BUSINESS SWEDEN
THE SWEDISH TRADE & INVEST COUNCIL

Energimyndigheten

Sustainable Energy Transformation

Opportunities in the Southeast Asia Energy Sector

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EXECUTIVE SUMMARY

The Southeast Asia economy has experienced an exponential growth since 2000, with each country recording more than 5% of growth per year in the past two decades. However, the economic strength of the region will be heavily challenged in 2020 when the world economy is expected to only grow at a slow pace due to the gradual slowdown of major economies including the US, China and Japan, and with impacts from intensifying trade protection measures. Against a background of rather subdued economic growth, the Southeast Asia policy makers will look to implement measures and stimuli to revitalise manufacturing, exports, and domestic investments, taking advantage of the benefits from the trade and supply chain redirection as well as previous fiscal stimuli and monetary easing in several economies.

In 2020, the Philippines, Vietnam, and Indonesia are expected to grow by 5%-7%, on the other hand, the growth in Thailand, Malaysia, and Singapore will likely be less than 5%. Overall, the GDP growth in Southeast Asia is forecasted to 4.1% in 2020 before performing better with an estimated further growth of 4.6% in 2021.

In order to reap full benefits of higher amounts of investment being reallocated to the region, efforts have been made within each country over the past years to improve regulatory environments and to put reforms in place to reduce the complications of starting a business, dealing with construction permits, and trading across borders. The ease of doing business in Southeast Asia has improved at a fast pace as a result.

Singapore continues to be the second top ranked economy on the World Bank's Ease of Doing Business index for a fourth consecutive year. Other Southeast Asia economies ranked among the top 30 are Malaysia (12th) and Thailand (21st) while Vietnam, Indonesia, and Philippines are ranked at 70th, 73rd, and 95th places respectively. In comparison, Sweden is ranked as 10th.

Sweden has established diplomatic ties with many of the countries in the Southeast Asia region that stretches far back, and the relationships have been gradually moving from development cooperation to mutual commercial relations. Multiple Southeast Asian countries have for long been important trading partners for Sweden and these commercial activities have stimulated collaborations in different areas. The Swedish government has established support functions that assist more than 600 Swedish companies operating in the region and other Swedish companies aspiring to enter the region. The major support functions include The Embassy of Sweden, Business Sweden, The Swedish Chamber of Commerce, Team Sweden, and Nordic Innovation House (NIH) in Singapore.

There are vast opportunities for Swedish companies as the region is in need for sustainable and innovative solutions across many fields where Swedish companies have a lot to offer. The region has large and young populations, a rapid growing middle class with strong purchasing power and governmental investments in multiple areas of development.

In the energy field, every Southeast Asian country needs to work toward providing adequate energy supply amidst rising demand, while committing to developing sustainable energy sources and enhancing energy efficiency.

Indonesia's energy market is highly dynamic and has been growing at the same pace as the economic growth. The government has overestimated the economic growth trajectory and set up an energy plan that is much higher than the actual growth of energy demand. Regardless, fossil fuel still remains the backbone of Indonesian energy source at least for the next 5 years.

With fossil fuel resources forecasted to last for not more than one generation, Indonesia is moving toward renewable energy. The country has set targets on renewable energy implementation, energy efficiency, and greenhouse gas emission reductions. A roadmap and plan to achieve targets have also been prepared.

Indonesia is in the equator, and this situation provides advantage in terms of solar power. However, only 0.02% of Indonesia's energy is supplied from solar power. Investments within this space is still highly limited. The government tries to push the development of solar power plants by regulating solar PV rooftops and encouraging the government and any related institution to install solar rooftop.

Indonesia's biodiversity has provided abundant resources of biomass energy. Most of the energy is being used directly by people and industries. Still very limited amounts of biomass power exist in Indonesia. The main reasons behind this is that the country has limited technology in providing constant volume as well as the quality of feedstock from plantations.

Indonesia's energy intensity and energy elasticity still sees big room for improvement. Indonesia's industries, mainly the high energy consumer such as cement, steel, and textile cannot be considered as efficient compared to other peer countries. Indonesia's energy consumption for HVAC as well as its overall grid requires innovative technology that could improve the efficiency.

National Electricity Company (PLN) as the grid owner and operator is now struggling in improving their energy losses during transmission and distribution. Technology that could increase the energy loss parameters are highly needed.

Green buildings and green industry are also on the course of becoming a standard for Indonesia's development within commercial and the industry. Better HVAC systems, building materials and mobility within buildings require more efficient technologies. This situation is also evident in the industrial sector which requires heat including boiler and chiller is the sector target for Swedish companies to increase the efficiency.

Swedish companies are well suited to support Indonesia in achieving the targets set. Academies, businesses, and governmental cooperation between two countries are needed in achieving the ambitious targets.

Malaysia's rapid industrialisation and urbanisation have inevitable impact on both the energy demand and the contribution to the carbon footprint. The country is well endowed with abundance of fossil fuels such as oil, gas and coal, as well as renewables such as hydropower, biomass, biogas and solar energy. Although conventional sources such as natural gas and coal are still dominant for power generation in Malaysia, the share of renewable energy is on the course of increasing. In terms of renewable energy, solar is essentially the largest contributor followed by biomass, biogas and small hydropower.

