COST AND FINANCING

The investment cost for the pilot pyrolysis system is \$3 million. Investment for Phase I (2020-2022) is uncertain. The overall investment will depend on the results of the feasibility study for the project. Pending the feasibility study results and Phase I, other plants in SCG's network may use the solution.

Additionally, SCG is open to establishing a joint venture with a foreign partner/technology provider to build and operate a pyrolysis facility in Thailand. This facility would sell the pyrolysis oil, carbon black, and syngas directly to SCG cement production facilities and other cement producers interested in reducing their coal use.

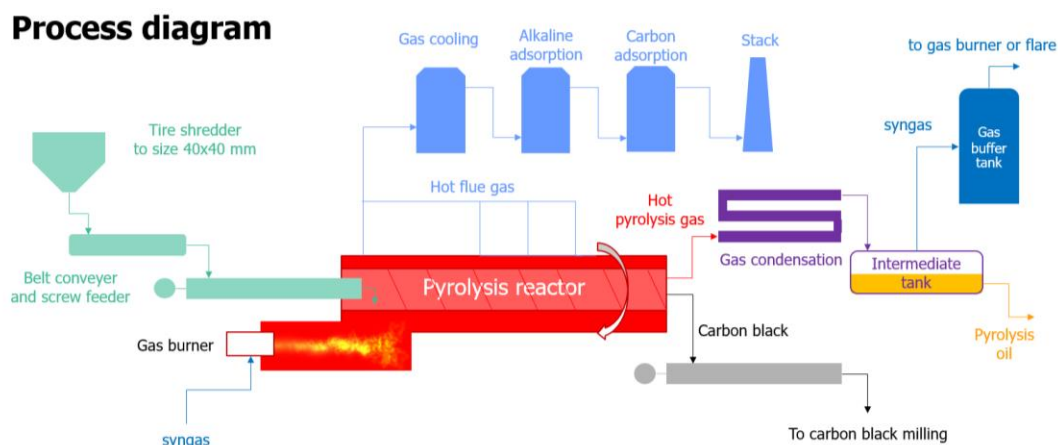
US EXPORT OPPORTUNITIES

The pilot project will be undertaken using open, competitive international bidding. U.S. firms are encouraged to bid on each of the component parts listed below. European and Chinese firms have already expressed interest in these opportunities. Also, SCG is interested to learn of U.S. financiers interested in establishing a joint venture pyrolysis facility.

The pyrolysis system equipment being sought by SCG (Figure 130) includes:

- Feedstock pre-treatment and feed conveyor (shredder and dryer (if needed), feed conveyor) (green portion of Figure 6).
- Pyrolysis reactor (red portion, but not limited to the rotary reactor).
- Gas condensing unit and oil storage tank (purple portion).
- Carbon black conveyor (grey portion).
- Gas treatment unit (blue portion).
- Gas buffer tank or flare (navy portion).


Figure 130: Typical Pyrolysis Equipment Diagram¹⁶⁵



CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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¹⁶⁵ Ibid

Blue Solar PV and Storage		
	SECTOR	Energy
	SUBSECTOR	Renewables (Utility-Scale Solar plus Storage)
	LOCATION	Suphan Buri, Thailand
	PROJECT VALUE	\$40 Million

PROJECT SUMMARY

Blue Solar Co., Ltd. of Thailand, is seeking to develop a 35.6-megawatt (MW) solar photovoltaic (PV) farm, with an integrated 36-megawatt-hour (MWh) battery energy storage system. The Blue Solar PV farm will be one of the first, privately-developed, utility-scale, battery energy storage projects in Thailand. Blue Solar is developing the project under Thailand's Small Power Producer (SPP) Hybrid Firm Power Purchase Agreement (PPA) model.

PROJECT DESCRIPTION

Blue Solar Co., Ltd., a private-sector Thai company, has developed solar projects domestically since 2015. The company's first project was installing solar rooftop solutions on 66 households, providing 450 kWh of power. Blue Solar's initial project began operations in March 2016.

Blue Solar's next installation, also in 2016, involved working with agricultural cooperatives to develop and operate two five-megawatt solar farms, from which the power was sold to the Provincial Electricity Authority (PEA).

The company's current project, in Suphan Buri (approximately 80 miles northwest of Bangkok), is Blue Solar's first SPP-scale solar farm (Figure 131). The company plans a capacity of 35.6 MW with an integrated 36 MWh battery energy storage system.

Blue Solar will locate the project on land privately owned by the company, currently in use for rice farming. The site is approximately 10 km from the main commercial and city center area in Suphan Buri. Blue Solar's solar farm project will be one of the first private sector deployments of a utility-scale solar farm with integrated battery storage. It is also one of 17 renewable energy projects designated by Thailand's Energy Regulatory Commission (ERC) to produce up to 300 MW of new renewable energy under the SPP Hybrid PPA model.

Figure 131: Conceptual Design of Blue Solar Solar Farm¹⁶⁶

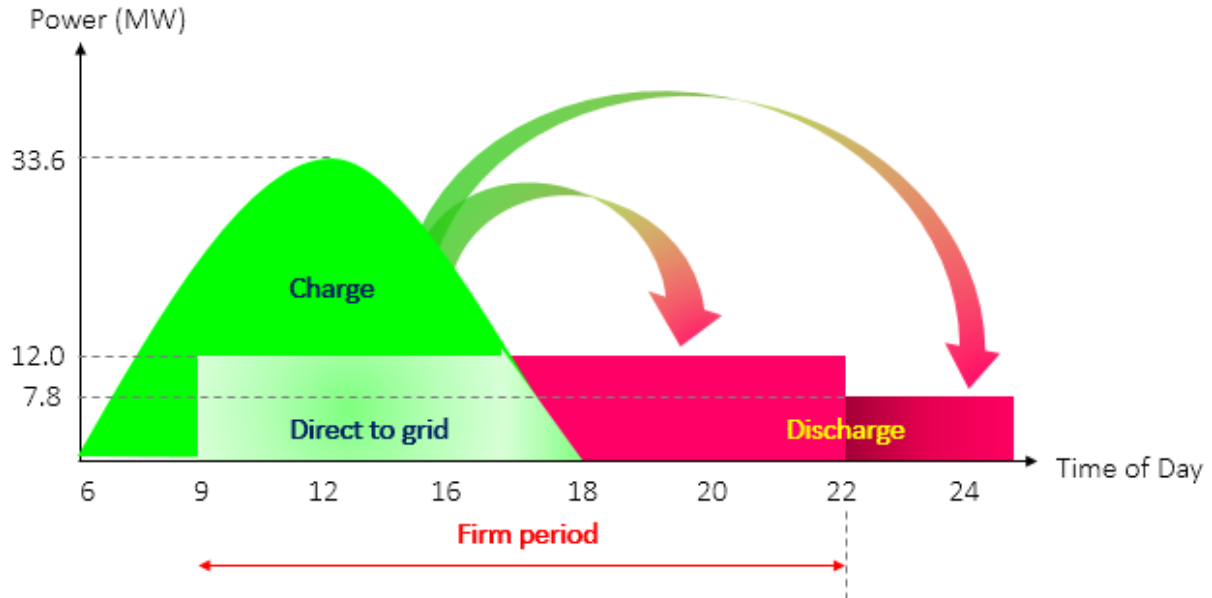


The hybrid PPA model (Figure 132) involves a contract to provide 12 MW to the local power grid. From 9 a.m. to 10 p.m. each day (the firm period), Blue Solar must supply the contracted power. The company can also sell power outside this timeframe, using the energy stored in the batteries. The proposed volume in the non-firm period (10 p.m. to 9 a.m.) is 7.8 MW. The Energy Generating Authority of Thailand (EGAT) is the power off-taker, who will transfer it to the PEA grid.

Over the project life, Blue Solar can request solar PV installed capacity increases up to 50 MW from ERC. Much of that capacity increase can result from tracker panels to increase efficiencies and take advantage of greater solar inputs. Technology enhancements in both PV tracking systems and energy storage are likely to continue to improve project economics.

¹⁶⁶ Blue Solar

Figure 132: Blue Solar Hybrid Structure¹⁶⁷



PROJECT STATUS AND IMPLEMENTATION TIMELINE

On Aug. 14, 2019, the U.S. Trade and Development Agency (USTDA) signed a \$553,000 feasibility study grant with Blue Solar under the U.S. Government's Asia EDGE program. The Asia EDGE program supports improvement in consumer access to cost-effective, reliable electricity across the Indo-Pacific region. Under the USTDA grant, Blue Solar selected POWER Engineers, Inc. as the feasibility study's prime contractor. Sub-consultants Delphos International, ERM and Customized Energy Solutions support the development of feasibility study technical analyses, energy models, environmental and social impacts, and assessment of U.S. solar and energy storage technologies that can benefit the project.

Key elements of the project have been completed or are near completion, including:

- Data sharing across the feasibility study group.
- Topology survey for foundation design.
- Code of Practice (COP) report submitted to ERC in 2019 has been approved and was submitted to EGAT in 2020.
- Community participation obligation fulfilled.
- Sizing specified (final report from power engineers pending).
- Technology readiness plan for submission to EGAT complete in 2020.
- Land lease completed and registration requirement fulfilled.

Upcoming key events and target dates include:

¹⁶⁷ Ibid

- Signature of PPA – Jan. 2021 (deadline of March 2021).
- Selection of EPC contractor and equipment – 4Q 2021.
- Land preparation and laying of foundation – 1Q 2022.
- Solar and energy storage systems arrival and installation – 2 and 3Q 2022.
- Systems integration and internal testing – 3Q 2022.
- Testing with off-taker (EGAT) – 4Q 2022.
- Begin commercial operations – 4Q 2022 (deadline of 12/2022 to allow Blue Solar to take advantage of the SPP Hybrid PPA).

Delays have been caused by the COVID-19 global pandemic, although the project is on track for completion within one year of the original estimate.

PROJECT COST AND FINANCING

The capital cost of the solar-power-with-energy-storage facility is estimated to be \$30 to \$40 million. Blue Solar expects to use bank-sourced project finance for the majority. Conversations are ongoing with lenders. The company also seeks to sell high value carbon credits to potential buyers in order to positively enhance the project economic return.

Given its position in the SPP hybrid PPA program, the feed-in tariff (FIT) structure is the same for both Firm Period and Non-Firm Period. The FIT structure for this plant is, for both Firm Period and Non-Firm Period, THB 0.6878/kWh (fixed) + THB 1.85/kWh (to be annually adjusted with inflation).

The SPP PPA Program includes a 20-year PPA for renewable power projects.

US EXPORT OPPORTUNITIES

Blue Solar has already begun speaking with firms regarding supply for batteries, solar panels, tracking technology and associated components. U.S. firms with technologies related to battery storage, racking, inverters, and tracking components will be competitive for opportunities associated with this solar project.


Battery selection is seen by Blue Solar as a critical challenge, as storage optimization is essential to achieving the best performance at the lowest cost.

Specific opportunities for U.S. suppliers will include:

- Engineering and design
- Racking
- Inverters
- Solar tracker technology, equipment and software
- Batteries
- Cabling

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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Cai Mep Ha LNG-to-Power		
	SECTOR	Transportation/Energy
	SUBSECTOR	LNG
	LOCATION	Vung Tau Province, Vietnam
	PROJECT VALUE	\$3 Billion

PROJECT SUMMARY

The Cai Mep Ha LNG-to-Power Project is located in Vung Tau Province in Vietnam. Initially, the Project will have a capacities of three million metric tons per year (mmpta) of liquefied natural gas (LNG) and 3,000 megawatts (MW) of power generation. Future phases will increase LNG capacity to 9 mmpta and power generation to 6,000 MW.

PROJECT DESCRIPTION

The Cai Mep Ha LNG-to-Power Project comprises an LNG import terminal with the capacity to process 3 mmpta of LNG and a 3,000 MW gas-fired, combined-cycle gas turbine (CCGT) power plant. The proposed Project also has the potential for LNG expansion in two additional phases of three million metric tons per year each and two additional phases with 1,500 MW expansions each for power generation totaling 6,000 MW.

The first phase of the Project, including the first 3 mmpta LNG import terminal and the 3,000 MW CCGT power plant, represents over \$3 billion of investment, with potential for future investment to support the planned expansions. The Project also provides an opportunity for U.S. LNG exporters to access a rapidly growing \$900 million LNG market.

The Project is located in the Cai Mep Ha area, Phu My town, Ba Ria, in Vung Tau province (Figure 133). An aerial view (Figure 134) provides a closer detail of the project site.

The location of the Cap Mei Ha Project is ideally suited for an LNG-to-power project, with the following features:

- Close proximity to an existing deep shipping channel.
- In open water, so marine traffic congestion is not a concern.
- Near existing transmission lines for the ability to transport power.
- Near existing power plants (Phu My and Nhon Trach plants, representing 5,200 MW of installed capacity currently).
- Near existing gas pipelines (potential to tie into or use rights-of-way for expansion).

- Close proximity to the significant electricity demand center of Ho Chi Minh City.

Gen-X Energy, a portfolio company of the Blackstone Group, is developing the Cap Mei Ha LNG-to-Power project.

Figure 133: Location of Cai Mep Ha Project with Expanded View of Southern Provinces

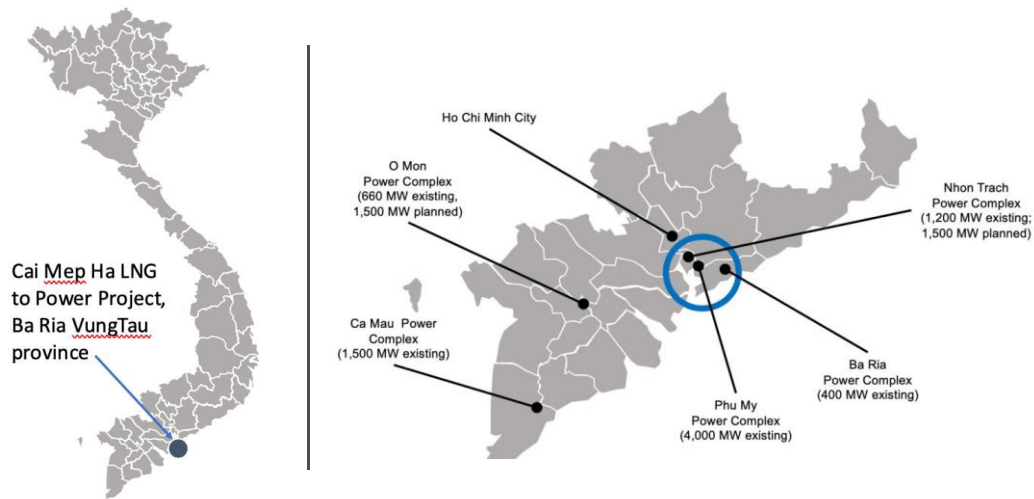


Figure 134: Aerial View of Cai Mep Ha LNG-to-Power Project Site



PROJECT STATUS AND IMPLEMENTATION TIMELINE

Recent development milestones include:

- Approval and inclusion of the Project in the Power Development Master Plan VIII (2021-30) scheduled for release in early 2021.
- Submissions of required documents to MOIT in June 2020. Awaiting next steps from MOIT.

Gen-X Energy has revised its proposal to focus on the LNG import terminal first, with the power plant following, since there are several competing projects for gas-to-power in Southern Vietnam. The company will focus on establishing a large, onshore LNG hub to supply multiple customers, with PetroVietnam indicating Gen-X Energy is in a strong position for an LNG import terminal.

The target dates for the financial closing are still unknown, pending the MOIT decision. The new Provincial Committee is seeking to delay the Project until 2028.

Gen-X Energy has submitted investment and project proposals to Ba Ria Vung Tau province and worked with provincial staff and agencies to obtain formal permission to use 200 hectares of land. Ba Ria – Vung Tau province has submitted a letter to the Prime Minister requesting the project investment policy's approval with the Government Office assigning MOIT to address the request.

COVID-19 has had little impact on project efforts but has slowed decision-making.

PROJECT COST AND FINANCING

The total estimated investment capital for the full project is \$6 billion, with Phase I requiring \$3 billion and Phases II and III estimated at \$1.5 billion each.

The Project will be financed with a combination of equity and non-recourse project debt. The invested capital will be mobilized from Gen-X Energy (backed by Blackstone) and other investors. Gen-X Energy currently owns 51 percent of the Project, with local investors holding 49 percent. Access to foreign direct investment (FDI) is considered a considerable strength of the Project. Debt financing will be secured from international lenders such as the United States International Development Finance Corporation and other multilateral and/or export credit agencies such as the International Finance Corporation (IFC) and Export-Import Bank of the United States, as well as domestic commercial banks, in line with the implementation schedule for the Project.

U.S. EXPORT OPPORTUNITIES

The Project's first phase will require approximately 3 mmtpa of LNG, providing substantial export opportunities for U.S. LNG suppliers. Gen-X Energy has letters of intent from multiple interested exporters including GE, Exxon Mobil, and Cheniere.


The management, planning, finance, and project structuring, as well as operations and maintenance services, will be provided by Gen-X Energy. Additional U.S. export opportunities include:

- Large gas turbine generators.

- Steam generators.
- Cryogenic pipes and valves.
- Specialized steel alloys for LNG service.
- Engineering services.
- Legal services.
- Banking and financial services.
- Inspection and quality control services.
- Operations and maintenance services.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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Bac Lieu Clean Energy		
	SECTOR	Energy
	SUBSECTOR	LNG
	LOCATION	Bac Lieu Province, Vietnam
	PROJECT VALUE	\$3 Billion

PROJECT SUMMARY

Delta Offshore Energy (DOE) is developing an integrated LNG terminal and combined-cycle gas turbine (CCGT) power plant in the Mekong Delta, Vietnam. DOE has signed a memorandum of understanding (MOU) with General Electric (GE) to provide technical and business development support for its CCGT technology. Other companies involved in the effort include Bechtel, Black and Veatch, ERM, and McDermott. Wood-Mackenzie has been hired for commercial advisory services. The build-out capacity of the CCGT plant is expected to be 3,200 megawatts (MW). The Project is approved by the Vietnamese Ministry of Energy and will be listed in the Vietnam Power Development Master Plan VIII (2021-30), scheduled for release in early 2021.

PROJECT DESCRIPTION

Delta Offshore Energy (DOE) has a binding MOU with the People's Committee of Bac Lieu Province, Vietnam, to develop and invest in an integrated 3,200 MW LNG-to-power project (Figure 135).

The Project includes a floating LNG (FLNG) receiving, storage and regasification terminal, along with mooring and a pipeline to the power plant gate. The power station will require approximately three million metric tons per year (mmpta) LNG offtake, with the exact amount subject to negotiation of capacity hours with Vietnam Electricity (EVN).

The terminal's excess capacity can be used to toll gas subject to Gas Sales and Purchase Agreements (GSPAs) between LNG suppliers and other third parties (e.g., gas-fired power plants, fertilizer plants, industrial parks, downstream petrochemical distributors).

Key elements of the Project's conceptual design include:

- Jetty-less floating terminal with an autonomous transfer system.
- Self-installing regasification jack-up platform.
- Floating storage unit.
- GE 9HA high efficiency, air-cooled gas turbine.

Figure 135: Bac Lieu Clean Energy Project Site in Bac Lieu Province



Key design aspects of the Bac Lieu Clean Energy Project are illustrated below (Figure 136).

Figure 136: Bac Lieu Clean Energy Project Design Features



The Project owners have selected the GE 9HA high-efficiency, air-cooled gas turbine. The GE turbines have proven track records across locations matching the conditions for this Project. Based on consultations with GE's engineering team, the Project will use the 9HA.02 unit at 544 MW. In a combined cycle, this equates to 768MW per block, each of which will represent one phase in the project's rollout. The 9HA.02 features a simplified air-cooled architecture, advanced materials, and proven operability and reliability. This high-power-density gas turbine's economies of scale enable the cost-effective conversion of fuel to electricity at more than 63 percent combined cycle efficiency.

The coastal conditions around the Mekong Delta favor the use of a floating storage solution for LNG supply. The storage vessel will be situated offshore from Bac Lieu Province. The project has incorporated several solutions to meaningfully improve the efficiency of the project's maritime elements. An offshore bathymetric survey of one square kilometer for the LNG terminal is complete. The project location allows minimal dredging for the installation of the FLNG vessel.

Onshore, 70 hectares of land have been secured for storage, gasification, and power generation.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

The target Commercial Operations Date for the first 750 MW phase is 2024. Delivery of each of the subsequent 750MW phases is expected to occur over subsequent two- to three-month intervals, with Project completion by the end of 2025.