Malaysia has set a target to increase its renewable energy in electricity generation from the current 2% to 20% by 2025, a majority of this would be driven by solar. It has a high potential for solar generation with the estimated potential for solar generation reaching 6,500 MW. To date, solar has an installed capacity of 381 MW, which accounts for 61% of the total installed capacity for renewable energy in the country.

Furthermore, Malaysia is currently the third largest exporter of solar modules and solar cells in the world and these vibrant upstream activities present opportunities for Swedish companies with know-how that is value-added to the manufacturing process including supply of technology, complimentary products and components, engineering and automation.

Being the second largest country producing palm oil after Indonesia, Malaysia has a huge source of waste from palm oil that can potentially be used for biomass. It is estimated that biomass has the potential to generate up to 2,400 MW of electricity in Malaysia, out of which only about 79 MW have been harnessed under feed-in tariff system to date. Swedish companies with commercially proven technologies for efficient production of power and heat from major biomass resources will stand a chance to gain by providing the right solutions to Malaysia's existing biomass combustion systems which still utilise low efficiency low-pressure boilers with the average overall cogeneration efficiency of merely 38%.

On the energy efficiency front, smart grids and smart metering are going to be the focal point for the sector as Tenaga Nasional Berhad (TNB), the only electric utility company in Peninsular Malaysia and also the largest publicly-listed power company in Southeast Asia, plans to roll out its initiative to build a "Grid of the Future" which includes the deployment 9.1 million smart electric meters to households across Peninsular Malaysia by 2026. The opportunities for Swedish companies are typically revolving around smart energy management system, sensors, ICT, IoT solutions and other energy-related technologies.

The Philippines' power demand continues to rise, and the country is racing against time to meet the energy needs of the country, especially as the Manamplaya gas fields is close to depletion. From 2007 to 2017, the energy demand has increased by 4% per annum with the highest growth of 9% being witnessed in the commercial sector.

Coal and natural gas remain the predominant indigenous fossil fuel resources in the Philippines, accounting for two-third of the total energy supply. However, the share of renewable energy continues to rise, owing to a long-standing use of geothermal and hydro resources for electricity generation and the use of biomass by the industrial and

residential sector. The installed capacity target of renewable energy set by the Department of Energy is 15.3 GW by 2030 and 20 GW by 2040.

With the influx of cheaper solar energy systems, solar energy in the country is one of the cheapest sources of renewable energy in the market. As solar rooftop technology becomes more and more readily available and cheaper over the years, households and commercial establishments as well as industries have started the adoption of solar rooftop technology and connect it to the grid. However, battery storage technology and the development of micro-grids are the two areas of solar energy that have yet to be fully-developed in the Philippines where over 7,600 islands are located. Swedish companies with solutions to these issues will find the Philippines an attractive country to expand into.

The Philippines is also regarded as a potential destination for investments towards waste-to-energy, mostly due to the favourable foreign investment incentives present for waste-to-energy projects such as 100% foreign ownership, unlike other renewable energy sources.

Technologies on improving power loss in the transmission and distribution sector will also be welcomed by the National Grid Corporation Philippines (NGCP), which is privately owned corporation in-charge of operating, maintaining and developing the Philippines' state-owned power grid, an interconnected system that transmits electricity to the nation. With around 20 typhoons battering the country each year, underwater cabling, smart-grids and micro-grids, which are the technologies that the country does not have a strong local background will represent areas of opportunities for Swedish companies.

Singapore's current energy mix is dominated by natural gas (95%). There are limited renewable energy sources available due to Singapore's small land area and resource constraints, where solar has been identified as the area with the highest potential.

Limited land for possible deployment within solar energy has introduced a demand for new technologies and solutions, including floating, building-integrated and mobile solar photovoltaic panels. In addition to the deployment of solar panels, Swedish companies could leverage innovative technological solutions within transmission and distribution systems, energy storage systems, grid interactions and solar radiation forecast with advanced forecasting algorithms solutions.

Regarding energy generation and transmission, the nationwide deployment of Energy Storage Systems (ESS) has a target of 200 MW beyond 2025. Technological solutions within smart energy storage systems, power system applications, smart power transmission and distribution grids, and microgrids for integration of solar panels are areas of opportunities for Swedish companies.

Another area of opportunity is within residential and commercial buildings whereas Singapore is currently initiating two main areas in the Smart Nation project -– innovation districts and smart towns. Main opportunities can be found within the large development projects, including solutions for district cooling and ventilation as well as smart metering and lighting.

Thailand's energy demand in all economic sectors has been increasing with the growth of 2.5% per year and Thai authorities are tasked to ensure the demand is fulfilled. Moreover, with more than half of its energy demand fulfilled by imported energy and the increasing energy price volatility, Thailand is finding itself having to cope with energy security challenges in the future. This calls for the Thai government to implement various energy development plans and schemes to ensure its energy security to support economic expansion while having environmental perspectives in focus.

The importance of renewable energy development is currently much more crucial than it was in the past. Thailand has abundance of renewable resources that it can take

advantage of and has started the journey toward increasing the share of renewables in its future energy mix, with sets of policy and incentive schemes to attract investments.