The Project has been offered an accelerated timeline for approvals in exchange for providing a fully private solution to Vietnam's strategic energy needs. The exchange should substantially reduce the time to final investment decisions. Under the terms of the Project's agreements, the Government of Vietnam has committed to delivering all of the agreements, licensing, permits, and other approvals required to facilitate financing within 12 months.

Over the last year, multiple technical studies have been completed or initiated, including a grid impact study submitted to the Ministry, with an environmental, social, health impact analysis (ESHIA) underway. Additional efforts to secure all zoning issues are addressed. Also, DOE has submitted a draft power purchase agreement (PPA) to the government, as well as all other required documents. DOE expects the government to approve the PPA within the next few months. The company has engaged local engineering and survey firms to execute much of the site assessment and pre-development work due to restrictions imposed by COVID-19. As a result, there are no measurable delays; instead, the Project has kept on schedule.

Wood-Mackenzie has been managing an LNG procurement process and is reviewing proposals from more than 20 entities, with a plan to select several suppliers.

PROJECT COST AND FINANCING

DOE expects CAPEX for project implementation to exceed \$3 billion.

A new Vietnam Law will govern investment implementation. Key features of this new law include:

- The project's special purpose vehicle will have the Enterprise Registration Certificate issued as the Bac Lieu Clean Energy (BLCE). BLCE is a 100 percent private foreign direct investment company (i.e., there is no element of ownership by a state-owned enterprise). BLCE will have the development and investment rights to the Project.
- The power purchase agreement will be negotiated using an internationally bankable template.
- Government guarantees and undertakings are not subject to the constraints, conflicts, and sequences in the process typically applied to build-operate-transfer (BOT) projects.

The Project sponsors believe the new structure will facilitate the equity raise for Project implementation. Equity investors are committed to the Project.

Debt financing for the Project is expected to blend financing from multilateral and bilateral development financing institutions and commercial entities. JP Morgan has been hired as the financial advisory firm and will be the lead debt arranger on the Project.

U.S. EXPORT OPPORTUNITIES

The largest U.S. export opportunity for this Project is LNG shipments. A prior commitment to Australia-listed Liquefied Natural Gas Ltd (LNG Ltd.) announced in September 2019 has been canceled due to the changing market conditions for LNG. U.S. LNG suppliers are being considered.

Significant U.S. exports will also be generated as a result of the MOU between the project and GE for the series 9HA gas turbines. Additional U.S. exports will be generated by the project's strategic alliances with Baker Concrete Construction, Inc. and McDermott. Further U.S. export opportunities will exist for capital goods and services during all project phases – development, financing, construction, and operation, including:

Systems

- Unloading systems.
- Moorings.
- Fire protection.
- Seawater in/out.
- Port spill control.
- SCADA systems.

Equipment


- Gas turbines.
- Gas compressors.
- Balance of plant.

Services

- Engineering, Procurement, Construction (EPC).
- Jetty construction.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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EVN Generation Portfolio Expansion		
	SECTOR	Energy
	SUBSECTOR	Power Generation
	LOCATION	Throughout Vietnam
	PROJECT VALUE	\$7 Billion

PROJECT SUMMARY

Vietnam Electricity (EVN), Vietnam's state-held power company, is undertaking three significant expansion projects within its generation portfolio that will appear in the Power Master Plan VIII (2021-2030):

1. Quang Trach I and II Thermal Power Plants (TPP) – Two supercritical and two ultra-supercritical coal-fired units totaling 2,400 megawatts (MW).
2. O Mon III and IV CCGT – Four combined cycle gas turbine generation units totaling 2,100 MW.
3. Dung Quat I and III CCGT – Two combined cycle gas turbine generation units totaling 1,500 MW.

EVN does not have additional fossil fuel plants under consideration at this time.

PROJECT DESCRIPTION

EVN is a state-owned company with the mission of ensuring sufficient electricity for Vietnamese national socio-economic growth. EVN is active in all aspects of the power business:

- **Generation:** EVN has a total installed capacity of 28,169 MW, representing 58 percent of Vietnam's power generation. EVN directly owns 10,540 MW of that generation capacity and controls the remaining share through 100 percent ownership of GENCO1 (6,938 MW), GENCO2 (4,496 MW), and GENCO3 (6,195 MW).
- **Transmission:** EVN owns the National Power Transmission Corporation (EVNNPT), which has 7,517 km of 500 kilovolts (kV) lines and 17,360 km of 220 kV lines.
- **Grid Operation:** EVN manages the operation of the national power system through the National Load Dispatch Center.

- **Distribution:** EVN controls five regional distribution companies serving the North Central, and South regions as well as Hanoi and Ho Chi Minh City.

The growth in power demand in Vietnam has ranged from 10 to 12 percent annually over the past decade. The trend is forecasted to continue over the near- to mid-term period. New power generation capacity is required to meet this growing demand. The locations of the three EVN projects include (Figure 137):

Quang Trach I and II Thermal Power Plants:

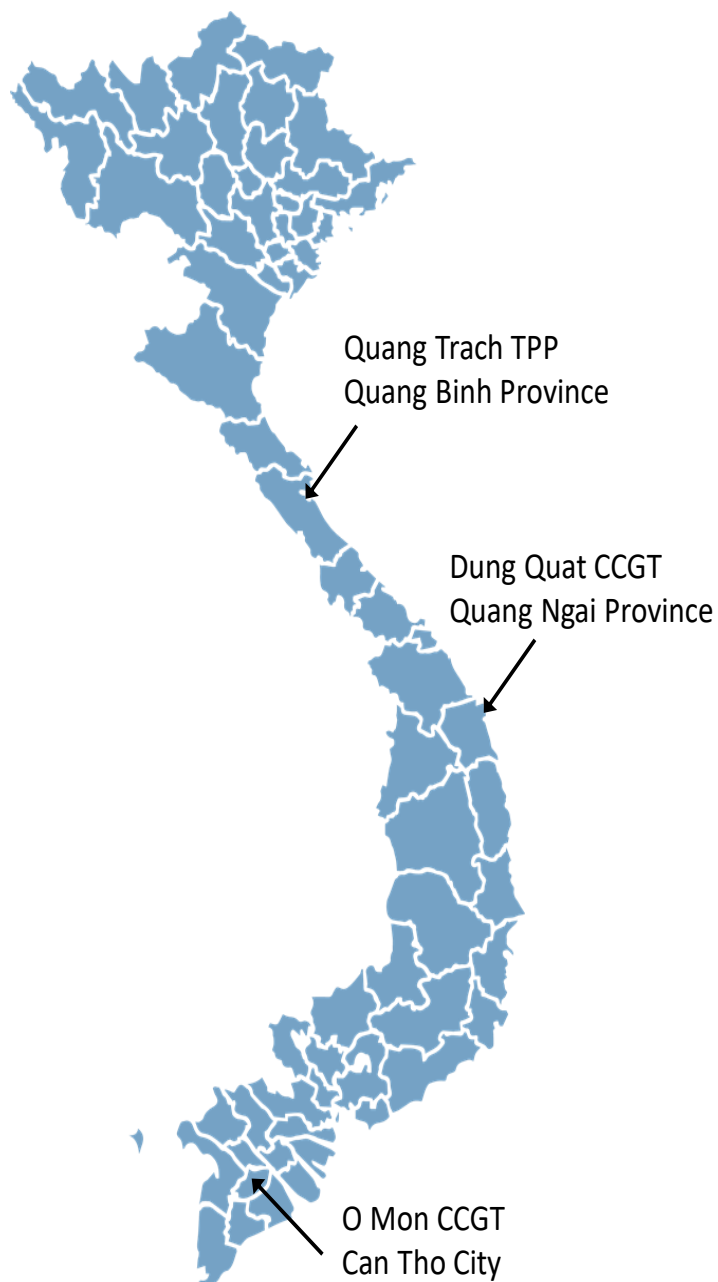
The Quang Trach Power Complex comprises two 1,200 MW projects under development in Quang Binh province. Groundbreaking took place on the two-unit Quang Trach I project in July 2011. The power plant was originally scheduled to enter into service in 2015.

The project had been delayed due to an economic downturn. In October 2016, EVN took over the project due to delays by the original developer, PetroVietnam. In November 2018, EVN completed land acquisition for the project and began upgrading the access road.

Quang Trach I will use supercritical combustion technology. Quang Trach II will use ultra-supercritical coal combustion. Both plants will be equipped with seawater flue gas desulfurization and electrostatic precipitators.

The Quang Trach I project is scheduled for startup in 2024. EVN will release the engineering, procurement, and construction (EPC) contract in early 2021. Quang Trach II is scheduled for startup in 2027/2028. The

Figure 137 Location of EVN Projects (Showing Mainland Only)



Preliminary feasibility study has been approved.

O Mon III and IV CCGT:

The O Mon Power complex, located in Can Tho City in the Mekong Delta region, has been operational since 2009. Unit 1 of the original power plant was commissioned in 2009 and unit 2 in 2015. O Mon II is planned but does not have a developer. EVN is developing O Mon III and IV.

Both O Mon III and IV are single unit, combined cycle gas turbine (CCGT) power plants of 1,050MW each. O Mon I is a dual fuel-fired power plant (oil and gas). O Mon III and IV are designed to fire natural gas from a new pipeline connecting the power complex to Vietnam's Block B field.

Dung Quat I and III CCGT: The Dung Quat Power Complex will be constructed in the Dung Quat Economic Zone, Binh Son District, Quang Ngai Province. The Dung Quat Power Complex will comprise three CCGT power plants with a capacity of approximately 2,250 MW.

EVN is developing the Dung Quat I and Dung Quat III power plants to be operational in 2023 and 2024, respectively. However, the operational date may be revised as the projects have not yet been approved. The preliminary feasibility studies have been approved.

Dung Quat II, BOT power plant, has signed a power sales agreement with EVN. Sembcorp (Singapore) is developing the plant, which is scheduled to be in operation in 2024. The Dung Quat power complex may be expanded in the future.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

The six power plants at the three power complexes listed in this profile are included in the Power Development Plan Version 7 approved in 2011 and updated in 2016. All six plants are permitted.

Target operation dates for these six plants range from 2023-2026, with two yet to be determined (Table 46), but the schedule is likely to change in the Power Master Plan VIII (2021-2030), scheduled for release in early 2021.

Table 46: EVN Power Plant Start-Up Dates

Power Plant	Startup
O Mon III	2026
O MonIV	2025-2026
Dung Quat I	2023
Dung Quat II	2024
Quang Trach I	TBD
Quang Trach II	TBD

EVN representatives have indicated reduced power demand due to the COVID-19 global pandemic. Nonetheless, the pandemic has not had a material impact on project schedules.

PROJECT COST AND FINANCING

The total investment amount for the portfolio of generation projects is estimated to be \$7 billion. The six power generation projects in the EVN portfolio each have its own structure and financing sources. Nevertheless, the power complexes involve shared infrastructure. Reported approximate financial magnitudes are:

- Total investment in Quang Trach I is \$2 billion (VND 42 trillion).
- Approved financing for O Mon IV is \$650 million (VND 13.9 trillion).
- The three combined-cycle gas turbine power plants, Dung Quat I, II, and III, and the Shared Infrastructure project at the Dung Quat Power Complex site have a total investment cost of about \$2.5 billion.
- Costs for Quang Trach II and O Mon III have not been disclosed.

With regard to financing mechanisms for power generation projects, The Ministry of Industry and Trade recently observed:

“Domestic corporations and project owners have struggled to finance projects since the Government put the loan guarantee policy on hold. There is only a limited source of ODA and concession loans invested in power projects. Sometimes though loan commitments of international banks and financial institutions had been obtained, state management authorities disapproved. It is very difficult to mobilize local sources of finance because most local banks have exceeded their credit limits to the project owners and relevant stakeholders.”

U.S. EXPORT OPPORTUNITIES

U.S. export opportunities for the EVN portfolio of projects include:

- Large gas turbines.
- Steam generators.
- Flue gas cleanup systems.
- SCADA systems.
- Engineering services.
- Legal services.

- Banking and financial services.
- Inspection and quality control services.
- Operations and maintenance services.

CONTACTS

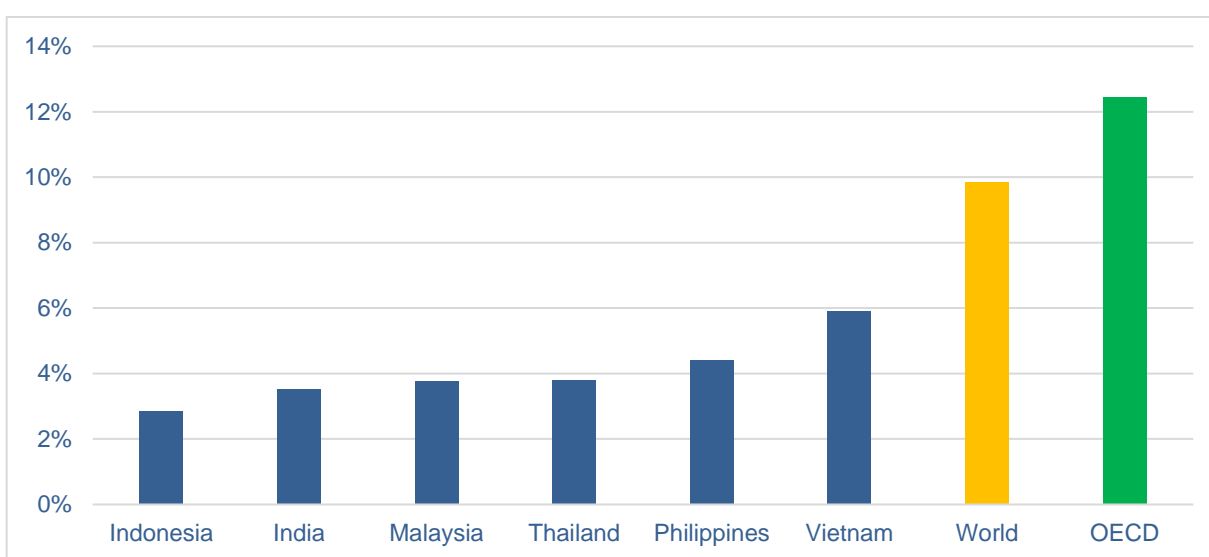
Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
EVN 11 Cua Bac St Ba Dinh Dist. Ha Noi Viet Nam Luong Thi An anlt@evn.com.vn www.evn.com.vn	Indo-Pacific Region 1101 Wilson Blvd. Suite 1100 Arlington, VA 22209 USA Ms. Tanvi Madhusudanan Country Manager tmadhusudanan@ustda.gov GPF Witthayu, Tower A, Suite 302 93/1 Wireless Road, Pathumwan, Bangkok 10330 Thailand Mr. Brandon Megorden Regional Manager for Asia bmegorden@ustda.gov U.S. Embassy in Hanoi 170 Ngoc Khanh St Hanoi Vietnam Ms. Tuyet Trees Country Representative Tuyet.Trees@trade.gov IndoPacific@ustda.gov www.ustda.gov	EVN 11 Cua Bac St Ba Dinh Dist. Ha Noi Viet Nam Luong Thi An anlt@evn.com.vn www.evn.com.vn

5 HEALTHCARE

Sector Overview: Healthcare

Healthcare expenditures vary widely, both globally and among the six countries profiled for this Resource Guide: India, Indonesia, Malaysia, Philippines, Thailand and Vietnam. World average healthcare expenditures as a share of GDP are approximately 10 percent. The countries considered in this Resource Guide range in healthcare expenditures as a percent of GDP from a low of 3.1 in Indonesia to a high of 5.7 in Vietnam. As a comparison, the OECD nations spend the greatest share of GDP on healthcare, at just over 12 percent (Figure 138).

Figure 138: Healthcare Expenditures as a Percent of GDP, 2018¹⁶⁸



On a per-capita basis, the countries considered in this Resource Guide are well below world averages for healthcare spending (Figure 139).

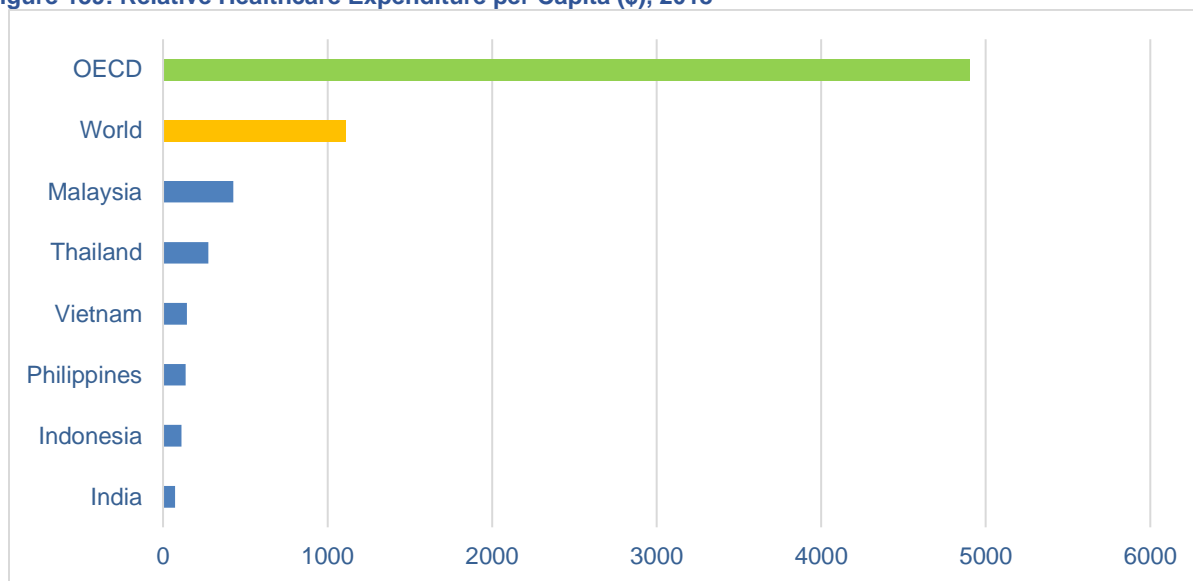
Factors influencing growth in healthcare expenditures¹⁶⁹ include:

- Population growth/number of births.
- Aging of population/prevalence of end-of-life care.
- Disease prevalence/incidence.
- Frequency of service utilization.
- Service price and intensity.

¹⁶⁸ World Bank <https://data.worldbank.org/indicator/SH.XPD.CHEX.GD.ZS>

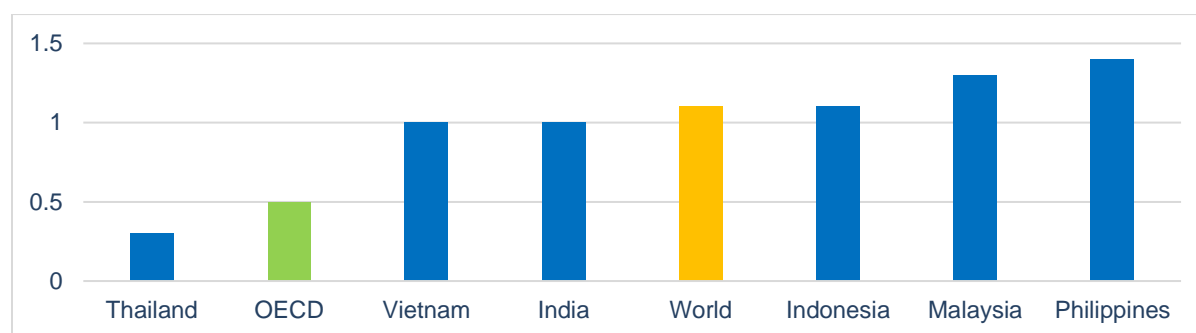
¹⁶⁹ Journal of the American Medical Association (JAMA)

Figure 139: Relative Healthcare Expenditure per Capita (\$), 2018¹⁷⁰



The countries considered for this Resource Guide, except Thailand, have population growth (i.e., number of births) at or above world average levels (Figure 140). At the other end of the spectrum, by 2021, the Asia Pacific region is projected to host 55 percent of the world's elderly (over 65 years of age) population¹⁷¹. Except for Thailand, the Resource Guide countries have a somewhat lower percentage of elderly than the global average (Figure 141). Half of the countries (India, Philippines, and Indonesia) have life expectancies under the world average (Figure 142), in part due to disease prevalence and lower levels of medical service access/utilization. However, the other half have life expectancies at or above world averages (Vietnam, Malaysia, and Thailand).

Figure 140: Annual Population Growth (Percent), 2019¹⁷²



¹⁷⁰ Ibid

¹⁷¹ Euromonitor

¹⁷² World Bank <https://data.worldbank.org/indicator/SH.XPD.CHEX.PC.CD>

Figure 141: Percent of Population over 65, 2019¹⁷³

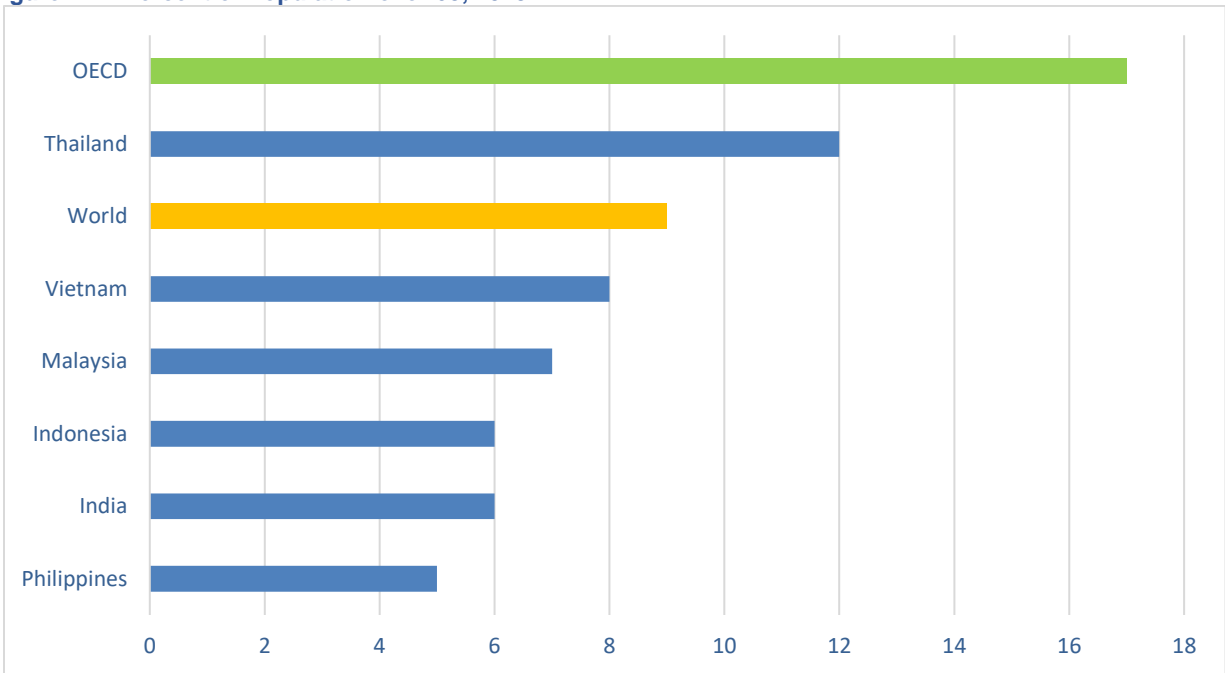
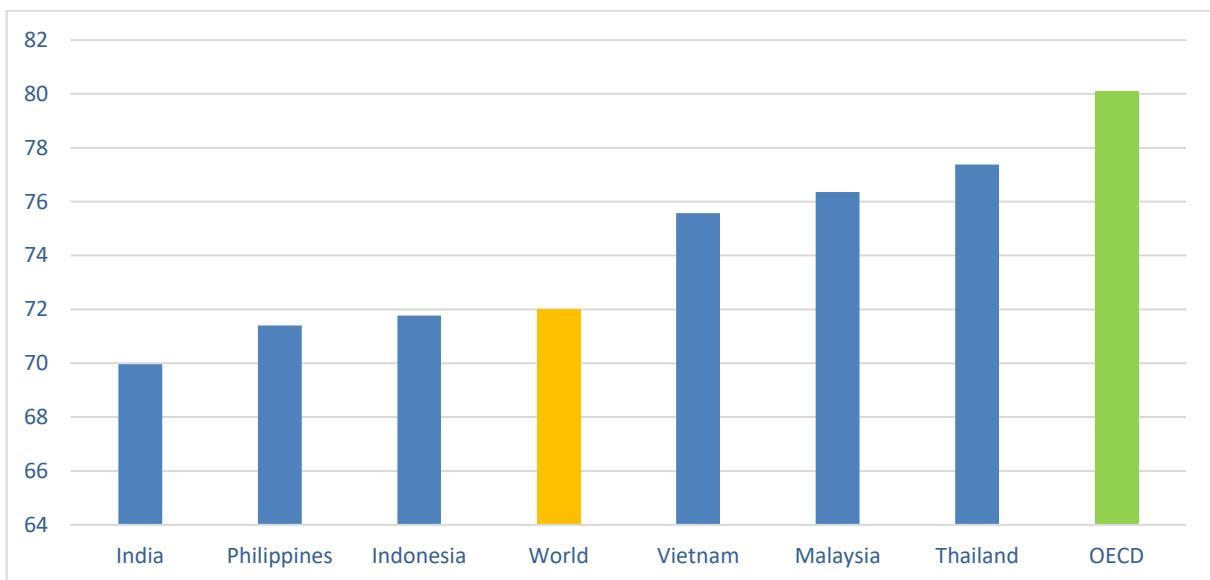


Figure 142: Life Expectancy (Years), 2021¹⁷⁴



Demographic data suggest the likelihood of substantial growth in investment in the Healthcare sector as the Resource Guide countries further industrialize, discretionary income levels rise, and healthcare extends to remote and underserved regions. At least three Healthcare categories,

¹⁷³ Ibid

¹⁷⁴ Source: World Population Review

hospitals, major healthcare equipment, and telemedicine, align regional needs with U.S. technological, manufacturing, and service capabilities.

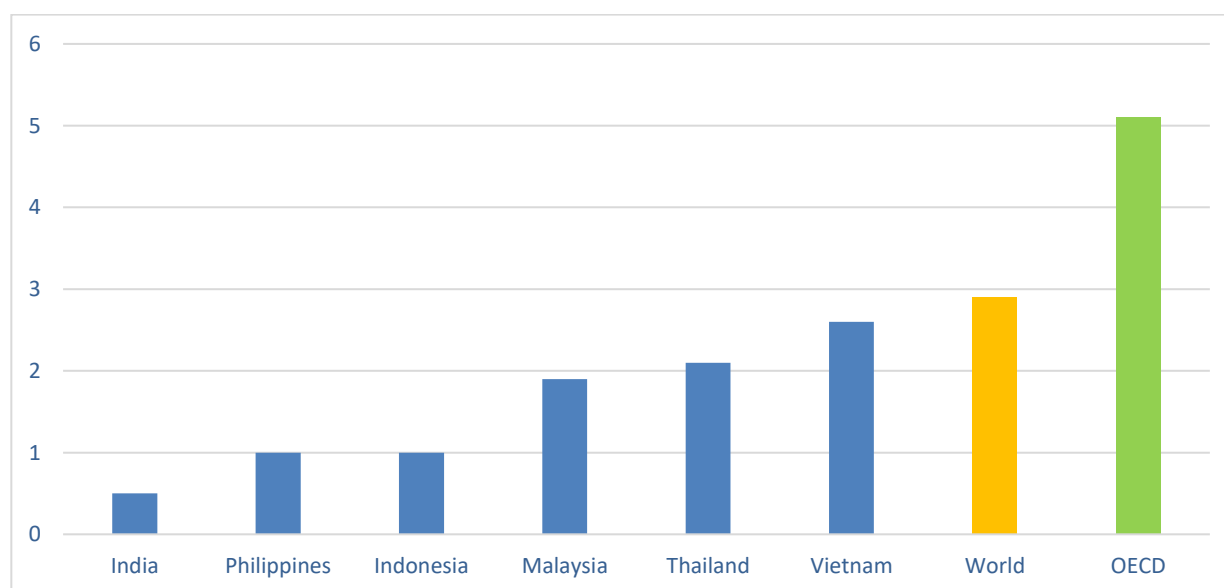
The COVID-19 global pandemic has caused several regional nations to shift funds from other government investments into healthcare, at least temporarily. For some, such as Malaysia, the pandemic has underscored the urgent need for additional hospitals in underserved areas.

Hospitals

The countries covered in this Resource Guide are currently below world averages for available hospital beds per 1000 population (Figure 143). Most of these countries have undertaken significant build programs for new hospitals. For example, private healthcare provider KPJ of Malaysia is building numerous new facilities in its home country, including aged care facilities, which are generally less available in the region than, for example, in the United States. Also, the company operates hospitals in Indonesia, Thailand and Bangladesh. The region features a mix of public and private healthcare, with private facilities typically offering superior care and a more comprehensive array of treatment options, albeit at a higher price.

The COVID-19 global pandemic has pointed up the acute need for additional hospital beds in underserved areas of each of the countries reviewed in this Guide. Also, opportunities for new and expanded specialist hospitals have taken on greater urgency.

Figure 143: Hospital Beds Per 1,000 People¹⁷⁵



¹⁷⁵ World Bank

As patients sought to arbitrage care costs and quality, medical tourism, before the COVID-19 global pandemic, was a growing industry in the six countries covered in this Resource Guide. Global surveys of preferred medical tourism destinations routinely mention India, Malaysia, and Thailand. Medical tourism presents an opportunity for additional construction and outfitting of larger, specialist hospitals with state-of-the-art diagnostic, treatment, recovery, and digital records-keeping capabilities. Post-pandemic resumption of more normal travel patterns will allow growth in medical tourism to resume.

Major Healthcare Equipment (Durable Medical and Medical Capital Equipment)

This subsector comprises the diverse array of capital equipment required to outfit hospitals, outpatient clinics, surgical centers, and sophisticated medical offices. Given the diversity of this subsector, market size estimates vary widely. Many suggest a value of at least \$150B globally, with roughly \$10B in the Indo-Pacific Region. Local segments generally have compound annual growth rates (CAGRs) of 6 to 14 percent, depending on the category.

Segments comprising this subcategory include:

- Medical imaging/radiology equipment (x-ray, MRI, CT, ultrasound, PET, endoscope, nuclear, workstations).
- Patient monitoring and digital record keeping.
- Hospital beds/stretchers.
- Intensive care/neonatal intensive care.
- Surgical suite/operating room/medical robotics.
- Cardiovascular, cardiology and defibrillation.
- Intravenous therapy systems/dialysis.
- Medical gas equipment.
- Compressors, pumps, autoclaves, suction devices.
- Refrigeration.

Telemedicine

Doctor shortages, particularly for medical specialties, are an issue in much of Asia, with India, Indonesia, and rapidly growing portions of Malaysia (e.g., Sarawak) experiencing acute shortages. The COVID-19 global pandemic has exacerbated these shortages in most, if not all, regional countries. Before the pandemic, Vietnam and Malaysia faced some shortages in remote areas, while the Philippines and Thailand had nearly overcome past deficiencies.

The rapidly growing telemedicine industry offers a means to ameliorate these challenges. Telemedicine allows patients and less skilled professionals to consult with and receive treatment and follow-up direction from more skilled practitioners located at a distance by using telecommunications and information technology (Figure 144). Telemedicine has been used extensively during the COVID-19 global pandemic to treat patients, provide remote medical instruction to providers, and train remote medical personnel.

The global telemedicine market nearly doubled from 2019 to 2020, reaching a level of almost \$80 billion globally.¹⁷⁶ Of that, the countries covered in this Resource Guide account for slightly under 10 percent. Double-digit growth is likely to continue over the next five years. Telemedicine segments include real-time telemedicine and remote patient monitoring. Used most widely today for cancer, radiology, pathology, neurology, psychology, and dermatology, more advanced telemedicine systems can even facilitate or perform surgeries. Pre-pandemic, these applications represented more than 50 percent of telemedicine use. However, COVID-19 has shifted the relative balance of specialty- versus primary-care telemedicine usage appreciably.

Figure 144: Telemedicine in Action¹⁷⁷




Summary

The Healthcare sector in the Indo-Pacific region is an attractive opportunity for U.S. interests. The demographics and current global health crisis favor continued strong growth in healthcare consumption. The region is already a heavy importer of the latest medical technology, much originating in the United States. Further, several countries have lesser restrictions on direct foreign investment in hospitals than in other economic sectors. U.S. capabilities fit well to support Indo-Pacific growth in Healthcare.

¹⁷⁶ Fortune Business Insights

¹⁷⁷ Diagnostic and Interventional Cardiology

Aster KLE Hospital		
	SECTOR	Healthcare
	SUBSECTOR	Hospitals
	LOCATION	Bangalore
	PROJECT VALUE	\$57 Million

PROJECT SUMMARY

Aster DM Healthcare has signed a 25-year lease agreement with Karnataka Lingayat Education (KLE) Society to set up a 600-bed hospital in Bengaluru, Karnataka. Aster Healthcare is a diversified healthcare group with operations in the Middle East, India and the Philippines. It operates a global network including 25 hospitals, 117 clinics and 238 pharmacies, of which 13 hospitals and four clinics are in India. Aster treated 19.4 million patients last year, with in-patient treatment increasing by 16 percent. Aster DM Healthcare expects the Aster KLE hospital to be operational by April 2024.

PROJECT DESCRIPTION

Healthcare has become one of India's largest sectors, both in terms of revenue and employment. With the launch of Ayushman Bharat in 2018, India became the world's most extensive government-funded healthcare system. Projected to reach \$372 billion by 2022, India expects its healthcare market to be among the top three fastest-growing markets globally. Key components of the healthcare market in India include:

- Hospitals (government and private).
- Pharmaceuticals.
- Diagnostics (imaging and pathology).
- Medical equipment and supplies.
- Medical insurance.
- Telemedicine.

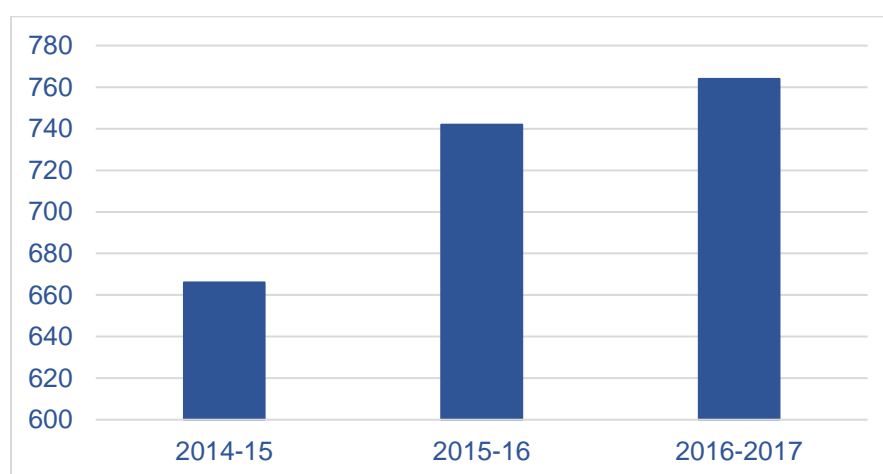
All Indian healthcare sectors expect to grow at double-digit rates, and by 2020-2022 supporting industries will reach record levels of revenues. Diagnostics, medical devices and healthcare information technology will reach \$32, \$20 and \$1.5 billion, respectively.

Driving the healthcare market is the hospital industry, expected to reach \$132 billion by 2022, from \$61.8 billion in 2017, with a CAGR of 16.5 percent. Given its large population and relatively low costs, India's hospital industry has attracted massive domestic and foreign investments to fund

basic medical care, healthcare delivery and advanced technology, as well as to expand market reach in both urban and rural areas. In India currently, there is inadequate coverage of public healthcare institutions and services.

From a general investment standpoint, 100 percent Foreign Direct Investment (FDI) is allowed under the Automatic Route for any greenfield or brownfield hospital project. International investors can set up new hospitals with 100 percent foreign ownership, without government pre-approval. U.S. investors have taken advantage of the enabling policies and growth outlook for hospitals, medical equipment, supplies and services to invest (Figure 145), including almost \$800 million during 2017 and 2018.

Figure 145: U.S. Foreign Direct Investment in Indian Hospitals, \$ Millions¹⁷⁸



Aster DM Healthcare will structure the Aster KLE Hospital as an operating lease between Aster DM Healthcare and the KLE Society, a recognized and trusted Indian education and healthcare provider. The operating lease will be structured to reduce CAPEX, real estate and rental risks for the Aster Group.

Aster DM Healthcare is a large international healthcare player with a presence in India and 16 other countries. In India, Aster operates six hospitals in six cities, plus four clinics in Bangalore. Aster's existing CMI Hospital (Figure 146) is highly regarded for its quality of care in several medical specialties. The Bombay Stock Exchange (BSE) listed Aster DM Healthcare Indian earnings last year at \$140 million. With this project's addition, Aster will service two million patients annually and operate 4,643 beds in India. The company is also in the early stages of considering a fourth hospital in Bangalore and a fifth hospital in Chennai. As well, the company is planning to launch a sizeable clinical lab chain in Bengaluru as a new vertical.

The KLE Society is associated with several universities and institutions in the US, including the Universities of Michigan and Illinois, and the Bill & Melinda Gates Foundation. KLE Society

¹⁷⁸ Department of Industrial Policy & Information, Government of India

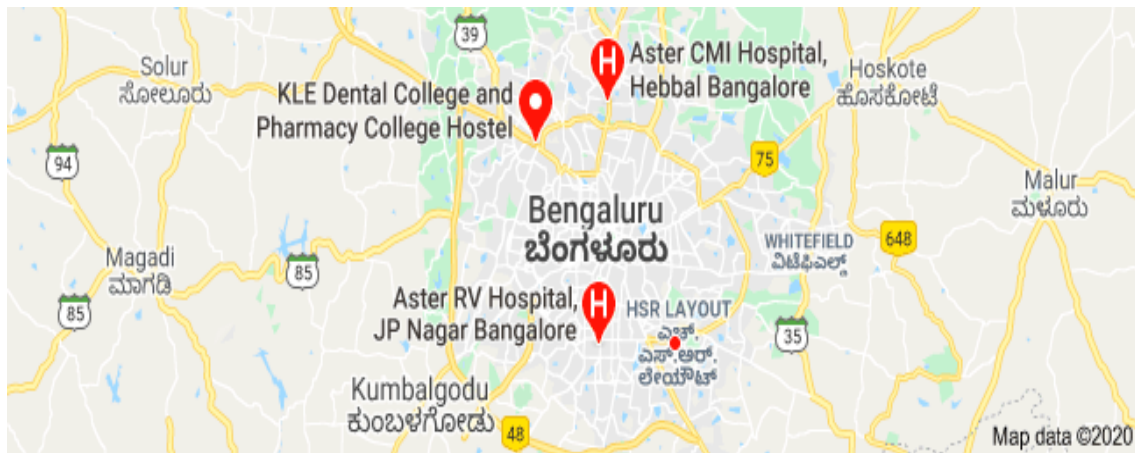
entered healthcare in 1986, with the establishment of a Hospital at Belagavi, Karnataka in South India. Today, the Society has more than 4,000 beds, making it one of the largest private-sector organizations providing healthcare in Karnataka.

The project site is near Yeshwantpur on Tumkur NH Highway Road (Figure 147)

Figure 146: Aster CMI Hospital - Bangalore¹⁷⁹



Figure 147: Aster KLE Hospital Planned Location Next to KLE Dental College¹⁸⁰



The new 600-bed hospital will be adjacent to the KLE Dental College and will be Aster's 15th hospital in India. Aster has planned the facility as a quaternary-care hospital with advanced medicine and other complex medical and surgical interventions. Each unit will include the latest

¹⁷⁹ Medifree

¹⁸⁰ Medicaldialogues.in

state-of-the-art medical technologies and equipment. The new hospital will cover the following medical specialties under its Centers of Excellence:

- Cancer Care.
- Cardiac Sciences.
- Neurosciences.
- Liver Care.
- Organ transplant.
- Orthopedics.
- Urology.
- Nephrology.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

Aster and KLE signed a Memorandum of Understanding and lease agreement in Bangalore on Sept. 24, 2019. While the plan was to complete the project by April 2024, the recent slowdown in its current hospitals' expected occupancy is likely to cause some delays. Further details on the project will be released shortly.

PROJECT COST AND FINANCING

The estimated project cost is \$57 million. KLE is providing the land for the project through a 25-year lease agreement. The project will be funded, executed and managed by Aster DM Healthcare.

U.S. EXPORT OPPORTUNITIES

The Aster KLE hospital is a greenfield project, offering U.S. companies opportunities to supply a range of capital medical goods, as India imports 75 percent of its medical equipment. The project also provides U.S. companies the prospect of long-term business relationships with a growing Indian hospital and medical services group.

Opportunities exist for U.S. companies to supply (and maintain) the following:


- High-technology equipment (e.g., cancer diagnostics, medical imaging including ultrasound, and polymerase chain analysis).
- Orthopedic surgical systems and prosthetic appliances.
- Orthodontic and dental implant equipment.
- Ophthalmic instruments and appliances.
- Operating theatre equipment and systems.
- Medical laboratory instrumentation.
- Laboratory/diagnostics facility design and equipment.
- Planning, design, engineering, and other services.
- Simulation laboratory training.
- Telemedicine architecture and training.