This green development leads to emerging opportunities for Swedish companies aspiring to expand into a high potential market. Solutions to increase renewable energy output will be welcomed by Thai energy producers. The priority is the highest for solar energy and Swedish consulting companies will find opportunities by participating in various solar farms projects being planned while manufacturers or distributors of high-performance solar panels, solar collectors and solar energy storage solutions will also find opportunities in smaller self-consumption projects. The second priority is placed on biomass, which represents opportunities for Swedish companies to work with Small Power Producers (SPPs) from consulting services, to engineering support for optimisation and efficiency and even to supply chain management such as pelletizing or bracketing for storage and logistics.

The Thai government is also working toward increasing the nation's energy efficiency both within the production and consumption side. Increasing investment budgets are now allocated to the development of smart grid projects taking place nationwide by public and private power companies. Swedish companies can provide engineering and consulting support to SPP in the areas of substation automation, microgrid development, distributed generation, energy storage and advanced metering infrastructure.

Residential and commercial buildings sector is also incentivised to improve their energy efficiency through the implementation of smart solutions while the industrial and transport sector attempt to lower both energy costs and greenhouse gas emissions. Swedish manufacturers and/or distributors of building envelop materials, HVAC, lighting equipment and lighting systems as well as water heating will find opportunities to increase their sales in Thailand.

Vietnam, being one of the fastest-growing economies in the region, is facing challenges in ensuring future energy demand while also complying with the government's objectives of reducing greenhouse gas emissions by promoting renewable energy and energy efficiency technologies.

Renewable energy is emerging as the tipping point for inclusive and sustainable development in Vietnam. Realising this movement, the government has planned to transform the power system of Vietnam towards a more sustainable and decentralised system that builds on abundant but variable domestic renewable energy sources, such as wind, solar and biomass energy. This transition will prompt several opportunities, as well as potential challenges, for Swedish companies to expand into this market by the form of supply chain, consultancy, investment or partnership.

For wind power there is currently no offshore projects which should show potential for Swedish companies to step in, either in terms of equipment supply or consulting services areas. In the biomass sector there are opportunities to provide solutions to generate energy out of materials at their rawest forms, there is also potential within the area of residential biomass. The waste-to-energy sector demands the technology of low-calorific incineration which is the most suitable one for current waste situation.

In parallel with the development of energy sources, energy conservation is considered as one of the effective solutions contributing to the nation's energy security. Energy efficiency has been promoted in several sectors through programs and regulations. As a result, increasing attention is paid to improving energy conservation, most notably in industrial and building sectors. Vietnam is seeking experiences and know-how from the international pioneers in the energy efficiency area, in which Swedish enterprises are among the world leaders. Seizing these opportunities will help position Swedish solutions in the market and possibly create good models for other countries to follow.

INTRODUCTION

During the first two decades of the 21st century, the economies of Southeast Asia have experienced unparalleled growth, and by now together hold a GDP equivalent to the world's fifth largest economy. This economic development is cause for celebration – poverty rates have decreased dramatically, its citizens live longer and healthier lives, and increasing disposable income means that people find more time for leisure and consumption.

The economic development, however, also has a flipside. Increased economic activity means a rapidly increased use of energy, often from non-renewable sources with discernible consequences for the local environment and the health of citizens. Technology as well as policy is lagging behind and innovations in clean, sustainable energy generation and utilisation have not hit the marketplace on the broader scale.

The increased demand for technical knowledge, education and systems thinking in investments into sustainable projects in developing countries is highlighted in the new Swedish export strategy ("Sveriges export- och investeringsstrategi") that aims to increase the Swedish presence in developing markets – especially in Asia. An emphasis is placed on Swedish SMEs, and for them to act as subcontractors and to be able to successfully provide products, expertise, components and services to foreign turnkey providers. It is noted that the strategy shall contribute to the export of green and environmentally friendly technology not only as a vehicle to support a reduction of overall climate emissions, but also as a tool to sharpen Swedish global competitiveness.

Southeast Asia is a large region, and while there is a trend of increasing political multilateral cooperation, the differences between the countries in many ways outweigh the similarities on a fundamental level – history, geography, demography, religion, as well as political and economic systems are highly diverse. The markets further differ in terms of current energy mix, sustainability of energy provision, prioritised investment focus areas, as well as public procurement procedures. Consequently, Swedish companies with innovative technologies and solutions within the energy field need a deep understanding of the intricacies of the markets and which areas constitute the biggest areas of future potential.

The Swedish Energy Agency has been actively working in multiple projects in Indonesia over the last couple of years. In order to gain further understanding of the region and to get a better overview of the current prioritised areas in Southeast Asia within climate and energy related areas, Business Sweden has been commissioned to write this report. The main aim is to provide Swedish governmental actors as well as Swedish companies offering innovative solutions in the energy field with an understanding of the markets in order to make informed decisions about areas to target when moving forward.

Focus in this report is given to the current and targeted energy situation facing Southeast Asia in order to support and ensure the longevity with emphasis on renewable energy and energy efficiency. This report is envisioned to give an overview of the energy sector in Southeast Asia with insights for Swedish companies looking to enter this region. An assessment has been conducted for each market included in the study to highlight the main areas of opportunity within renewable energy and energy efficiency for each country based on availability and accessibility, estimated cost, alignment with government's strategic priorities, market size and potential growth in combination with the availability of Swedish solutions, capability to implement, entry barriers and competition.