- Information and communications technology backbone.
- Patient monitoring and record-keeping systems.
- Effluent and medical waste treatment and disposal.
- Long-term maintenance and service contracts.
- Hardware and software training.
- Safety training, including fire.

Several American medical device and supply companies already use India as a manufacturing base, either by setting up their own facilities or acquiring domestic manufacturers. Examples include 3M, Becton Dickinson and Hollister.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
<p>Aster DM Healthcare Ltd 33rd floor , Tower D, Aspect Tower, Business Bay, PO Box 8703 Dubai United Arab Emirates Dr. Azad Moopen – Promoter, MD, ED chq@asterdmhealthcare.com www.asterdmhealthcare.com</p>	<p>Indo-Pacific Region 1101 Wilson Blvd. Suite 1100 Arlington, VA 22209 USA Ms. Tanvi Madhusudanan Country Manager tmadhusudanan@ustda.gov U.S. Trade and Development Agency U.S. Embassy in Delhi Shantipath Chanakyapuri, New Delhi Delhi 110021 India Ms. Mehnaz Ansari Senior Regional Representative, South Asia mansari@ustda.gov IndoPacific@ustda.gov www.ustda.gov</p>	<p>U.S. Commercial Service The American Center 24 Kasturba Gandhi Marg New Delhi 100 001 91-11-2347-2000 India Ms. Ruma Chatterjee Commercial Specialist ruma.chatterjee@trade.gov www.trade.gov</p>

Patna Medical College & Hospital Redevelopment		
	SECTOR	Healthcare
	SUBSECTOR	Hospitals
	LOCATION	Patna, Bihar, India
	PROJECT VALUE	\$790 Million

PROJECT SUMMARY

The State Government of Bihar plans to upgrade the 1700-bed Patna Medical College and Hospital (PMCH) to create a 5,462-bed state-of-the-art hospital with ultra-modern medical facilities. Additionally, the government will expand PMCH's Bachelor of Medicine and Bachelor of Surgery (MBBS) seating capacity from 150 to 250 seats, respectively, implementing the three-phase project over the next seven years. The project is budgeted to cost \$790 million, with the first, second and third phases budgeted at \$300 million, \$260 million and \$230 million, respectively. Once completed, PMCH will be the world's second and India's largest hospital in terms of bed capacity.

PROJECT DESCRIPTION

Healthcare has become one of India's largest sectors, both in terms of revenue and employment and is projected to reach \$372 billion by 2022. With the launch of Ayushman Bharat in 2018, India became the world's most extensively government-funded healthcare system. Soon, growth in healthcare services will place India among the top three fastest growing consumers of healthcare services in the world. Key components of the healthcare market in India include:

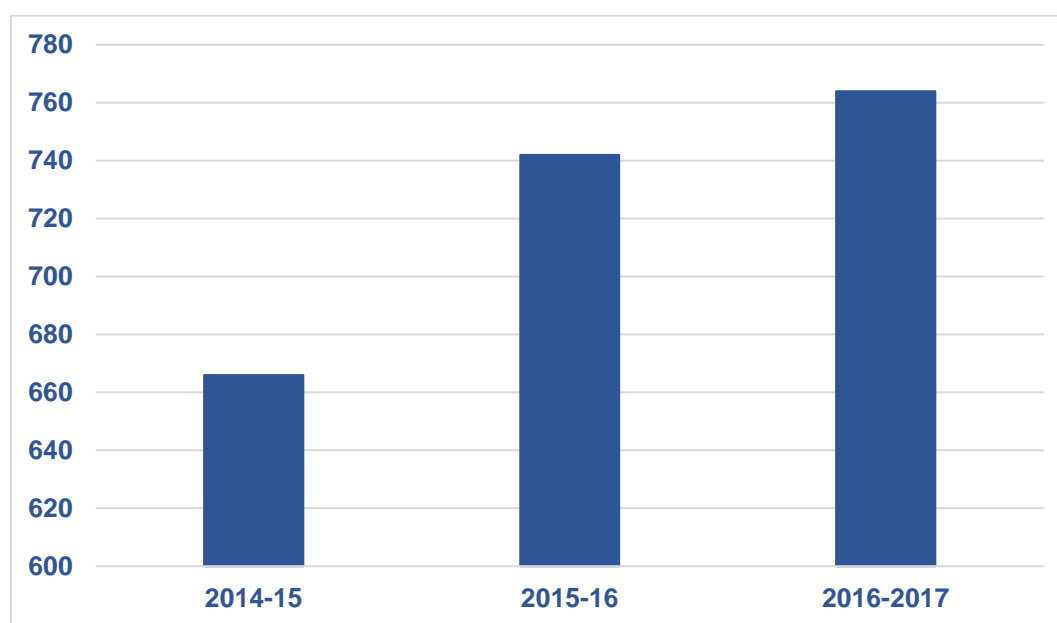
- Hospitals (government and private).
- Pharmaceuticals.
- Diagnostics (imaging and pathology).
- Medical equipment and supplies.
- Medical insurance.
- Telemedicine.

All Indian healthcare sectors expect to grow at double-digit rates. By 2020 to 2022, supporting industries will reach record levels. Diagnostics, medical devices and healthcare information technology will reach \$32, 20 and 1.5 billion, respectively. Driving the healthcare market is the hospital industry, expected to reach \$132 billion by 2022 from \$61.8 billion in 2017, a CAGR of 16.5 percent. Given its large population and relatively low cost, India's hospital industry has attracted massive domestic and foreign investments to fund basic medical care, healthcare

delivery and advanced technology, as well as to expand market reach in both urban and rural areas. In India, there is inadequate coverage of public healthcare institutions and services.

From a general investment standpoint, 100 percent Foreign Direct Investment (FDI) is allowed under the Automatic Route for any greenfield or brownfield hospital project. International investors can set up new hospitals with 100 percent foreign ownership without government pre-approval. U.S. investors have taken advantage of the enabling policies and growth outlook for hospitals, medical equipment, supplies and services to invest (Figure 148), deploying almost \$800 million in 2017/18.

Figure 148: U.S. Foreign Direct Investment (FDI) in Indian Hospitals, \$ Million¹⁸¹



Established in 1925, on 19 hectares of land, Patna Medical College and Hospital, originally known as Prince of Wales Medical College, is located in Patna, the state capital of Bihar, India. Patna is the oldest medical college and hospital in the state.

The Patna Redevelopment project envisions a large-scale expansion (Figure 149) to create a total of 5,462 beds versus PCMH's current capacity of 1,700 beds. When completed, PCMH will be second only to Chang Gung Memorial Hospital in Taiwan, whose capacity of 10,000 beds is the largest globally. Bachelor of Medicine/Bachelor of Surgery (MBBS) graduate student seating will be expanded from 150 to 250 seats, with PCMH medical school post-graduate seating expanding from 146 to 150 seats.

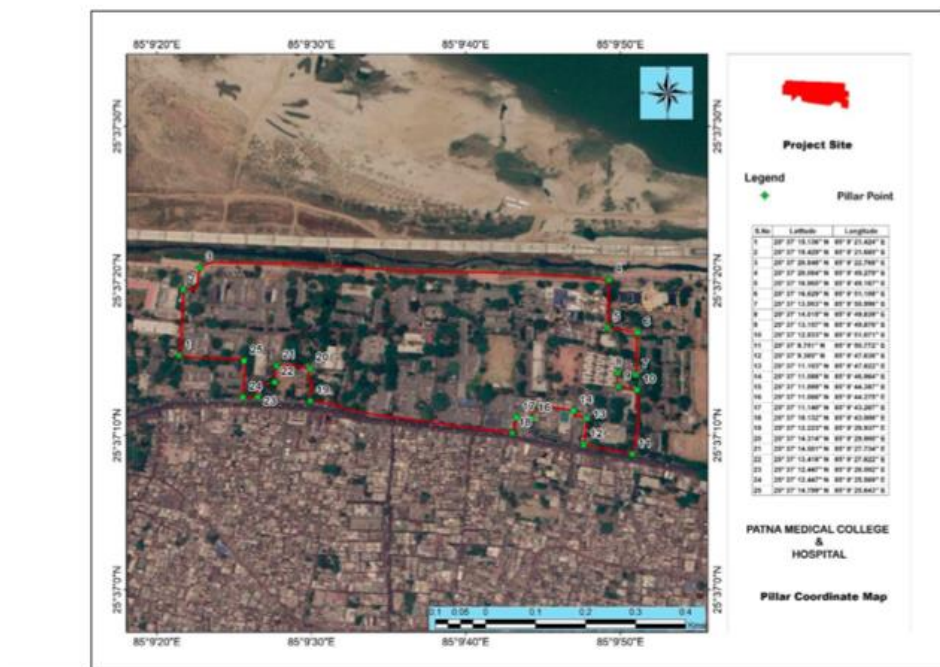
¹⁸¹ Department of Industrial Policy & Information, Government of India

Figure 149: PMCH Proposed Redevelopment Plan¹⁸²



The project site is well-connected and accessible (Figure 150), with a defined project area statement plan (Table 47).

Figure 150: PMCH Project Site¹⁸³



¹⁸² PMCH Release

¹⁸³ PMCH Environment Clearance Report

Table 47: PMCH Expansion – Area Statement Plan¹⁸⁴

S. No.	Particulars	Details
1	Land Area	195,867.9 m ² (19.58 hectares)
2	Built-up Area	Proposed Built-Up Area: 716,856 m ² Existing Built-Up Area: 158,696 m ²
3	Water Consumption	3,062 thousand liters per day
4	Power Requirement	27,360 KVA
5	Connectivity	Ashok Rajpath
6	Parking	193,370 m ²
7	Green Area	39,175 m ²

The completed hospital will host 29 wards, including a variety of medical specialties (Table 48).

Table 48: PMCH Expansion¹⁸⁵

Medical Specialty	Planned Beds
Orthopedics	702
Pediatrics	610
General and Pediatric Surgery	522
General Medicine	478
Obstetrics and Gynecology	462
Ophthalmology	240
Intensive Care Unit	217
Endocrinology	85
Nephrology	75
Neurology	75
Psychiatry	75
Urology	75
Cardiology	72
Gastroenterology	72
Neurosurgery	72
Organ Transplant	55
Plastic Surgery	50
Burn Unit	30

The first project phase will create 300 million square feet of the project's planned 720 million square feet. Phase 1 includes the following:

- Two hospital blocks.

¹⁸⁴ Ibid

¹⁸⁵ PMCH

- Hostels for nurses and support staff.
- Doctor residences.
- Central utility, including laundry.
- Blood bank.
- Patient-stay facilities.
- Multi-level parking.

Bihar Medical Services & Infrastructure Corporation (BMSIC) will develop additional facilities in the subsequent two phases. The facility will eventually have a 450-bed, low-income boarding facility, a separate power substation, and its own water treatment plant. Separate multi-story buildings will be created on the campus for doctor and medical staff residences. Plans also include “green” buildings with “fool proof” fire safety and medical gas pipelines.

BMSIC has invited bids to redevelop PMCH and for selection of the primary Engineering, Procurement, and Construction (EPC) contractor. The bid process will occur in three phases. The primary contractor will determine subsequent sub-contracting.

The scope of the initial tender for the EPC contract includes:

- Demolition of existing structures.
- Buildings for staff and faculty residence.
- Building hostels and auditoriums.
- Internal and external plumbing and sanitary works.
- Electrical works.
- Site development and boundary wall plus landscaping.
- Sewage treatment plant.
- Fire detection and suppression.
- CCTV.
- Medical and non-medical furniture.
- Computers and servers.
- Electrical and mechanical services.
- Management information systems (MIS).
- Supply of medical equipment and medical devices.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

The detailed project report (DPR) for the PMCH revamp was prepared by Delhi-based architecture consultants Suresh Goyal and Associates under the guidance of BMSIC. The project, executed under an EPC structure, will take seven years to complete.

Announced in May 2018, the government floated the tender for the \$790 million project in Sept. 2019. The state government asked two companies to submit financial bids, with Larsen & Toubro (L&T) being the lowest. However, the bid was higher than the tender committee's standard and, in March 2020, the tender evaluation committee asked L&T to justify its bid. The COVID-19 global

pandemic and the associated economic slowdown further delayed the process. This is a prestigious project for the state government and will be fast-tracked in the first quarter of 2021.

PROJECT COST AND FINANCING

The PMCH is owned by the state; hence the project will be funded by the government of Bihar. The estimated project cost is \$790 million, with the first, second and third phases requiring \$300 million, \$260 million, and \$230 million, respectively. The medical equipment component will cost approximately \$130 million.

U.S. EXPORT OPPORTUNITIES

Opportunities for U.S. firms in this project will be to supply equipment, know-how and services, including:

- Modular operating theaters.
- Medical laboratory instruments.
- Diagnostics facility design and equipment.
- Nurse call systems.
- Medical gas pipeline systems.
- Pneumatic tube systems for medication delivery.
- Central sterile services.
- Pneumatic waste systems.
- Laundry collection systems.

The budget for capital medical equipment, including cancer diagnostics, medical imaging, et al is approximately \$130 million. In addition, U.S. export opportunities exist for high technology consumables and associated specialized equipment such as orthopedic and prosthetic appliances, orthodontic and dental implants, and ophthalmic products.


Additional opportunities related to hospital operations will also exist. These may include:

- Hardware and software training, including simulation laboratory training.
- Telemedicine architecture and training.
- Information and communications backbone.
- Patient monitoring and record-keeping systems.
- Effluent and medical waste treatment and disposal.
- Long-term maintenance and service contracts.
- Safety training, including fire.

Several American medical device and equipment companies are already using India as a manufacturing base by either setting up facilities or acquiring domestic manufacturers. These include 3M, Becton Dickinson and Hollister.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
<p>Bihar Medical Services & Infrastructure Corp. Ltd. 4th Floor, BSBCCCL Building Hospital Rd, Shastri Nagar Patna, Bihar India Mr. Ramanand Mahato Chief GM Projects +91 9471009108</p> <p>Mr. Sanjaya Kumar Singh MD IAS Managing Director md.bmsicl-bih@nic.in +91 612 2283287</p> <p>http://bmsicl.gov.in</p>	<p>Indo-Pacific Region 1101 Wilson Blvd. Suite 1100 Arlington, VA 22209 USA Ms. Tanvi Madhusudanan Country Manager tmadhusudanan@ustda.gov</p> <p>U.S. Trade and Development Agency U.S. Embassy in Delhi Shantipath Chanakyapuri, New Delhi Delhi 110021 India Ms. Mehnaz Ansari Senior Regional Representative, South Asia mansari@ustda.gov</p> <p>IndoPacific@ustda.gov www.ustda.gov</p>	<p>U.S. Commercial Service The American Center 24 Kasturba Gandhi Marg New Delhi 100 001 India</p> <p>Ms. Ruma Chatterjee Commercial Specialist Ruma.Chatterjee@trade.gov</p> <p>www.trade.gov</p>

Private Hospitals - Sabah and Sarawak		
	SECTOR	Healthcare
	SUBSECTOR	Hospitals
	LOCATION	Sabah and Sarawak, Malaysia
	PROJECT VALUE	\$50-90 Million per Project

PROJECT SUMMARY

The States of Sabah and Sarawak are simultaneously medically underserved and seeking to expand their medical tourism industries. Both desire to attract new private hospitals to serve the local population with specialty medical care and create a desired medical tourism destination.

PROJECT DESCRIPTION

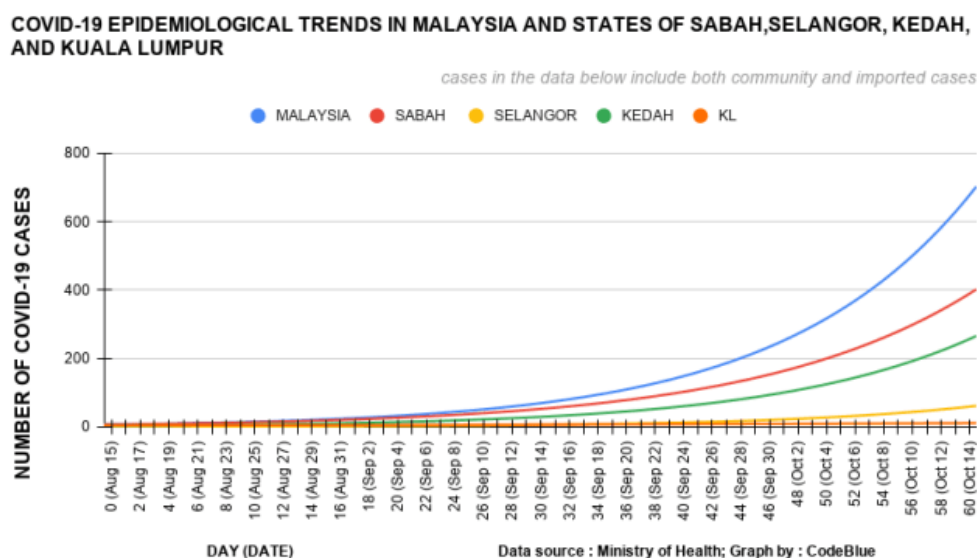
The Malaysian government recently announced allocations of \$385 million to construct new hospitals and upgrade hospitals in Klang, Kampar, Labuan (Sarawak), and Kota Kinabalu (Sabah). While these funds are targeted primarily at public hospitals, the states of Sabah and Sarawak are proactively seeking to attract new private hospitals, as well.

New specialist hospitals capable of providing disease, trauma, reconstructive medical, and surgical services are needed to treat residents. The COVID-19 global pandemic has hit the State of Sabah worse than any other region in Malaysia (Figure 151), intensifying the need for hospital service expansion. A serious polio outbreak in January 2020 further highlighted the vulnerability of Sabah's public healthcare system.

Before the pandemic, there was one doctor to every 500 Malaysians countrywide, while Sabah's ratio was one doctor to 900 residents. The specialty requirements of treating COVID-19 patients have further stressed an already services-limited public hospital system in Sabah and Sarawak. Private hospitals take up some slack for certain patient populations.

Pre-pandemic, steady growth in healthcare spending was in place in Malaysia, with a 7.8 percent increase in 2018-2019, as the former Government hoped to meet the WHO recommended 7 percent of GDP spent on healthcare. In the most heavily populated Malaysian state of Selangor, State Government, through Selangor State Development Corporation's (PKNS's) wholly-owned subsidiary, Selgate Corporation, plans to build five hospitals in five years as an alternative to public hospitals to ease congestion. While numerous private hospitals already exist in Selangor, historically, middle and lower-income groups have opted for lower-cost government hospitals. This model is already in practice in states such as Johor and Melaka through Government-owned private arms and may be used in Sabah and Sarawak, as well.

Figure 151: COVID-19 Epidemiological Trends in the Malaysian States



In the fully-private hospital sector, typically, more luxurious facilities and a different slate of services are preferred, particularly for medical tourists. For example, Sabah seeks to emulate South Korea by offering medical aesthetics and plastic surgery services to its existing tourist base, including Korean and Chinese visitors. Prior to the COVID-19 global pandemic, Sarawak served approximately 45,000 medical tourists annually, with most from Indonesia and a smaller number from China.

In 2017, Malaysia had:

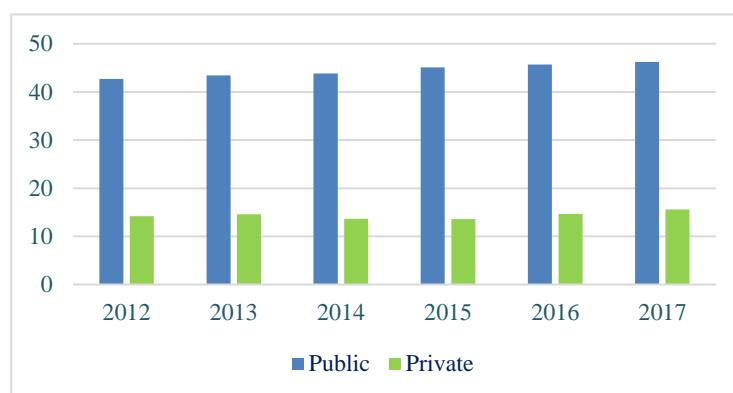
- 200 private hospitals with roughly 15,000 beds (Figure 2),
- 16 maternity homes (50 beds)
- 22 nursing homes (700 beds)
- Two residential hospice centers (17 beds)
- 100 ambulatory care centers (186 beds)
- Four blood banks (25 banks/tanks)
- 450 hemodialysis centers (4,843 dialysis chairs)
- One community mental health center, and
- One combined ambulatory care and hemodialysis center (14 beds/21 dialysis chairs).

There are also 7,571 registered private medical clinics and 2,137 private dental clinics in the country.

While private hospital outpatient attendance has been less than 10 percent of overall outpatient care provided in-country, private hospitals accounted for 42 percent of total hospital admissions (Figure 152). Approximately 27 percent of doctors are in private practice. Private specialist services are widely available in peninsular Malaysia but limited in Sabah and Sarawak.

As discretionary incomes rise, demand for private healthcare services typically increases as well. As Sabah and Sarawak both focus on industrialization and attracting more tourism, both states expect demand for quality specialist healthcare to grow rapidly. Similarly, medical tourism typically attracts affluent travelers. Medical aesthetics and executive health screening have proven popular services for Malaysian private healthcare consumers and medical tourists.

Figure 152: Hospital Beds (Thousands) in Malaysia, 2017¹⁸⁶



In Sarawak, 11 private hospitals currently operate, with another six under development. The state hosted roughly 45,000 medical tourists in 2018, primarily from Indonesia and secondarily from China. While known for eco-tourism, Sabah has had more difficulty attracting medical tourists due to transportation challenges, but the area is building a new airport and runway. While the COVID-19 global pandemic has sharply curtailed medical tourism during 2020, the state governments of Sabah and Sarawak expect growth to continue once regional and international travel resumes.

KPJ Healthcare Berhad (KPJ) is the largest builder and operator of private hospitals in Malaysia, with 25 private hospitals in the country and sites in Indonesia, Thailand, and Bangladesh, and aged care facilities in both Malaysia and Australia. KPJ operates a specialist hospital in Kota Kinabalu (Sabah) and three in Sarawak. The Kota Kinabalu facility (Figure 153) has been proactively marketing to the medical tourism market.

Project opportunities exist for foreign development of private hospitals, as there are no restrictions on foreign ownership. Alternatively, a joint venture or other working relationship with a Malaysian developer or owner/operator is possible. There is a considerable history of U.S. companies participating in this sector in Malaysia (Table 49).

¹⁸⁶ Statista

Figure 153: Medical Tourism: Sabah¹⁸⁷



Table 49: U.S. Company Participation Examples – Malaysian Hospitals

Company	Affiliation	History
Columbia Asia	Originally owned by Seattle-based Columbia Pacific Management	Entered Asia in 1996. Sold 17 Southeast Asian hospitals (13 in Malaysia) to a joint venture between Malaysian-based Hong Leong Group and U.S. alternative investment firm, TPG. The transaction occurred in Sep 2019 for \$1.2 billion. Columbia's aggressive expansion strategy across Asia continues post-sale.
Regen Rehabilitation Hospital	60% owned by Khazanah (Malaysia sovereign fund)) and 40% held by NYSE-listed Select Medical Holdings Corp.	Built in 2018.

For capital medical equipment, the growth of current facilities and outfitting new hospitals offer opportunities both for the private sector and for Malaysian government-private hospital corporation developments. Surgical robotic systems are specifically desirable.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

Private hospital development in Malaysia typically follows a build-operate-transfer (BOT) model with a two-to-four-year timeline for the build, including site selection, site preparation, construction of the building, and outfitting medical and surgical suites, patient rooms and hospital administration/patient record keeping infrastructure. Once a hospital is commissioned, the builder

¹⁸⁷ KPJ and Sabah Economic Development Authority

typically operates the facility until positive cash flow is reached and then sells the hospital to a real estate investment trust (REIT). Typically, the builder retains an interest in the REIT and a facility management contract.

PROJECT COST AND FINANCING

For those interested in participating in developing new private hospital properties, project cost and financing will vary depending on the medical specialization and scale (measured by the number of beds) of the project. Typical private hospital construction costs in Malaysia range from about \$25 to \$90 million, with the upper end of the range representing highly specialized facilities appropriate for medical tourism. A typical specialist hospital requires an investment of at least \$50 million. Financing is typically 30 percent equity with 70 percent debt from local banks, though funding from other sources is possible.

KPJ, for example, manages the land acquisition and builds a portion of its projects directly, and ultimately sells to a REIT under a build-operate-transfer (BOT) model once the project is cash-flow positive. Upon sale, KPJ reportedly takes the deal valuation as 50 percent cash and 50 percent investment in the unit trust, as well as retaining facility management.

The KPJ business model is quite similar to hotel and resort development models. Like private hospitals, hotel and resort development is also open to foreign investors in Malaysia. This business model creates an opportunity to expand medical tourism hospital projects to include luxury accommodations for patient recovery and rehabilitation and temporary housing of patient families either in a single complex or in paired facilities.

For suppliers of capital medical equipment, options exist to supply fully-private sector and government-private corporation specialist hospitals as they expand their scale and portfolio of services. The focus for 2021-2023 will be on tertiary care medical equipment infrastructure.

U.S. EXPORT OPPORTUNITIES

Two groups of U.S. export opportunities are available for new private hospital construction in Sabah and Sarawak:

Facility Development and Management (Private Sector Hospitals)

- Architectural and design services
- Engineering, procurement, and construction services
- Facility management
- Marketing and branding services

Capital Medical Equipment (Private Sector and Government Private Corporation Hospitals)

- Medical imaging/radiology equipment (x-ray, MRI, CT, ultrasound, PET, endoscope, nuclear, workstations)
- Patient monitoring and digital record keeping

- Hospital beds/stretchers
- Intensive care/neonatal intensive care equipment
- Surgical suite/operating room equipment
- Medical and surgical robotics systems
- Cardiovascular, cardiology, and defibrillation equipment
- Intravenous therapy systems/dialysis
- Medical gas equipment
- Compressors, pumps, autoclaves, suction devices
- Refrigeration

CONTACTS

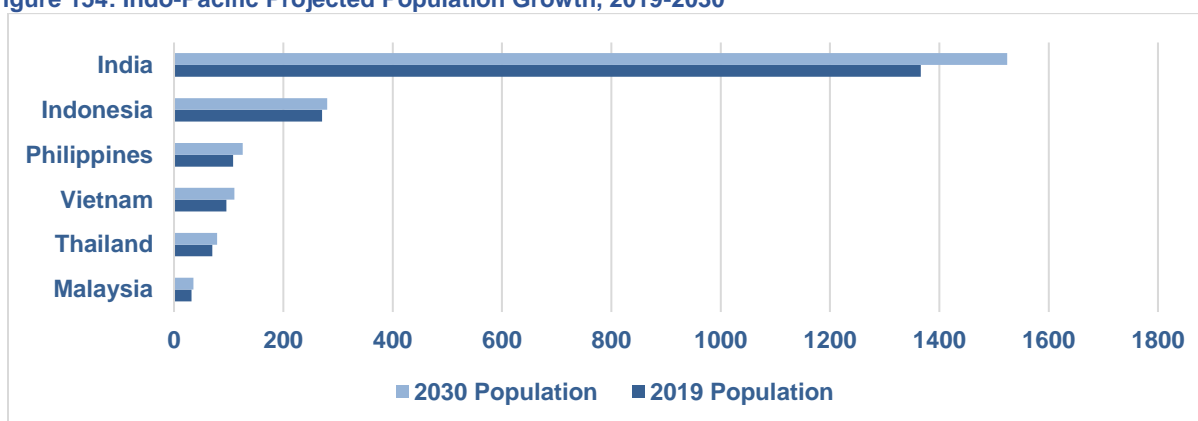
Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
<p>Sabah Economic Development and Investment Authority Lot 1 Wisma SEDIA Off Jalan Pintas Penampang 88300 Kota Kinabalu, Sabah Malaysia Ms. Karen Qyrstine Mijin karenqyrstine.seda@gmail.com</p>	<p>Indo-Pacific Region 1101 Wilson Blvd., Suite 1100 Arlington, VA 22209 USA</p> <p>Ms. Alissa Lee Senior Country Manager alee@ustda.gov GPF Witthayu Tower A, Suite 302 93/1 Wireless Road Bangkok, 10330 Thailand</p> <p>Mr. Brandon Megorden Regional Manager for Asia bmegorden@ustda.gov IndoPacific@ustda.gov www.ustda.gov</p>	<p>Mr. Dennis Simmons Senior Commercial Officer U.S. Embassy Kuala Lumpur 376 Jalan Tun Razak 50400 Kuala Lumpur Malaysia Phone: 60-3-2168-5000 dennis.simmons@trade.gov</p>

6 AGRIBUSINESS AND WATER

Sector Overview

Agribusiness and Water are critical sectors as the Indo-Pacific region faces population growth, food and fresh water security issues and climate change. Over the period 2019 to 2030, the overall population in the six countries covered in this Resource Guide will increase by nearly one billion (Figure 154). The expanded Indo-Pacific population will require additional food and water access; in water, both potable and to meet the increased demand of other water-consuming activities, including irrigation, sewerage and industry.

Figure 154: Indo-Pacific Projected Population Growth, 2019-2030¹⁸⁸



Agriculture contributes between seven and 16 percent of GDP for the countries profiled. Owing to both favorable growing climate and level of industrial development, all of the Resource Guide countries rely more heavily on agricultural activities as a contributor to GDP than the World or OECD averages (Figure 155).

Principal crops in the Indo-Pacific Region include palm oil, rice, rubber, sugarcane, coffee, tea and spices (Table 50), all of which enjoy sizeable export markets. A wide variety of other cereals, fruits and vegetables, such as corn, wheat, cassava, coconuts and bananas, are grown for both domestic consumption and export.

Agriculture accounts for about 70 percent of freshwater use globally (Figure 156), with the Indo-Pacific region tracking at somewhat higher levels (up to 80 percent). The consumption of water across the Resource Guide countries varies widely (Figure 157). On a per-capita basis, Malaysia, Vietnam and Thailand consume roughly two-thirds of India's level, with the Philippines and Indonesia at 90 to 95 percent of India.

¹⁸⁸ World Bank plus Consultant estimate

Figure 155: Contribution of Agriculture, Forestry and Fishing to GDP, 2019 (Percent)¹⁸⁹

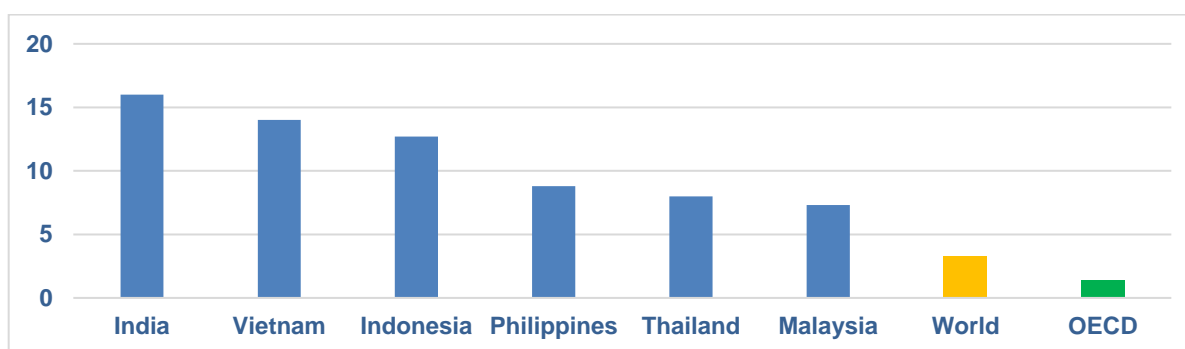


Table 50: Indo-Pacific Region Principal Crops

Country	Principal Crops
India	Rice Wheat Cotton Corn Millet Coffee and Tea Rubber
Indonesia	Palm Oil Rice Corn Rubber Cocoa Coffee, Tea and Spices
Malaysia	Palm Oil Rice Cocoa Logging
Philippines	Sugarcane Palay/Rice Coconut Banana Calamansi (Philippine lime/lemon)
Thailand	Rice Rubber Corn Cassava Palm Oil Sugarcane
Vietnam	Rice Cassava Maize (Corn) Sweet Potatoes

¹⁸⁹ World Bank

Figure 156: Uses of Freshwater by Geographic Region, 2014¹⁹⁰

Share of freshwater withdrawals by sector (%) in 2014

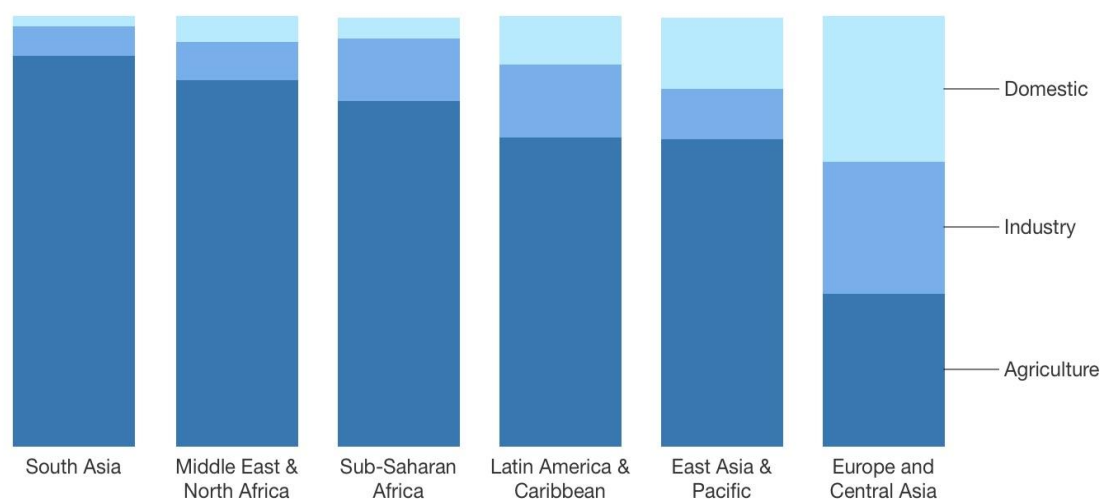
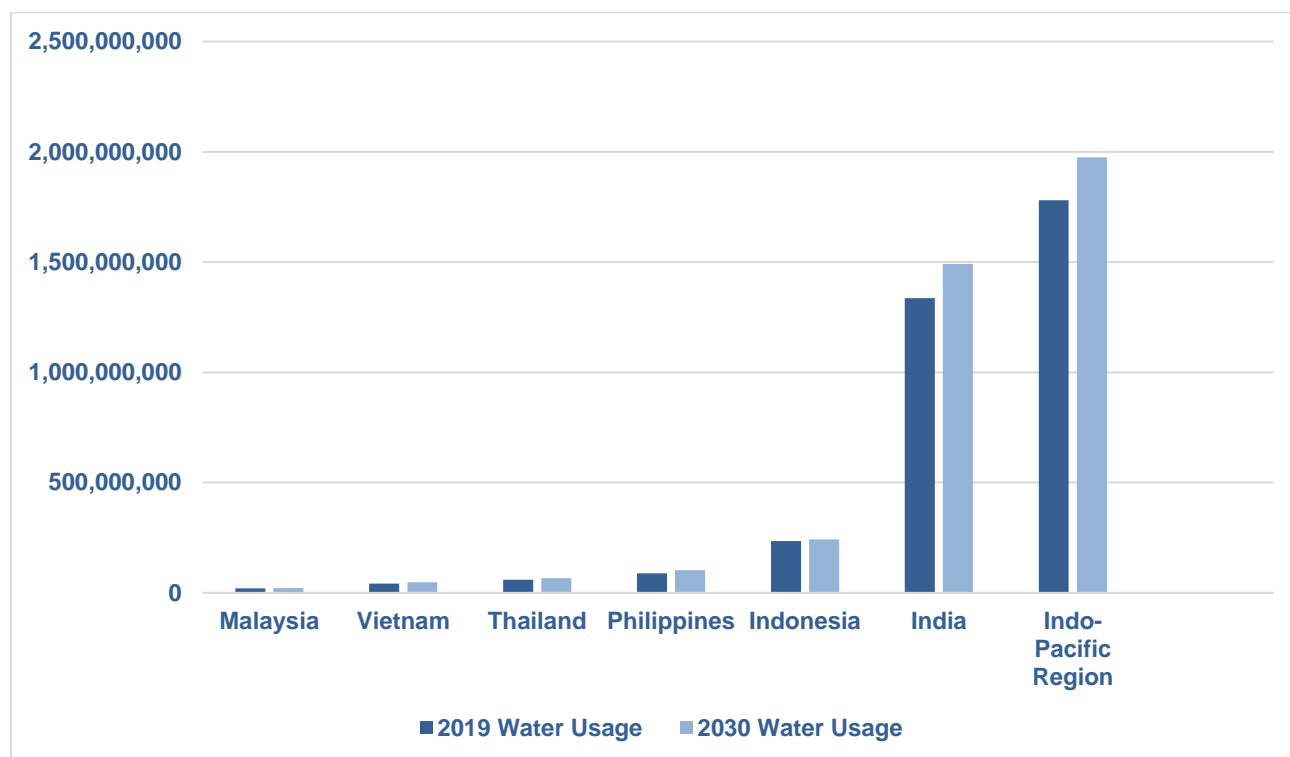


Figure 157: Indo-Pacific Water Consumption, 2019-2030 (Million Liters)¹⁹¹



¹⁹⁰ Ibid, most recently available.

¹⁹¹ World Bank and Worldometers plus Consultant estimate.

Agribusiness

Agribusiness comprises three large and diverse sectors (Table 51):

Table 51: Agribusiness Sectors and Subsectors

Sector	Subsectors
Agricultural Inputs	Animal feeds Seeds and traits/crop science Fertilizers Agricultural chemicals Machinery – conventional Equipment and systems– emerging technologies (e.g., sensors, drones, GPS, data analytics, et al)
Agricultural Production	Farming/orcharding/vertical farming Ranching/breeding Composting Farm cooperatives Carbon credits Biofuels Agritourism Commodities exchanges
Agricultural Processing and Manufacturing	Milling Food processing High tech foods (e.g., meat substitutes, 3D printing) Food storage Cold storage/cold chain Logistics Packaging including “smart” packaging Quality and security management

Agribusiness in the Indo-Pacific region offers considerable potential to achieve broad-based economic transformation and contribute materially to better managing both the regional and global environment. The broadly defined regional industry hosts a complex web of inter-related challenges, including:

- Low productivity.
- A weak value chain center (production) surrounded by strong and increasingly concentrated input and processing sectors.
- Logistical lack of access to some markets.

- Within the agricultural production sector, a large skew of capabilities between smallholder, low acreage sites and large landholding, technically-sophisticated “factory farms.”

Farming practices vary across the Indo-Pacific region, as do the nature and number of smallholders versus large commercial farms. In India, for example, in 2018, only 13 percent of agricultural households had landholdings greater than two hectares. Fewer than 5.2 percent owned a tractor and 1.8 percent a power tiller. Irrigation was limited to between 0.8 and 1.6 percent. In Indonesia and Malaysia, while rice is frequently smallholder farmed, a mix of smallholders, agricultural cooperatives and integrated plantation/extraction conglomerates (who are large employers) populate the palm oil business. The two countries are the largest palm oil exporters globally, with Thailand a distant third. In Vietnam, rice occupies 94 percent of arable land. A split model of smallholder farmers primarily supplying domestic demand leaves large modern commercial farms to provide high-quality rice to the export market.

The use of new technologies is vital to remain competitive in the agribusiness sector. Farmers continually seek to reduce crop costs and increase yields per square acre/hectare to stay competitive. For example, there is strong interest in crop science-derived seed/trait and agricultural chemical combinations, organic farming solutions and Smart Farming (Figure 158). Smart Farming applies Information and Communication Technologies (ICT) to reduce labor, more accurately track and monitor the growing process (including water consumption) and manage the business of farming. In the processing sector, opportunities for improved food storage, including the cold chain, logistics and supply chain tracking and management capabilities, are increasingly important to optimize domestic- and export-related activities. Providing Agribusiness solutions to the Indo-Pacific region presents a sizeable opportunity for U.S. technology holders, several of whom are already present.