SOUTHEAST ASIA
GENERAL MARKET OVERVIEW

Southeast Asia: An Economic Powerhouse in the Making

With a combined gross domestic product (GDP) of USD 2.5 trillion, roughly 3.5% of global GDP, and a population of 557 million, Southeast Asia presents a compelling proposition for sustainable growth. If Southeast Asia were a country, it would be the 7th largest economy in the world and it is projected to move up to the 4th position by 2050. It would have the 3rd largest labour force in the world, only behind China and India, and it would also have a larger population than the European Union or North America.

Another plus point for the region is its strategic location as it is situated in the confluence of major trade routes, with USD 5.5 trillion of global trade passing through each year.

Efforts have been made by the governments to capitalise on rising household purchasing power and meeting the challenges of providing large investments in infrastructure and human-capital development. The region is ready to propel into the next frontier of growth and realise its full potential.

Figure 1. Southeast Asia Overview

Source: Association of Southeast Asian Nations, 2019

Table 1. Southeast Asia Key Indicators

Key Indicators	Indonesia	Malaysia	Philippines	Singapore	Thailand	Vietnam	Sweden
Population (m)	261	31	103	6	69	93	10
2018 GDP (bUSD)	1,042.2	354.3	333.9	364.2	487.2	224.9	556.0
2018 GDP per Capita (USD)	3,893	11,239	3,103	64,581	7,273	2,564	54,356
Global Competitive Index (0-100)	64.9	74.4	62.1	83.5	67.5	58.1	81.7
Ease of Doing Business (0-100)	69.6	81.5	62.8	86.2	80.1	69.8	82

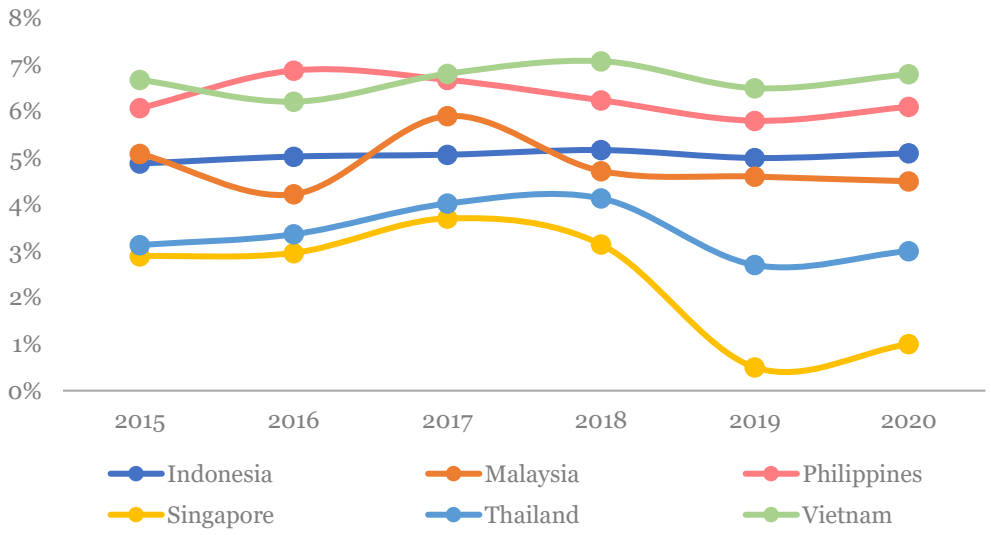
Source: IMF, 2019; World Bank, 2019; World Economic Forum, 2019

Economic Outlook: Navigating Troubled Waters

The unresolved and significant geopolitical risks plaguing the global economy are exacerbating the headwinds the Southeast Asia economy must face. The region's historically strong economic growth is expected to be challenged by prolonged global policy uncertainty and trade wars which will decelerate the growth of trading partners' economy

GDP growth in Southeast Asia is forecasted to 4.1% in 2020 and 4.6% in 2021 as drags are expected to continue to diminish prospects of any pickup in the region's economy. The slowdown in growth is particularly notable in export-oriented Thailand and Singapore due to the US-China trade war and the delayed investments amid high uncertainty. The economic expansion in Malaysia, Indonesia, Philippines, and Vietnam will be under pressure due to low export performance and low commodity prices but domestic demand is expected to partly offset the adverse impacts of external factors.

Figure 2. Real GDP Growth
(Percentage point, year over year)



GDP growth in the Southeast Asia region during 2019-2020 is expected to be hampered by external factors

Source: IMF, 2019

Indonesia, the largest economy in Southeast Asia and a diverse archipelago nation home to more than 300 ethnic groups, has achieved impressive economic growth since the Asian financial crisis of the late 1990s.

Indonesia's economic growth is projected to slightly slowdown to 5.0% in 2019 before accelerating further at 5.1% in 2020. The economy is expected to be driven by the traction of robust domestic demand as fundamentals remain strong, coupled with prudent macro-fiscal-exchange rate policy. The outlook for private consumption continues to be supported by low inflation and improved labour market condition. The general elections will reduce political uncertainties and will contribute to more optimistic business sentiment as a result of the proposed structural reforms, which is expected to strengthen both private and public investment.