Figure 158: Smart Farming in Action¹⁹²



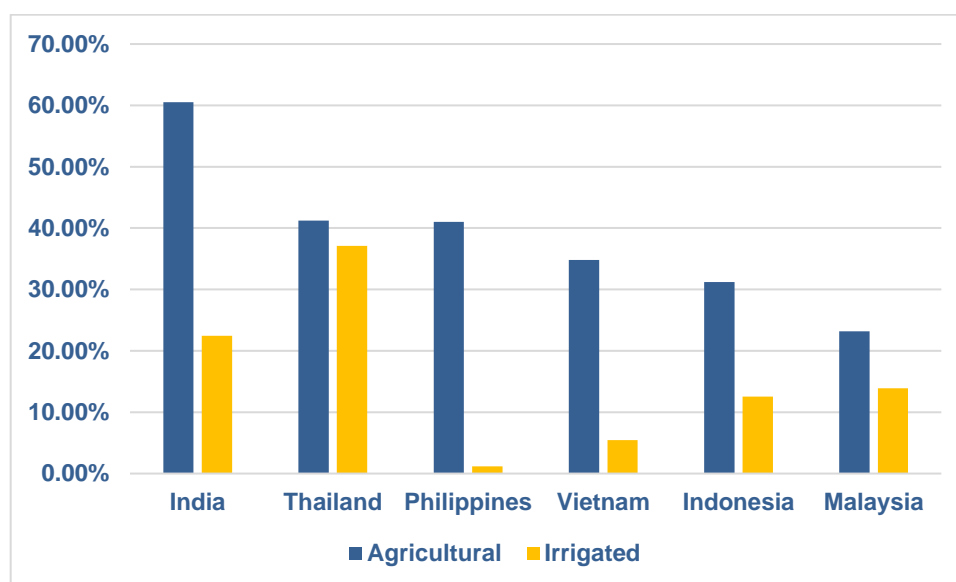
This Resource Guide features one agribusiness project profile. It serves as a model of a hybrid public/private approach to agricultural production under consideration by several of the Resource Guide countries.

¹⁹² FullDronesolutions.com

Water

Water management in agriculture in the Indo-Pacific region is critical to domestic food security and maintenance of important export markets. Asia, in total, represents 70 percent of the global irrigated area, which, in turn, represents roughly 80 percent of the continent's freshwater demand.¹⁹³ In the Indo-Pacific region, agricultural and irrigated land dedication varies widely, with India dedicating the most agricultural and arable land on a percentage basis (Figure 159). India and Thailand currently support the highest levels of irrigation on a percentage of land coverage.

Figure 159: Indo-Pacific Region Agricultural, Arable and Irrigated Land (Percent)¹⁹⁴



The region faces several challenges to irrigation, some of which offer opportunities for U.S. companies with relevant technology and service offerings:

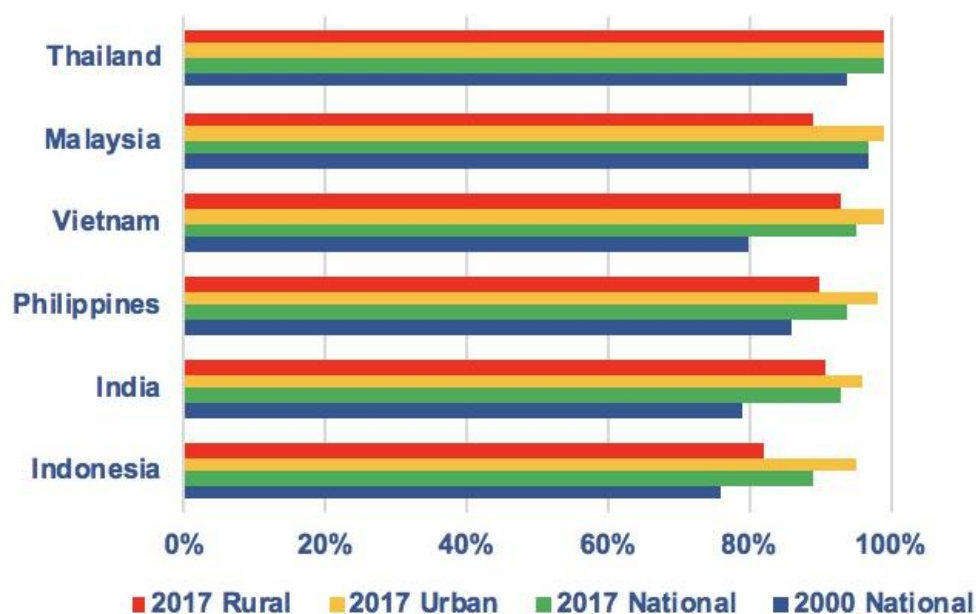
- Outdated systems.
- Lack of water accounting and productivity assessment.
- Fragmented interventions, including addressing water-energy linkages in isolation rather than holistically.
- Weak governance in capacity building/infrastructure development.
- Matching pricing policies to avoid undermining investment economics.

Beyond agriculture, water access is also critical to other areas of economic development and human wellbeing. The Resource Guide countries all provide basic drinking water service to at least 95 percent of their urban populations (Figure 160). Thailand services both urban and rural populations at a 99+ percent level. India, Indonesia and the Philippines continue to work to improve drinking water access for both urban and rural residents. This Resource Guide reviews two such efforts.

¹⁹³ Asian Development Bank

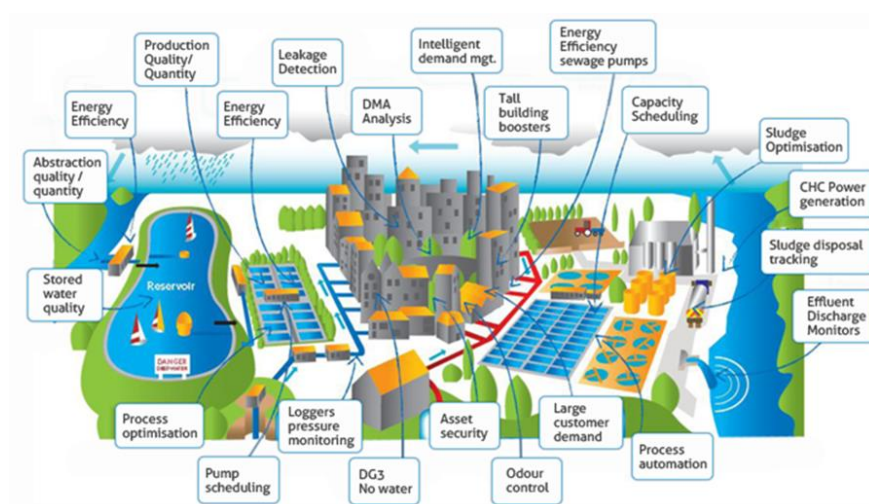
¹⁹⁴ CIA World Factbook

Figure 160: Indo-Pacific Region Availability of Basic Drinking Water, 2000-2017¹⁹⁵



With continued regional population growth and migration to cities, numerous smart city development programs include applying technology to manage scarce water and sewer resources to support growing demand. Smart city development frequently features a Smart Water Network (Figure 161) to better anticipate and react to issues including water leak detection, quality, theft, conservation, weather and disaster impacts on the water system, consumption tracking and sewage and water treatment activities. Comprising four layers (Table 52), Smart Water Networks represent an opportunity for U.S. suppliers with the requisite technologies.

Figure 161: Example Smart Water Network¹⁹⁶



¹⁹⁵ WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene


¹⁹⁶ Aquamatrix.net

Table 52: Smart Water Network Layers and Componentry

Smart Water Network Layer	Components
Physical	Pipes, pumps, valves, reservoirs, delivery endpoint infrastructure, chemicals
Sensing and Control	Flow, pressure, water quality, reservoir level, water temperature, acoustic information sensors and associated equipment
Collection and Control	Fixed cable networks, radio, cellular and Wi-Fi communications systems
Data Management and Display	SCADA (Supervisory Control and Data Acquisition) and GIS (Geographic Information System) systems, network visualization tools and water balance applications

Summary

The Agribusiness and Water sector in the Indo-Pacific region is an attractive opportunity for U.S. interests. Country governments are proactively responding to the demographic changes driving growth by supporting and developing improved infrastructure in both sub-segments. The region is already an importer of the latest technologies, some originating in the United States, though considerable growth opportunities remain.

Jalandhar Bulk Water Supply		
	SECTOR	Water and Environment
	SUBSECTOR	Water Supply and Control
	LOCATION	Jalandhar, Punjab
	PROJECT VALUE	\$175.3 Million (Phase One)

PROJECT SUMMARY

The Jalandhar Bulk Water Supply project will provide safe and sustainable treated surface water to meet drinking water needs in three major cities (Amritsar, Ludhiana and Jalandhar) in the state of Punjab. The three cities currently obtain supply from groundwater via tube wells. Significant depletion of groundwater in Jalandhar and adjacent Punjab towns is creating challenges in meeting drinking water needs. The project will integrate treated surface water into the existing drinking water supply system.

The project will be executed in two Phases:

- **Phase One Focus:** daily water supply demand for 100 percent of the projected population in the targeted towns by the year 2036 -- or 275 MLD (minimum liquid discharge)/113 cusecs (cubic foot per second) for 13.87 million people.
- **Phase Two Focus:** daily water supply demand for 100 percent of the projected population in the targeted towns in the year 2051 -- or 365 MLD/149 cusecs for 18.39 million people.

Phase One is estimated to cost \$175.3 million and will be funded via a public-private partnership (PPP), employing a hybrid annuity model (HAM). This phase will have World Bank (WB) and Asian Development Bank (ADB) financing. Phase One estimated completion is 24 months, including a three month trial run.

PROJECT DESCRIPTION

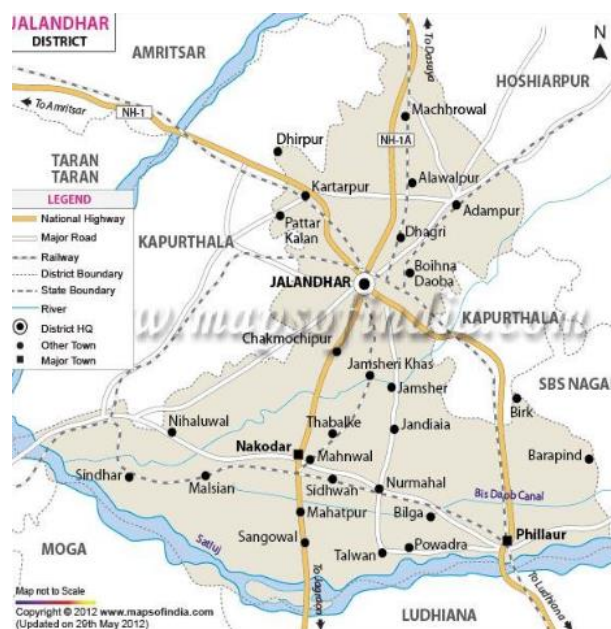
Rapid improvements are being made in increasing India's drinking water supply and sanitation. The National Urban Drinking Water and Sanitation Programs, the Swachh Bharat Mission (SBM) and the National Rural Drinking Water Programs (NRDWP) have all been launched to provide safe and continuously available drinking water in open-defecation-free (ODF) districts.

Punjab has an extensive urban water supply, sewage, and sewage treatment network in place. About 85 percent of the urban population receives a basic water service at a level of 135 liters per

capita per day (LPCD) through public water supply schemes. Upon project commissioning, coverage will increase to 97 percent of the urban population.

Jalandhar (Figure 162) is the third-largest city in the State of Punjab. Jalandhar obtains 100 percent of its water from groundwater extraction via tube wells operated by the Municipal Corporation of Jalandhar (MCJ) and other organizations, including private owners. The rate of groundwater depletion increases every year, with the situation worsening as the city grows and develops. According to a report by the Central Ground Water Board, the water table has declined 25 meters in the past 25 years, representing an average depletion rate of one meter per year. Moreover, the water quality obtained from the tube wells is deteriorating, with high percentages of fluoride, heavy metals and uranium being found in the water. As a result, operation and maintenance (O&M) costs for the 520 tube wells in place are dramatically increasing.

Figure 162: Map of Jalandhar¹⁹⁷



The Jalandhar project plans to use treated surface water from available surface water sources (i.e., river basins) and integrate the treated surface water into the existing regional drinking water supply system (Figure 163). While reducing the use of groundwater, regional drinking water needs can still be met. The Punjab Water Supply & Sewerage Board (PWSSB), in association with the Punjab Municipal Infrastructure Development Company (PMIDC), will be responsible for the development of the project, which includes construction of a water treatment plant in Jalandhar with a capacity of 275 million liters/day (MLD). The project will be structured as a public-private partnership (PPP), employing a hybrid annuity model. The Punjab Water Supply & Sewerage Board (PWSSB) will be the principal executing agency and bidding authority for the project. PMIDC will be responsible for making payments to the concessionaire.

¹⁹⁷ Punjab Water Supply & Sewerage Board

Figure 163: Jalandhar Irrigation Canal¹⁹⁸



The project objectives, as presented by the PMIDC and the PWSSB, include:

- Supply potable water to the citizens by shifting the source of water from groundwater to surface water.
- Treat raw water at the planned water treatment plant (WTP) such that quality water meets Indian Standard (IS) 10500, along with the latest amendments.
- Reduce dependence on groundwater.
- Implement viable technologies and international best practices to develop, operate, and maintain the WTP and other facilities.
- Invite large scale private sector participation.

Features of the project include:

- The PWSSB will provide the required site to the concessionaire to develop the facilities and implement the project.
- The concessionaire will be required to design, finance, construct and complete the facilities.
- The PWSSB will facilitate the allocation of the raw water from the Jalandhar Irrigation Canal to the concessionaire.
- The concessionaire will operate and maintain the facilities from the commercial operation date through the O&M contract period's expiration.

Phase One requires the construction and installation of a 275 MLD WTP, raw water intake, raw water pump house and rising main, storage and sedimentation tank and a clear water reservoir (CWR). From a management standpoint, this Phase also includes the design, testing, commissioning, operating and maintaining of the relevant facilities and systems for a period of 10-years.

The specific scope of work and services includes the following:

¹⁹⁸ Ibid

- Detailed topographic surveys and geotechnical investigations of the project sites, including mapping all assets.
- Identifying and applying for all necessary permissions and permits for the project's design, construction and operation.
- Collecting raw water quality data and conducting water quality tests at intake locations before designing the system.
- Designing the water treatment plant and associated works, including hydraulic, structural, electrical, instrumentation, mechanical and piping process.
- Designing the SCADA system.
- Preparing and submitting detailed project reports for all civil, mechanical, electrical, structural and architectural elements. Submission of design and operation manuals, and health and individual system components guidelines.
- Conducting environmental impact assessments and preparing and implementing an environmental management plan during construction and operation.
- Constructing the water supply system and associated works, both onsite and offsites.
- Testing and commissioning of individual components and the overall water treatment facility system to meet the design requirements.
- Operating and maintaining all assets constructed under the contract for 10 years after successful testing and commissioning, including recruiting and training personnel.
- Preparing and enacting a Disaster Management Plan, including an emergency response plan for unforeseen events, e.g., the presence of pollution at any intake location.
- Establishing an operational Project Office adequately staffed to manage all project phases (design, construction, and operation).

Facility, equipment and infrastructure project elements include the following:

- **Withdrawal of water:** design and construction of intake point, including gates at Jagrawan village to transfer raw water from Jalandhar Irrigation Canal to WTP site with 275 MLD capacity.
- **Storage and sedimentation tank:** design and construction of four reinforced cement concrete (RCC) storage and sedimentation tanks (206.250 cubic meters each) capable of holding three days of water demand during maintenance/closure of the Jalandhar Irrigation Canal.
- **Raw water pumping machinery and other accessories:** design and provision of raw water pumping machinery, including all necessary electrical and other installation works, design and construction of raw water pumping main, valves and specials, valve chambers, supporting structures, and anchor/thrust blocks.
- **Water Treatment Plant:** design and construction of a complete WTP, with an output capacity of 275 MLD and the provisions for aeration and rapid mixing for coagulation.
- **Clearwater underground service reservoir:** construction of RCC underground clear water reservoirs (2 x 34,500 cubic meters) in Jagrawan village.
- **SCADA system:** installation, synchronization, testing, and commissioning of a SCADA system for flow control and monitoring between raw water intakes.
- Construction of overhead service reservoir.
- Land development and gated security wall of 1.8 m height.
- O&M of all components for 10 years from the date of commissioning.

Estimated quantities of major components include:

- **Construction of storage and sedimentation tanks:** four tanks, with a capacity of 206,250 cubic meters each.
- **Construction of WTP:** capacity of 275 MLD in Jagrawan village.
- **Two clearwater tanks in Jagrawan village:** capacity of 34,500 cubic meters each.
- **Installation of the SCADA system:** at the waterworks site.
- **Operation and Maintenance:** of all components proposed under this project for ten years.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

The PWSSB will implement this project through a concessionaire arrangement. PWSSB has prepared the detailed project report. Detailed feasibility reports for financial and technical considerations were prepared in Dec. 2019 to enable bidding. The work period is 24 months, including a three-month trial run, plus O&M for 10 years. Larsen & Toubro Construction was awarded the contract for Phase One in Sept. 2020.

The PPP partner (L&T) will subcontract for various components of design, equipment supply, construction and engineering services, technology partners and O&M to relevant domestic and international vendors over the next 24 months.

PROJECT COST AND FINANCING

Phase One will cost \$175.3 million. PWSSB expects to obtain financing for the project from the World (WB) and Asian Development (ADB) Banks. Currently, the Government of Punjab (GoP) through the Government of India (GoI) is negotiating a loan under a Multi-tranche Financing Facility (MFF) with the Asian Development Bank (ADB) for the proposed Punjab Urban Infrastructure Improvement Program (PUIIP). Bulk surface water supply in Jalandhar is one of the proposed subprojects under the PUIIP.

PWSSB recently awarded the project to L&T Construction and expects completion by 2023. The greenfield project is to be carried out on a PPP - Hybrid/DBOT (Annuity) basis.

U.S. EXPORT OPPORTUNITIES


The project is a greenfield project, with opportunities for U.S. companies to collaborate with the PPP partner, including:

- Design of the entire water supply system.
- Construction contracts including:
 - Sedimentation tanks.
 - Underground storage tanks.

- Supply of primary pipelines to carry water from the irrigation canal.
- Supply of secondary pipelines for treated water.
- SCADA system design, equipment and technology.
- Turnkey water treatment plant design and supply.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
<p>Punjab Water Supply and Sewerage Board (PWSSB) Plot No 1 B, Sector 27A Madhya Marg Chandigarh 160019 India +91 172 265 1176 ceopwssb@punjab.gov.in www.pwssb.gov.in</p>	<p>Indo-Pacific Region 1101 Wilson Blvd. Suite 1100 Arlington, VA 22209, USA Ms.Tanvi Madhusudanan Country Manager tmadhusudana@ustda.gov U.S. Trade and Development Agency U.S. Embassy in Delhi Shantipath Chanakyapuri, New Delhi Delhi 110021 India Mehnaz Ansari Senior Regional Representative, South Asia mansari@ustda.gov IndoPacific@ustda.gov www.ustda.gov</p>	<p>U.S. Commercial Service The American Center 24 Kasturba Gandhi Marg New Delhi 100 001 India Arup Mitra Senior Commercial Specialist Arup.mitra@trade.gov www.trade.gov</p>

Marathwada Water Grid		
	SECTOR	Water and Environment
	SUBSECTOR	Water Supply and Control
	LOCATION	Marathwada Region Maharashtra, India
	PROJECT VALUE	\$2.3 Billion

PROJECT SUMMARY

The Marathwada water grid project will create an integrated pipeline network to supply water for drinking, industrial and agricultural purposes in the Marathwada region. The project will connect 11 major dams in Marathwada, west India, through a secondary grid of pipelines and transfer water from these dams into Marathwada. The project business model is Design-Build-Finance-Operate-and-Transfer (DBFOT), with a hybrid-annuity-based, public-private partnership (PPP) structure. The total project investment is estimated to be \$ 2.3 billion.

PROJECT DESCRIPTION

Marathwada is one of six regions in the state of Maharashtra. Marathwada (which coincides with the Aurangabad Division of Maharashtra) consists of eight districts in the heart of Maharashtra: Aurangabad, Beed, Latur, Osmanabad, Parbhani, Jalna, Nanded and Hingoli. The region has a population of 18.7 million and a geographic area of 64,500 square km. Marathwada traditionally receives little rainfall due to its geographic location and environmental conditions (Figure 164), often facing severe drinking water scarcity.

As a consequence, the Marathwada region is dependent on major dams such as Jayakwadi, Majalgaon, Lower Dudhna, Yeldari, Vishnupuri, Manjara, Mannar and Sidhdheshwar, as well as many medium and minor irrigation projects for its water supply. However, limited rainfall over the last several years has prevented some of these reservoirs from storing adequate water supplies, further exacerbating the region's water scarcity problems. To permanently solve this problem, the state elected to develop a water grid project similar to the successful Gujarat and Telangana water grid projects.

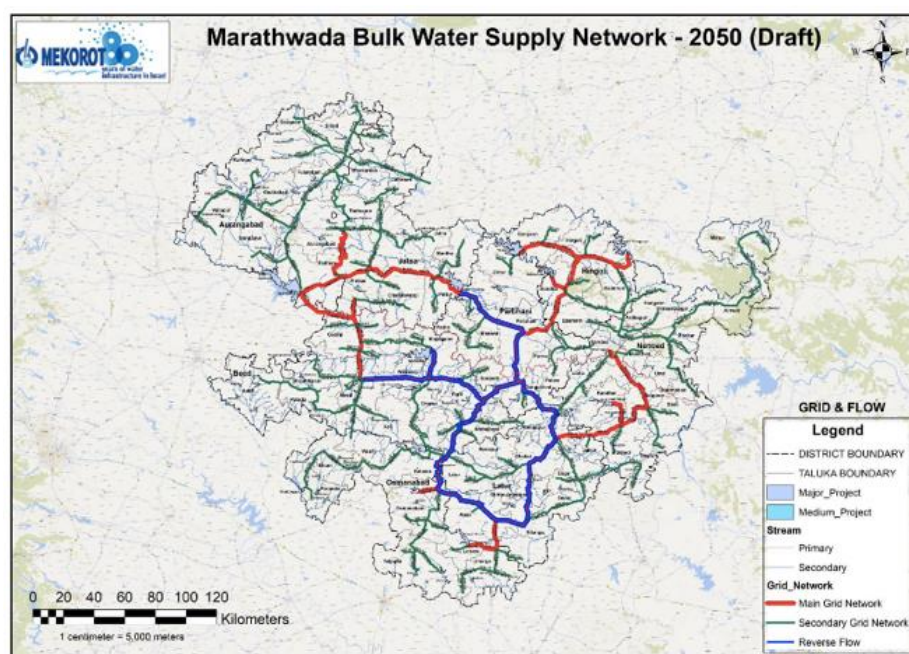
The Marathwada water grid project will be the first of the National Jal Jeevan Mission, a \$50 billion national effort to provide piped drinking water to all Indian rural homes by 2024. The project proposes to connect 11 major dams in Marathwada through large pipelines. A primary loop will connect the reservoirs to enable water to be pumped from dams with surplus water to reservoirs with low storage levels. The project further includes a secondary grid of pipelines to transfer water to the region's 76 sub-districts (taluka). The Water Supply and Sanitation

Department of Maharashtra (Maharashtra Jeevan Pradhikaran – MJP), in Aurangabad, is the nodal agency for this project and will implement the project over five years (Figure. 165).

Figure 164: Marathwada Drought Conditions



Figure 165: Water Infrastructure in Marathwada¹⁹⁹



¹⁹⁹ Mekorot - RFQ Tender Notice No. 7 of 2019-20 , Maharashtra Jeevan Pradhikaran

The Marathwada Water Grid project will be segmented into four packages, based on a study prepared by the Israeli national water company, Mekorot Development & Enterprises Limited. The Mekorot study addressed the following:

- Planning & design.
- Cost estimates.
- Demand Assessments.
- Identification of water supply sources (i.e., dams and reservoirs).
- Evaluation of the proposed linking of various reservoirs through a piped network that would enable the transfer of water from surplus to deficit reservoirs.
- Water release plans.
- Identification of tapping points and tapping arrangements.
- Detailed design and digital maps.

The State Cabinet has approved the four packages recommended by Mekorot for project completion. Concessionaires for each package will lay the primary pipelines for transferring bulk water from the reservoirs and the secondary pipeline grid for treated water, as well as develop the requisite water treatment plants (WTPs).

The four geographic packages include:

Package One – Aurangabad and Jalna: Approved Phase One with \$613 million budget. This phase involves:

Aurangabad:

- Lay a 208-km raw-water rising main and a 529-kilometers pure-water rising main.
- Construct four Water Treatment Plants (WTP) with a total capacity of 261 million liters per day (MLD).

Jalna:

- Lay a 143-km raw-water rising main and a 315-kilometers pure-water rising main.
- Construct three WTPs with a total capacity of 114 MLD.

Package Two – Beed (Central Maharashtra): Approved Phase Two with \$685 million budget. The scope of work includes:

- Lay a 373-km raw-water rising main, a 705 km pure-water rising main and 1,078 km of water pipelines.
- Construct five WTPs with a total capacity of 255 MLD.
- Construct raw-water pumping stations, pure-water pumping stations, and inline booster pumping stations.

Package Three – Osmanabad and Latur: Approved in Aug. 2019 with \$446 million budget to create an integrated, piped network for the supply of drinking water, as well as water for industrial and agricultural uses for the cities of Osmanabad and Latur.

Latur:

- Lay 607-km of pipeline.
- Construct pumping stations and inline booster pumping stations as required.
- Lay 149-km of raw-water rising main and 458-km of pure-water rising main.

Osmanabad:

- Lay 717 km of pipeline.
- Construct three WTPs with a total capacity 181 MLD (Osmanabad – 64 MLD, Washi – 59 MLD and Terna – 58 MLD).
- Construct pumping stations and inline booster pumping stations as required.
- Lay a 204-km raw-water rising main and a 513-km pure-water rising main.

Package Four (Final) – Nanded-Parbhani-Hingoli: This package has not yet been presented, reviewed, and cleared.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

Maharashtra initially invited tenders in Sept. 2019 based on a Hybrid Annuity Model for Design, Build, Finance, Operate and Transfer (DBFOT) for packages One, Two and Three. Under this model, following prequalification and vetting of designs, the State will select the bidder quoting the lowest Net Present Value (NPV) for construction and 15-year operations. The concessionaire will tender and contract for equipment and services following primary contract awards.


The tender targets global firms with experience in large water supply or similar projects (e.g., oil or irrigation pipelines). Due to a change in the local government in Oct. 2019, as well as the impact of the COVID-19 global pandemic in 2020, the state government has postponed the last date for bid submission several times. Currently, the state government is re-evaluating the project financing, electricity requirements and payback revenue streams before awarding any bids. Bid award is likely to take place in the next several months.

PROJECT COST AND FINANCING

The Government of Maharashtra and private partners will fund the Water Grid project. The full-project cost estimate is \$2.3 billion. Tranches will be announced and awarded for each of the four phases as a Hybrid Annuity Model. The state government will fund 60 percent of the project cost, with the developer raising the remaining capital through a mix of equity and debt financing. Although the project's assets will remain with the state, a long-term model will ensure the repayment of funds to the developer.

U.S. EXPORT OPPORTUNITIES

The project size and expected duration (a minimum of 5 years) create a range of possible participation options. For large U.S. companies with expertise in water management, participation

Northern Corridor Agribusiness Anchor Companies – Dairy and Paddy Rice		
	SECTOR	Agribusiness
	SUBSECTOR	Dairy Paddy Rice
	LOCATION	Northern Corridor, Malaysia
	PROJECT VALUE	>\$50 Million per Project

PROJECT SUMMARY

The Northern Corridor Economic Region (NCER) is developing a higher-value food supply chain, while concurrently seeking to elevate farmer incomes. The NCER will use an Anchor Company business model, pairing a successful private-sector company with a local nucleus farm in select agricultural sectors, the first of which are Dairy and Paddy Rice. The concept has proven successful in the East Coast Economic Region (ECER), encouraging private sector participation in agribusiness projects and simultaneously grooming local farmers. After the NCER supplies first-level infrastructure, private sector Anchor Companies will provide most project funding, but with highly attractive tax and other incentives.

PROJECT DESCRIPTION

Malaysia's agriculture, fisheries and forestry sector accounts for eight percent of the country's GDP, while employing 10 percent of the labor force. Palm oil, rubber, cocoa and wood products comprise half of the output, with tropical fruits and rice, among other significant crops. In 2019, the country's global agricultural trade was over \$43 billion, \$25 billion in exports and over \$18 billion in imports. Malaysia is the world's second-largest palm oil producer and exporter after Indonesia. Even with its agricultural trade surplus, Malaysia is still dependent on imports for critical products, for example wheat, rice, protein meal, dairy products and beef, as well as most deciduous and citrus fruits.²⁰⁰

The Northern Corridor Economic Region (NCER) is one of the regions identified under the Ninth Malaysia Plan to accelerate economic growth. NCER spans the four northern states of Peninsular Malaysia, Perlis, Kedah, Pulau Pinang and Perak. The Corridor's strategic location within the Association of Southeast Asian Nations (ASEAN) has made the NCER an attractive destination for business operations.

²⁰⁰ 2020 U.S. Commercial Guide <https://www.trade.gov/knowledge-product/malaysia-agricultural-sector>.

Land, however, is limited in the NCER. Most land has been converted to commercial and industrial use, creating an imperative to maximize agricultural land utility. Further, as in other countries and regions, the COVID-19 global pandemic has disrupted food supply chains and led to high agricultural waste levels.

Agriculture is key to Malaysia's national food security agenda and is the third-largest contributor to the NCER's economy. In 2018, agriculture comprised 9.2 percent of the region's GDP and contributed approximately five billion dollars (RM19.7 billion) to Malaysia's overall GDP. An essential goal of the NCER is to develop modern agriculture by applying new agribusiness technologies.

The Northern Corridor Implementation Authority (NCIA) is the statutory body responsible for direction, policies and strategies promoting the development of the NCER. The NCIA seeks to increase overall private-sector participation in the Corridor, including in Agribusiness, modeled on the federal government's public-private partnership development emphasis.

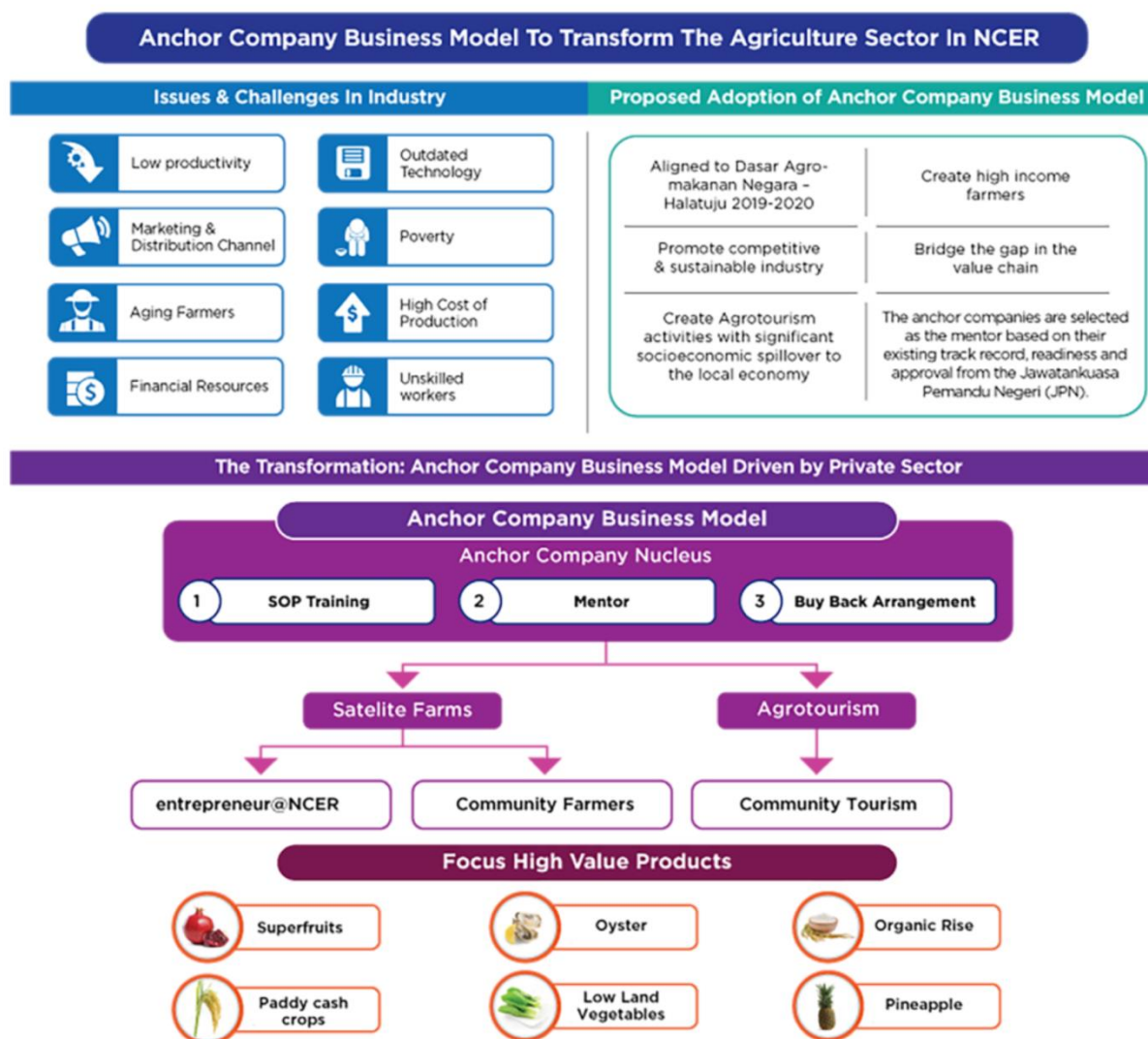
Specifically, the NCIA is pairing the state of Pulau Pinang's core strengths (global connectivity and a mature business eco-system) with a strong presence of multinational enterprises and a sizeable talent pool to address the area's urban-rural development divide. The NCIA plans to make the region a Special Agro Economic Zone (SAEZ) pending completion of a feasibility study ongoing by a U.S. company.

Aligned with Malaysia's National Agro-Food Policy (NAFP) 2019 – 2020, the NCIA is developing Anchor Company business models (Figure 166) in the Dairy and Paddy Rice sectors to ensure high-value, sustainable food supply chains. The Anchor Company concept has already proven successful in the East Coast Economic Region (ECER). The NCIA will apply the model to all strategic agribusiness projects in the NCER region for the next five years.

The NCIA model encourages private sector participation in agribusiness projects and grooms local farmers simultaneously. The model pairs a strong business enterprise with a designated nucleus farm for development. The Anchor Company also mentors contract farmers and purchases high-quality output from satellite farms through buyback arrangements. The Anchor company must be capable of covering the full spectrum of the relevant value chain.

Local government will enable each Anchor project with first-level infrastructure/site preparation, including land clearing, road development and provision of electricity, water supply and internet access. In addition, tax and other incentives will complement Anchor company investments in the projects.

Figure 166: The NCER Anchor Company Business Model



The NCER has identified two food segments for priority development under the Anchor Company model:

1. Dairy Sector

Dairy farming in Malaysia typically requires 1000 hectares to achieve sound returns. The NCER looks to replicate the results achieved in a similar ECER dairy project where Holstein Milk serves as the Anchor Company. U.S. non-profit Endeavor Entrepreneur, Tuan Ee Loi, is Holstein's founder.

In the ECER, Holstein Milk offers 100 percent fresh, all-natural milk products. Before Holstein's participation, the ECER's dairy industry struggled, either importing most of its milk from Australia or using powder. Holstein has worked with the ECER to train and provide local farmers with know-how and equipment to raise local production levels.

Currently, only five percent of milk consumed in Malaysia is produced locally, in a market valued at \$450 million.²⁰¹ Holstein currently holds a 35 percent market share of the domestic market. The Malaysian sovereign wealth fund, Khazanah Nasional Bhd is a key investor.

2. Paddy Rice Sector

The only non-perennial crop grown in significant quantity in Malaysia is paddy rice. Eleven percent of total agricultural land, or 700,000 hectares, is dedicated to rice cultivation. The NCER region is the rice bowl of Malaysia. Paddy farming is closely related to social impact and food security for the nation.²⁰²

The NCIA seeks to integrate technology and smart farming into the value chain. Currently, Malaysia tightly regulates paddy farming. Nonetheless, the NCIA believes paddy farming has a high potential for increased yield and subsequent higher income to farmers. Organic paddy cultivation through satellite and contract farming is the focus.

Beginning in 2011, the NCER achieved success in paddy cultivation using an Estate Management Model (EMM). The EMM integrated modern agriculture concepts into paddy farming, resulting in increased paddy yields, moving from fewer than four tonnes per hectare, up more than 50 percent to six tonnes per hectare. The program included improving basic infrastructure and soil fertility. Bio-organic microbes also contributed to improved growing yields. Modern machinery reduced yield losses during harvesting, as well as improved operational efficiency. The NCER, however, believes there is an important opportunity to reach an even higher level of production using smart farming. As a result, the NCIA seeks an Anchor Company partner to apply smart agribusiness technology in conjunction with a nucleus farm and associated contract farmers.

Beyond Dairy and Paddy Rice, the NCIA expects to develop additional Anchor Company projects, including:

- Cash crops.
- Superfruits.
- Hemp.
- Aquaculture.
- Livestock farming.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

The NCIA is currently conducting negotiations with several prospective Anchor Companies, including U.S. interests. The NCIA has not defined a fixed timeline for contracting Anchor

²⁰¹ Endeavor Entrepreneur. <https://endeavor.org/entrepreneur/tuan-ee-loi/>.

²⁰² Khazanah Research Institute, The Status of Paddy and Rice Industry in Malaysia, April 2019.

Companies; instead, the focus is on securing partners who can span the Dairy and Paddy Rice value chains, making the projects successful.

The NCER has commissioned and begun a feasibility study to secure Special Agro Economic Zone (SAEZ) status, which may provide additional development incentives for target Anchor Companies.

PROJECT COST AND FINANCING

Malaysia's Budget 2021 allocated \$190 million (RM780 million) for agribusiness development in the five regional economic Corridors, including the NCER. For the Dairy and Paddy Rice NCER projects, local government will supply first-level infrastructure including site preparation, road building and utilities access. The chosen Anchor Company (ies) will also have access to attractive incentives.

For example, the NTAX Package provides region-specific, broad-based fiscal incentives to encourage and reward substantive investments. These incentives include:

- Income Tax Exemption - up to 100 percent tax exemption for up to 15 years.
- Investment Tax Allowance - up to 100 percent allowance up to 10 years.
- Import duty exemptions on raw materials, components, machinery, spare parts and equipment.
- Fifty percent reduction in stamp duty on instruments of transfer or lease of land in Kedah and Perlis.
- Customized incentives and rewards for specific promoted activities, for instance, research and development (R&D).