Export growth is forecasted to be mild amid deteriorating global conditions and slower growth of Indonesia's major trading partners while import growth is expected to be muted in the near term.

Table 2. Indonesia Key Economic Indicators
(Percentage point, year over year)

Economic Indicators	2018	2019f	2020f
Gross Domestic Product	5.2	5.0	5.1
Private Sector Expenditure	5.1	5.2	5.2
Public Sector Expenditure	4.8	5.1	5.0
Exports	6.5	2.6	3.5
Imports	12.0	0.0	3.2

Source: IMF, 2019; World Bank, 2019

Malaysia has diversified its economy and transformed from initially an agriculture and commodity-based country, into one with robust manufacturing and services sectors. It has become one of the most open economies in the world and a leading exporter of electrical appliances, electronic parts and components.

The growth of Malaysia's economy is projected at 4.6% in 2019 and 4.5% in 2020. This marginal increase is underpinned by resilient domestic demand as household consumption spending and private investment continue to improve, thanks to stable labour market and low inflation. The Malaysian government is expected to marginally increase the level of public expenditure to support economic expansion. Private investment is expected to gain traction in 2020, following the resumption of infrastructure projects and ongoing capital spending in the services and manufacturing sectors.

Despite the anticipated expansion, Malaysia will have to cope with external uncertainties, which may pose downside risks to growth prospects. The slowdown in global economic and trade performance brings about moderate expansion in exports in 2019 and only slight recovery can be expected in 2020. Amid external headwinds, Malaysia's exports are expected to grow at 1% in 2020, while its pace of imports is estimated to grow by 2.7%.

Table 3. Malaysia Key Economic Indicators
(Percentage point, year over year)

Economic Indicators	2018	2019f	2020f
Gross Domestic Product	4.7	4.6	4.5
Private Sector Expenditure	7.2	5.8	5.9
Public Sector Expenditure	0.1	-1.8	1.0
Exports	1.5	0.1	1.0
Imports	0.1	-2.5	2.7

Source: World Bank, 2019; Ministry of Finance, 2019

The Philippines is among of the most dynamic economies in Asia. The country has witnessed increasing urbanisation, a growing middle-income class, and a large and young population. Philippines' vibrant economy is rooted in strong consumer demand supported by sound labour market and robust remittances. It is commonly known for performance in the services sector including the business process outsourcing, real estate, finance and insurance industries.

Philippines' economy in 2019 is hindered by a rapid deceleration in investment growth as a result of both contraction in public spending and weakened global economy. It is projected that the economy will expand by 5.8% in 2019 and will gain traction in 2020 with the growth of 6.1%. Private consumption will be the main driver in the short term, supported by moderating inflation, stable inflows of remittance, and an improving job market. The Philippines government also plans to support the growth with expansionary fiscal policies and various monetary policies including policy rate cuts aided by fresh liquidity via Reserve Requirement Ratio (RRR) reductions to revive investment momentum going into 2020.

The global economic environment remains challenging, limiting the Philippines' export growth prospects as the growth of the Philippines' main goods exports—electronics and electronics components—had already started to slow down as of 2018. Meanwhile, import growth is expected to outpace export growth in 2019, driven by an increase in domestic economic activities, anchored in the capital requirements of public infrastructure projects.

Table 4. Philippines Key Economic Indicators
(Percentage point, year over year)

Economic Indicators	2018	2019f	2020f
Gross Domestic Product	6.2	5.8	6.1
Private Sector Expenditure	5.6	5.9	6.0
Public Sector Expenditure	12.8	10.8	10.0
Exports	11.5	12.4	13.0
Imports	14.5	14.0	16.4

Source: World Bank, 2019

Singapore is a high-income economy and one of the world's most business-friendly regulatory environments for local entrepreneurs. It also is ranked among the world's most competitive economies. Manufacturing became the main driver of growth, coupled with the development of the financial sector to become the regional financial service hub. These two sectors remain the twin pillars of Singapore's high value-added economy today.

Singapore's economy is likely to continue facing headwinds into 2020. With uneven growth across industries and significant uncertainties for the trade-related cluster, the economy was likely to expand by 0.5% in 2019 before picking up slightly by 1.0% in 2020. The country has to cope with a negative external environment, but at the same time, still has positive domestic resilience as the information technology and the telecommunications sector can serve as a cushioning factor for the slowdown. The Singaporean government is also expected to rely on its "huge chest of ammunition" to maneuver through uncertainties with a highly expansionary fiscal policy and easing monetary policy in 2020.

Table 5. Singapore Key Economic Indicators
(Percentage point, year over year)

Economic Indicators	2018	2019f	2020f
Gross Domestic Product	3.1	0.5	1.0
Private Sector Expenditure	2.7	2.7	2.6
Public Sector Expenditure	14.4	14.1	14.2
Exports	5.2	-2.7	0.9
Imports	4.7	-2.8	1.4

Source: IMF, 2019; World Bank, 2019

Thailand has made remarkable progress in economic development, moving from a low-income to a middle-income country in less than a generation. Thailand is the second largest economy in Southeast Asia after Indonesia and serves as an economic anchor for its developing neighbour countries. The country's economy appears resilient and is expected to advance at a moderate pace despite domestic political uncertainty.

Despite relatively healthy domestic demand, it is forecasted that external factors will hamper the growth of Thai economy, resulting in a moderate growth of 2.7% and 3.0% in 2019 and 2020 respectively. Exports in 2019 is projected to decline prior to a slight recovery in 2020 due to the economic slowdown in key trading countries, the impacts from trade protection measures, as well as the appreciation of Baht. On the imports front, an increase in consumer goods and capital goods imports is unlikely to offset the decline in imports of raw materials and intermediate goods, resulting in a contraction of imports in 2019.

The below-target budget disbursement, especially among state-owned enterprises also serves as a drag to economic growth in 2019. A faster pace of expansion is expected for 2020 as household consumption and private investment are projected to maintain momentum, coupled with improved public spending following the roll out of major infrastructure projects. The recovery of exports and tourism sector will also act as a major boost to the expansion of Thai economy.

Table 6. Thailand Key Economic Indicators
(Percentage point, year over year)

Economic Indicators	2018	2019f	2020f
Gross Domestic Product	4.1	2.7	3.0
Private Sector Expenditure	4.5	4.0	3.8
Public Sector Expenditure	3.3	2.3	6.5
Exports	7.5	-2.0	2.3
Imports	13.7	-3.6	3.5

Source: IMF, 2019; World Bank, 2019; NESDB, 2019

Vietnam's shift from a centrally planned to a market economy has transformed the country from one of the poorest in the world into a lower middle-income country and one of the most dynamic emerging countries in East Asia region. Vietnam has a young population, stable political system, commitment to sustainable growth, relatively low inflation, stable currency, vibrant FDI inflows and strong manufacturing sector.

Vietnam's GDP growth was expected at 6.5% in 2019, backed by robust exports and foreign investment, and 6.8% in 2020 is expected as most of the growth drivers are likely to persist. Furthermore, similar to other Southeast Asia countries, Vietnam will benefit from rising foreign investment in manufacturing as businesses shift production from China to bypass higher tariffs. Vietnam will look to capitalise its suitable geographic location and sound business climate to attract investors.

However, the country's pace of privatisation of state-owned enterprises and pace of budget spending on infrastructure have been slower than anticipated which may act as a drag in the short term. Vietnam also remains heavily exposed to global economic sentiments given its high trade openness and limited fiscal and monetary policy buffers.

Table 7. Vietnam Key Economic Indicators
(Percentage point, year over year)

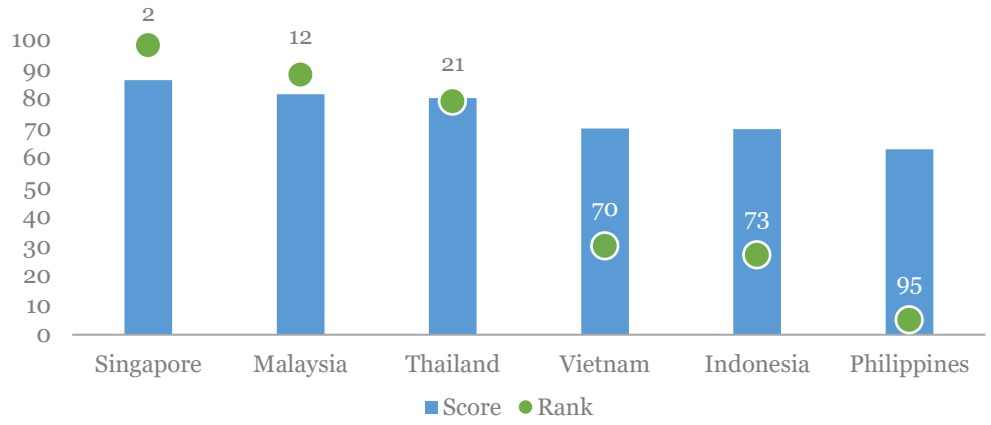
Economic Indicators	2018	2019f	2020f
Gross Domestic Product	7.1	6.5	6.8
Private Sector Expenditure	7.2	7.1	7.0
Public Sector Expenditure	9.1	5.8	9.2
Exports	13.3	7.5	7.0
Imports	9.8	8.3	9.0

Source: IMF, 2019; World Bank, 2019; ADB, 2019

Ease of Doing Business

There is ample room for developing economies in Southeast Asia to catch up with developed countries. However, efforts have been done in the region over the past years to improve regulatory environments in each country and to put in place reforms to reduce the complication of starting a business, dealing with construction permits, and trading across borders. Singapore continues to be the second top ranked economy on the World Bank's Ease of Doing Business (EODB) index for a fourth consecutive year. Other Southeast Asia economies ranked among the top 30 are Malaysia (12th) and Thailand (21st) while Vietnam, Indonesia, and Philippines are ranked at 70th, 73rd, and 95th respectively. In comparison, Sweden is ranked at 10th.