U.S. EXPORT OPPORTUNITIES

Underlying the Anchor Business model is the transformation and modernization of the NCER's agriculture sector. Specifically, the NCER is desirous of applying Smart Farming practices to maximize production and efficiency. Particularly desired new and sustainable technologies include:

- High-yield farming models and technologies.
- Advanced agriculture, new farming concepts, including vertical farming.
- New crop varieties with higher productivity and quality.
- Agricultural machinery and automation.
- Smart farming and other agritech (e.g., artificial intelligence (AI), big data analytics, drones and robotics, agricultural sensors, GPS applications et al).
- Advanced farm and inventory management techniques and applications.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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ANNEX 1: Table of Acronyms

2G	Second Generation Cellular Network
3D	Three Dimensional
3G	Third Generation Cellular Network
4G	Fourth Generation Cellular Network
5G	Fifth Generation Cellular Network
AAI	Airports Authority of India
AC	Alternating Current
ACI	Airports Council International
ACSR	Aluminum Conductor Steel-Reinforced Cable
ADB	Asian Development Bank
ADIF	Administrador de Infraestructuras Ferroviarias
ADMS	Advanced Distribution Management System
AECOM	AECOM Technology Corporation
AEPL	Airef Engineers Private Limited
AEV	All Electric Vehicle
AFC	Approved For Construction
AFCS	Automatic Fare Collection System
AG	Aktiengesellschaft (Corporation - German)
AHP	Adani Hazira Port
AHPPL	Adani Hazira Port Private Limited
AI	Artificial Intelligence
AIIB	Asian Infrastructure Investment Bank
AMC	Access Management Company
AMI	Advanced Metering Infrastructure
AMRC	Andhra Pradesh Metro Rail Corporation Limited
ANS	Air Navigation Services
AOT	Airports of Thailand
API	Application Programming Interface
APM	Automated People Mover
APSEZ	Adani Ports and Special Economic Zone Limited
ARHDM	Atmospheric Hydrodemetallization Unit
ARP	Airport Reference Points
ASCN	ASEAN Smart Cities Network
ASEAN	Association of Southeast Asian Nations
ATC	Air Traffic Control
ATMS	Advanced Traffic Management System
ATR	Regional Transport Airplanes (Aerei da Trasporto Regionale or Avions de Transport Régional)
ATV	Automatic Ticket Vending

AWS	Amazon Web Services
B	Billion
BARSYL	Balaji Railroad Systems Limited
BIMP-EAGA	Brunei-Indonesia-Malaysia-Philippines East Association of Southeast Asian Nations (ASEAN) Growth Area
BKK	Suvarnabhumi Airport
BLCE	Bac Lieu Clean Energy
BMSIC	Bihar Medical Services & Infrastructure Corporation
BMU	Bi-mode Multiple Units
BOOM	Build-Own-Operate-Maintain
BOOT	Build-Own-Operate-Transfer
BOT	Build-Operate-Transfer
BP	British Petroleum
BPaaS	Business Process as a Service
BP Batam	Batam Indonesia Free Zone Authority
BPC	Bid Process Coordinators
BPCL	Bharat Petroleum Corporation Limited
BPSD	Barrels Per Stream Day
BSE	Bombay Stock Exchange
BTH	Hang Nadim International Airport
CAAT	Civil Aviation Authority of Thailand
CAAV	Civil Aviation Authority of Vietnam
CAGR	Compound Annual Growth Rate
CATC	Continuous Automatic Train Control
CBL	Cikarang-Bekasi-Laut
CBM	Coalbed Methane
CBTC	Communication-Based Train Control System
CBU	Completely Built Unit
CC	Composite Core
CCEA	Cabinet Committee on Economic Affairs
CCGT	Combined Cycle Gas Turbine
CCOE	Cloud Computing Center of Excellence
CCS	Combo Charging System
CCTV	Closed Circuit Television
CD	Chart Datum
CDM	Collaborative Decision Making
CDP	Comprehensive Development Plan
CDU	Crude Distillation Unit
CEA	Central Electricity Authority
CGS	Central Gas Stations
CHAdemo	Charge de Move
CHC	Controlled Hydrodynamic Cavitation
CIM	Common Information Model

CIP	Critical Infrastructure Protection
CLG	Chevron Lummus Global
CMBT	Chennai Moffusil Bus Terminus
CMI	Case Mix Index
CMPDI	Central Mine Planning and Design Institute
CMRL	Chennai Metro Rail Limited
CO2	Carbon Dioxide
COD	Commercial Operations Date
Co-Gen	Cogeneration
COP	Code of Practice
COVID-19	Coronavirus Disease (of) 2019
CP	Cathodic Protection
CP	Charoen Pokphand
CRCC	China Railways Construction Corporation Limited
CRZ	Coastal Regulation Zone
CT	Commuter Train
CT	Computerized Tomography
CVRS	Central Voice Recording
CWR	Clear Water Reservoir
DB	Database
DBFOT	Design-Build-Finance-Operate-and-Transfer
DBOOT	Design-Build-Own-Operate-Transfer
DBOT	Design-Build-Operate-Transfer
DC	Direct Current
DDC	Detailed Design Consultancy
DCIP	Dispatching Center Improvement Project
DER	Distributed Energy Resources
DFC	Development Finance Corporation
DFR	Detailed Feasibility Report
DFW	Dallas/Fort Worth International Airport
DFTZ	Digital Free Trade Zone
DG	Diesel Generator
DGH	Directorate General of Hydrocarbons
DGRA	Delhi-Gurgaon-Rewari-Alwar
DIAL	Delhi International Airport Authority Limited
DICT	Department of Information and Communications Technology
DLP	Defect Liability Period
DMA	District Metered Area
DMC	Driving Motor Car
DME	Distance Measuring Equipment
DMK	Don Mueang Airport
DMRC	Delhi Metro Rail Corporation
DMS	Distribution Management System

DMU	Diesel Multiple Units
DOCSIS	Data Over Cable Service Interface Specification
DOE	Department of Energy
DOE	Delta Offshore Energy
DPR	Detailed Project Report
DRAIPL	Dineshchandra R Agrawal Infracon Private Limited
DSB	Digital Signage Board
DVOR	Doppler Very High-Frequency Omni Range
DWT	Deadweight Tonnage
E	Export
E&M	Electrical and Mechanical
EAC	Expert Appraisal Committee
EC	Environmental Clearance
ECER	East Coast Economic Region
ED	Doctor of Education
EE	Energy Efficient (Efficiency)
EEC	Eastern Economic Corridor
EGAT	Electricity Generating Authority of Thailand
EHIA	Environmental Health Impact Assessment
EHSR	Eastern High-Speed Rail
EI	Electronic Interlocking
EIA	Environmental Impact Assessment
EIB	European Investment Bank
EIRR	Economic Internal Rate of Return
EMM	Estate Management Model
EOGEPL	Essar Oil & Gas Exploration & Production Limited
EPC	Engineering, Procurement, Construction
EPL	Essar Ports Limited
EPMC	Engineering Project Management Consultant
EPS	Early Production System
ERC	Energy Regulatory Commission
ERS	Emergency Restoration Service
ESB	Enterprise Service Bus
ESD	Emergency Shut Down
ESHIA	Environmental, Social, Health, Impact Analysis
ESIA	Environmental and Social Impact Assessment
ESL	Ernad Special Line
EU	European Union
EV	Electric Vehicle
EVCI	Electric Vehicle Charging Infrastructure
EVN	Vietnam Electricity
EVNNPT	National Power Transmission Corporation
FBC	Final Business Case

FDI	Foreign Direct Investment
FEED	Front-End Engineering Design
FIDS	Flight Information Display System
FIT	Feed-In Tariff
FLNG	Floating Liquified Natural Gas
FPSO	Floating Production Storage and Offloading
FSO	Floating Storage and Offloading
FSRU	Floating Storage Regasification Unit
GAD	General Arrangement Drawings
GAGAN	GPS Aided GEO Augmented Navigation
GAIL	Gas Authority of India Limited
GC	General Consultancy
GDP	Gross Domestic Product
GE	General Electric
GEECL	Great Eastern Energy Corporation Limited
GEO	Geographic
GGS	Gas-Gathering Stations
GHG	Green House Gas
GIPIP	Good International Petroleum Industry Practices
GIS	Geographic Information System
GIS	Gas-Insulated Substations
GM	General Manager
GNIDA	Greater Noida Industrial Development Authority
GOCC	Government Owned and/or Controlled Corporation
GoI	Government of India
GoP	Government of Punjab
GoTN	Government of Tamil Nadu
GoUP	Government of Uttar Pradesh
GPI	Global Procurement Initiative
GPON	Gigabyte Passive Optical Network
GPS	Global Positioning System
GRESC	Geothermal Renewable Energy Service Contract
GSE	Ground Support Equipment
GSEG	Gujarat State Energy Generation Ltd.
GSI	Geological Survey of India
GSPA	Gas Sales and Purchase Agreement
GW	Gigawatt
GWR	Gas/Water Ratios
ha	Hectare
HAM	Hybrid Annuity Model
HDD	Horizontal Directional Drilling
HELP	Hydrocarbon Exploration and Licensing Policy
HC	High Court

HMC	Harbor Mobile Crane
HID	Hitachi
HMD	Hazira Manufacturing Division
HPPL	Hazira Port Private Limited
HQ	Headquarters
HSBB	High Speed Broadband
HSD	High-Speed Diesel
HSE	Health, Safety and Environment
HT	High Tension
HTLS	High Temperature Low Sag
HUDCO	Haryana Urban Development Corporation
HV	High Voltage
HVAC	Heating, Ventilation, and Air Conditioning
HVU	High Vacuum Distillation Unit
HWU	Hydraulic Workover Unit
I	Import
I/E	Import/Export
ICD	Inland Container Depot
IaaS	Infrastructure as a Service
IATA	International Air Transport Association
ICT	Information and Communications Technology
IEAT	Industrial Estate Authority of Thailand
IED	Intelligent Electronic Device
IFC	International Finance Corporation
IGIA	Indira Gandhi International Airport
IIT	Indian Institutes of Technology
IL&FS	Infrastructure Leasing and Financial Services Limited
ILS	Instrument Landing Systems
INACA	Indonesian National Air Carrier Association
IOCL	Indian Oil Corporation Limited
IoT	Internet of Things
IP	Internet Protocol
IPP	Independent Power Producer
IPS	Intermediate Pigging Station
IR	Indian Railways
IRS	Institute of Remote Sensing
IS	Indian Standard
ISG	Information Services Group
ISTS	Inter-State Transmission System
IT	Information Technology
ITS	Intelligent Transportation System
JAMA	Journal of the American Medical Association
JENDELA	Jalanan Digital Negara Plan

JICA	Japan International Cooperation Agency
JV	Joint Venture
kcal	Kilocalorie
Kg	Kilogram
KGCE	Kinabalu Gold Coast Enclave
KIIFB	Kerala Infrastructure Investment Fund Board
KL	Kuala Lumpur
KLE	Karnataka Lingayat Education
KLS	Kolathunadu Lines Strengthening
km	Kilometer
KPJ	KPJ Healthcare, Berhad
KPPIP	Committee for Acceleration of Priority Infrastructure Delivery
KSEB	Kerala State Electricity Board
KTL	Kochi Lines Package
KUL	Kuala Lumpur International Airport
KV	Klang Valley
kV	Kilovolt
KVA	Kilo-Volt-Ampere
kWh	Kilowatt Hour
L	Large
L	Liter
L1	Lowest Bidder
L&T	Larsen & Toubro Limited
L&TIEL	L&T Infrastructure Engineering Limited
LC	Local Content
LCC	Low-Cost Carrier
LD	Long-Distance
LDS	Leak Detection System
LEED	Leadership in Energy and Environmental Design
LEPCC	Licenser, Engineering, Procurement, Construction and Commissioning
LGU	Local Government Unit
LNG	Liquefied Natural Gas
LOA	Length Overall
LPCD	Liters Per Capita Per Day
LPG	Liquefied Petroleum Gas
LPWAN	Low Power Wide Area Network
Ltd	Limited
M	Medium
m	Meter
m2	Square Meter
MATRADE	Malaysian External Trade Development Corporation
MBBS	Bachelor of Medicine, Bachelor of Surgery
MBIR	Manesar-Bawal Investment Region

Mbps	Mega Bits per Second
MbPT	Mumbai Port Trust
MC	Motor Car
MCJ	Municipal Corporation of Jalandhar
MCMC	Malaysian Communications and Multimedia Commission
MCMV	Multi-Circuit Multi-Voltage
MD	Medical Doctor
MDEC	Malaysia Digital Economy Corporation
MDMS	Meter Data Management System
MDoNER	Ministry of Development of North Eastern Region
MDPE	Medium-Density Polyethylene
Meralco	Manila Electric Company
MEP	Mechanical Electrical and Plumbing
MESTECC	Ministry of Energy, Science, Technology, Environment, and Climate Change
MFF	Multi-tranche Financing Facility
MGT	Minimum Guaranteed Throughput
MIC	Marine Integrated Cluster
MICE	Meetings, Incentives, Conferences and Exhibition
MILO	Nestle Tradename for Chocolate and Malt Mix
MIS	Management Information System(s)
MJP	Water Supply and Sanitation Department of Maharashtra
MLD	Minimum Liquid Discharge
MLD	Million Liters per Day
MLO	Mainline Operator
MM	Million
MMSCFD	Million Standard Cubic Feet per Day
MMT	Metric Million Tons
MMPA	Million Metric Tons Per Annum
MNC	Multinational Corporation
MNRE	Ministry of New and Renewable Energy
MoC	Ministry of Coal
MoCA	Ministry of Civil Aviation
MoD	Ministry of Defence
MoDNER	Ministry of Development of North Eastern Region
MoEFCC	Ministry of Environment, Forest and Climate Change
MoF	Ministry of Finance
MoHA	Ministry of Home Affairs
MOIT	Ministry of Industry and Trade
MoP	Ministry of Power
MoR	Ministry of Railways
MoS	Ministry of Shipping
MOT	Ministry of Transport
MOU	Memorandum of Understanding

MPPA	Million Passengers per Annum
MRI	Magnetic Resonance Imaging
MRO	Maintenance, Repair, and Overhaul
MS	Motor Spirit
MSW	Municipal Solid Waste
MT	Million Tons
MT	Magnetotelluric
MTPA	Metric Tonnes Per Annum
MV	Medium-Voltage
MVA	Mega Volt Amp
MVV 2.0	Malaysian Vision Valley 2.0
MVVS	MVV Secretariat
MW	Megawatt
MWh	Megawatt hour
MY	Malaysia
N/A	Not Applicable
NABH Nirman	NextGen Airports for Bharat
NAFP	National Agro-Food Policy
NATM	New Austrian Tunnel Method
NCER	Northern Corridor Economic Region
NCIA	Northern Corridor Implementation Authority
NCR	National Capital Region
NCRPB	National Capital Region Planning Board
NCRTC	National Capital Region Transport Corporation
NCT	National Capital Territory
NDB	Nondirectional Beacon
NDB	New Development Bank
NDIL	National Digital Infrastructure Lab
NDIP	National Digital Infrastructure Plan
NE	Northeastern
NEC	North Eastern Council
NEERI	National Environmental Engineering Institute
NERC	North American Reliability Corporation
NESDC	Office of the Economic and Social Development Council
NFC	Near Field Communication
NGCP	National Grid Corporation of the Philippines
NIAL	Noida International Airport Limited
NIC	Network Interface Cards
NML	North Malabar Lines
NIAL	Noida International Airport Limited
NPV	Net Present Value
NR	Northern Railways
NRDWP	National Rural Drinking Water Programs

NSI	North-South Interlink
NTPC	NTPC Ltd. (formerly National Thermal. Power. Corporation, Limited)
NYSE	New York Stock Exchange
O&G	Oil and Gas
O&M	Operation and Maintenance
OALP	Open Acreage Licensing Policy
OBC	Outside Business Case
OCC	Operational Control Centre
OCU	Olefins Conversion Unit
OD	Outside Diameter
ODA	Official Development Assistance
ODF	Open Defecation Free
OECD	Organization for Economic Cooperation and Development
OFC	Optical Fiber Cables
OHE	Overhead Line
ONAF	Oil Natural Air Forced
ONAN	Oil Natural Air Natural
ONEP	Office of Natural Resources and Environmental Policy Planning
ONGC	Oil and Natural Gas Company Limited
OPGW	Optical Ground Wire
ORD	O'Hare International Airport
OSV	Offshore Support Vessel
PA	Public Address
PaaS	Platform as a Service
PAPI	Precision Approach Path Indicators
PAT	Port Authority of Thailand
PDIL	Projects & Development India Limited
PDP	Power Development Plan
PDPA	Project Delivery Partner Agreement
PEA	Provincial Electricity Authority
PET	Positron-Emission Tomography
PETRONAS	Petroleum National Bhd
PGCIL	Power Grid Corporation of India Limited
PHEV	Plug-in Hybrid Electric Vehicle
PHP	Philippines Peso
PKNS	Selangor State Development Corporation
PLN	Perusahaan Listrik Negara
PLL	Punj Lloyd Limited
PMC	Project Management Consultancy
PMCH	Patna Medical College and Hospital
PMIDC	Punjab Municipal Infrastructure Development Company
PNGRB	Petroleum and Natural Gas Regulatory Board Regulations
PNPKI	Philippine National Public Key Infrastructure

PO	Post Office
POIC	Palm Oil Industrial Cluster
PPA	Power Purchase Agreement
PPP	Public-Private-Partnership
PPPAC	Public-Private Partnership Appraisal Committee
PPT	Paradip Port Trust
PRIHATIN	Economic Credit/Stimulus Program
PRSB	Pembinaan Redzai Sdn Bhd
PRU	Propylene Recovery Unit
PSDF	Power System Development Fund
PSHPL	Paradip-Somnathpur-Haldia Pipeline
PSO	Public Service Operations
PSSCC	Public Safety and Security Command Center
PSU	Public Sector Undertaking
PTCC	Power and Telecommunication Coordination Committee
PUIIP	Punjab Urban Infrastructure Improvement Program
PV	Photovoltaic
PwC	Price Waterhouse Coopers
PWSSB	Punjab Water Supply & Sewerage Board
QoE	Quality of Experience
QR	Quick Response
R&D	Research and Development
RA	Risk Assessment
RCC	Residual Catalytic Cracking
RCC	Reinforced Cement Concrete
RCS-UDAN	Regional Connectivity Scheme – ‘Ude Desh ka Aam Naagrik’
RDF	Refuse-Derived Fuel
RDF-2	Refuse-Derived Fuel 2
RDMP	Refinery Development Master Plan
RE	Renewable Energy
RE	Reinforced Earth
REIT	Real Estate Investment Trust
RESA	Runaway-End-Safety-Area
RFCC	Residual Fluid Catalytic Cracker
RFP	Request for Proposals
RFQ	Request for Qualifications
RIL	Reliance India, Limited
rites	Rail India Technology and Economic Service
RM	Malaysian Ringgit
RMK-12	Twelfth Malaysia Plan
RoB	Roads Over Bridges
Ro-Ro	Roll On/Roll Off
ROW	Right of Way

RP	Regulated Period
RRTS	Regional Rapid Transit System
RTM	Regulated Tariff Management
RuB	Roads Under Bridges
RVNL	Rail Vikas Nigam Limited
S	Small
S&T	Signaling & Telecommunications
SaaS	Software as a Service
SAE	Society of Automotive Engineers
SAEZ	Special Agro Economic Zone
SAIP	Sabah Agro-Industrial Precinct
SAT	Site Acceptance Tests
SBM	Swachh Bharat Mission
SBMLC	Sepangar Bay Manufacturing and Logistic Cluster
SC	Supreme Court
SCADA	Supervisory Control and Data Acquisition
SCCTV	Surveillance Closed-Circuit Television
SCG	Siam Cement Group
SECI	Solar Energy Corporation of India
SEDC	Sarawak Economic Development Corporation
SEZ	Special Economic Zone
SEZ	Solar-Energy-Rich Zones
SFTPaaS	Secure File Transfer Protocol as a Service
SHA	Security Hold Area
SHE	Sandakan Education Hub
SIA	Social Impact Studies
SIL	Simplex Infrastructures Limited
SIPCOT	State Industries Promotion Corporation of Tamil Nadu
SKK	Sarai Kale Khan
SKO	Super Kerosene Oil
SMTaaS	Simple Mail Transfer Protocol as a Service
SNB	Shahjahanpur-Neemrana-Behror
SNCF	Société Nationale des Chemins de Fer Francais
SOC	Security Operations Center
SOGDC	Sabah Oil and Gas Development Corporation Sdn Bhd
SOGIP	Sipitang Oil 7 Gas Industrial PARC
SPP	Small Power Producer
SPSB	Sabah Ports Sdn Bhd
SPV	Special Purpose Vehicle
SQ KM	Square Kilometer
SRT	State Railway of Thailand
SRTO	Single-Rail Transfer Operator
SRU	Storage Regasification Unit

STaaS	Storage as a Service
STATCOM/SVG	Static Synchronous Compensator/Static Var Generator
STP	Sewage Treatment Plant
SUC	State Universities and Colleges
SV	Sectionalizing Valve
SVS	Sectionalizing Valve Stations
T1	Telecommunications Line Transmitting at a Speed of 1.544 Mbps
T2	Telecommunications Line Transmitting at a Speed of 6.3 Mbps
TA	Technical Assistance
TC	Trailer Car
TBCB	Tariff-Based Competitive Bidding
TCF	Trillion Cubic Feet
TEFR	Techno-Economic Feasibility Report
TEU	Twenty-foot Equivalent Unit
TGPI	Tayabas Geothermal Power, Incorporated
THB	Thai Baht
TM	Telekom Malaysia
TNB	Tenaga Nasional Berhad
TNT	Trinitro Toluene
TOI	Times of India
ToR	Terms of Reference
TPG	TPG Capital, formerly Texas Pacific Group
TPP	Thermal Power Plants
TSL	Tata Steel Limited
TOD	Transit Oriented Development
TSP	Transmission Service Providers
TVS	Tunnel Ventilation Systems
UAE	United Arab Emirates
UAS	Unmanned Aircraft System
UK	United Kingdom
UMTC	Urban Mass Transit Company
UNCTAD	United Nations Conference on Trade and Development
UP	Uttar Pradesh
US	United States
USD	United States Dollar
USTDA	United States Trade and Development Agency
UTP	U-Tapao
V	Volt
VAC	Ventilation Air Conditioning
VCL	Varindera Constructions Limited
vCPU	Virtual Central Processing Unit
VGf	Viability Gap Fund
VHF	Very High Frequency

VLAN	Virtual Local Area Network
VM	Virtual Machine
VND	Vietnamese Dong
VOCPT	V.O. Chidambaranar Port Trust
VoIP	Voice Over Internet Protocol
VOR	VHF Omnidirectional Radio Range
vRAM	Virtual Read Accessible Memory
VTMS	Vessel Traffic Management System
VVVF	Variable-Frequency Drive
VUDA	Visakhapatnam Urban Development Authority
WB	World Bank
WDC	Western Dock Captive
WEZ	Wind-Energy-Rich Zones
WIFI	Wireless Fidelity
WPIL	Worley Parsons, India
WRSCT	Western Region Standing Committee on Transmission
WRSS	Western Region Strengthening Scheme
WTE	Waste to Energy
WTP	Water Treatment Plant
XL	Extra Large
YEIDA	Yamuna Expressway Industrial Development Authority