Figure 3. Ease of Doing Business
(2020, ranking and score)



Source: World Bank, 2019

A total of 13 reforms have been made during 2019 in the Southeast Asia

which focuses on improvements in the areas of starting a business and trade across boarders

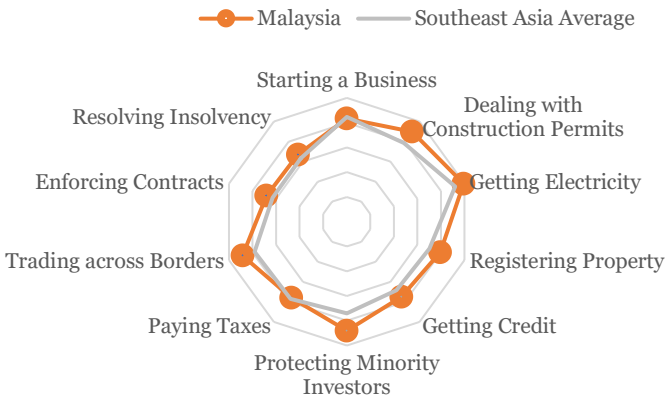
Indonesia's ranking in the index has remained stagnant at 73rd despite efforts to attract investment by removing unfriendly regulations. Indonesia scores 69.6 out of 100, an increase of 1.6 points since last year. Various reforms Indonesia has initiated resulted in improvements in starting businesses, paying taxes, trading across borders, improving electricity and enforcing contracts. However, according to the World Bank the country still needs to resolve challenges around rigid employment and minimum wage regulations, which in turn has implications for job creation and economic growth.

Figure 4. Indonesia's Ease of Doing Business
(2020, score)

Source: World Bank, 2019

Malaysia moves up from the 15th to the 12th position amongst 190 economies worldwide. The improved ranking is contributed by the public and private sector members' collaboration and commitment within the technical working groups under the Special Task Force to Facilitate Business (PEMUDAH) to improve the ease-of-doing-business environment. Malaysia scores 81.5 in 2020, which represents an increment of 0.9 from 2019. According to the World Bank the on-going reform initiatives are on the right track to further enhance competitiveness, productivity and governance in the ease of doing business as well as to promote investments, which will accelerate national economic development and prosperity.

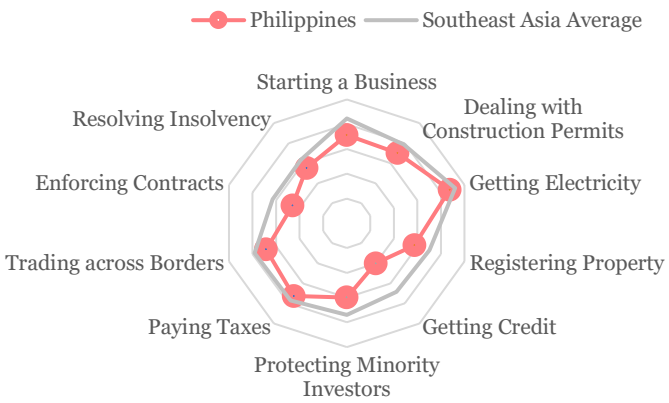
Figure 5. Malaysia's Ease of Doing Business
(2020, score)



Source: World Bank, 2019

The Philippines rises to 95th place from 124th while its overall score improved to 62.9 in 2020 from 60.9 point in 2019. Its scores improve in the following areas: starting a business, dealing with construction permits, protecting minority investors, and paying taxes. The Philippines recently set up an Anti-Red Tape Authority, one of the offshoots of an Ease of Doing Business Act signed in 2018. Starting a business in the Philippines has become easier following the abolition of the minimum capital requirement for domestic companies. The country has also made dealing with construction permits easier by improving coordination and streamlining the process for obtaining an occupancy certificate. Moreover, requiring greater disclosure of transactions with interested parties and enhancing director liability for transactions with interested parties helps strengthen minority investor protections.

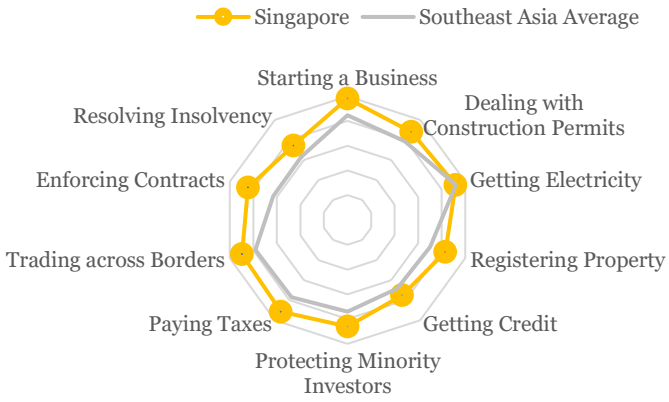
Figure 6. Philippines's Ease of Doing Business
(2020, score)



Source: World Bank, 2019

Singapore has retained its place as second best in 2020 ahead of Hong Kong, Denmark and Korea, with the US, Georgia, UK, Norway, and Sweden rounding out the top 10 spots. The top spot is occupied by New Zealand. Singapore scores highly on the ease of starting a business, which only needed 1.5 days and two procedures. It has also made dealing with construction permits easier by streamlining the process, improving public access to land information, and improving its approach to land or building inspections.

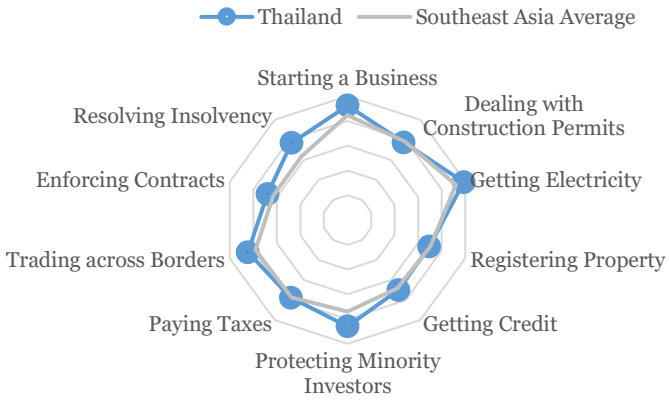
Figure 7. Singapore's Ease of Doing Business
(2020, score)



Source: World Bank, 2019

Thailand moves up six places to 21st in 2020 rankings as the country scored 80.1, slightly below Malaysia. The jump is attributed to the government's efforts in streamlining the approval process for doing business, adopting digital systems for government services, and improving rules and regulations to catch up with changes in business, beefing up its competitive edge. Thailand sees a significant improvement in both score and ranking in two indicators: dealing with construction permits, which ranked 34th with a score of 77.3, and protecting minority investors, ranking 3rd with a score of 86.

Figure 8. Thailand's Ease of Doing Business
(2020, score)



Source: World Bank, 2019

Vietnam ranks 70th in the 2020 report. The country has fallen one spot from its position in 2019 despite the overall score improving by 1.4 points, scoring a total of 69.8 points. Vietnam ranks the best in the following areas of assessment – getting credit and paying taxes, ranking 25th among all the economies. On the other hand, its performance is the weakest in resolving insolvency, ranking 122nd overall. In general, Vietnam has recorded improvements in most areas, only declining in the overall score for resolving insolvency for the second consecutive year.

Figure 9. Vietnam's Ease of Doing Business
(2020, score)

Source: World Bank, 2019

SWEDISH PRESENCE IN SOUTHEAST ASIA

SWEDISH PRESENCE IN SOUTHEAST ASIA

Sweden has established diplomatic ties with many of the countries in the Southeast Asia region that stretches far back, and the relationships have been gradually moving from development cooperation to mutual commercial relations. Multiple Southeast Asian countries have for long been important trading partners for Sweden and these commercial activities have stimulated collaborations in different areas.

Currently, there are more than 600 Swedish companies established in Southeast Asia leading to numerous jobs being created locally and Swedish companies takes advantage of a geographically strategic location in the middle of Asia to create their hubs for the entire Asia-Pacific region (APAC). While most of the companies establish a sales function, there are an increased portion that setup manufacturing facilities and research and development. The majority of the regional headquarters for Asia Pacific or Southeast Asia are being ran out of Singapore where most major Swedish banks are also present.

Historically, the focus of Swedish companies in Asia have been oriented towards markets such as China and India resulting in unnoticed opportunities in the Southeast Asia region. There are several support functions established in each country with the purpose of serving as the local support for Swedish companies entering the region.

Swedish Support Functions

The Embassy of Sweden is present in all the Southeast Asian countries and the main task of the Embassy is to promote and strengthen the relations between Sweden and the respective country. The Embassy's activities are focused on trade promotion, but also to contribute to further cooperation in other areas such as culture, education and defence. The Embassy also provides consular services to Swedish citizens living or visiting the respective country as well as supporting in immigration related services.

Business Sweden's purpose is to support Swedish companies to establish abroad, grow global sales and support international companies to invest in Sweden. Business Sweden has had numerous years of experience in supporting Swedish companies in their penetration of the Southeast Asia market and thus far has managed to foster a

strong and successful network of local business leaders and policy makers with the goal of promoting Swedish competitiveness in the region.

The Swedish Chambers of Commerce are non-for-profit, non-governmental and non-political organisations committing to provide support for Swedish companies and individuals operating in the region. The chambers help develop the region into an attractive investment destination and trading partner for Swedish business. The chambers are the voices of the Swedish business striving for an open and fair market environment.

Team Sweden functions as an umbrella making up public authorities, government agencies and companies that all work to promote Swedish exports abroad. The constellation of Team Sweden looks somewhat different in each country but is typically led by the Swedish Ambassador and made up by the Embassy of Sweden, Business Sweden and the Swedish Chamber of Commerce. Team Sweden has close and highly values ties with the Swedish network, cooperating daily to support Swedish companies and their establishment and presence in respective country. Some sectors where collaboration has recently happened include Sustainable Energy, Education and Research, Sustainable transport, and Smart Cities. Activities generally are seminars, workshops, delegation visits and pilot projects.

Nordic Innovation House (NIH) in Singapore was established in 2018 and is co-funded by the Nordic Council of Ministers. It is a joint cooperative effort between the Nordic embassies to facilitate an innovation hub for Nordic start-ups, scaleups, and growth companies. Representatives from Business Sweden and the Embassy of Sweden have key roles in the organisation, providing support for Swedish companies to take part of the NIH community. Singapore is one out of four locations in the world for NIH including Silicon Valley, New York City and Hong Kong.

Swedish Companies Operating in the region

Out of the 600 Swedish companies having presence in Southeast Asia there is currently a concentration mainly in manufacturing, transportation, healthcare, retail, energy and environment. Some of the representative players are Volvo, Scania, ABB, SKF, Atlas Copco, Astra Zeneca, Envac, H&M and IKEA, just to name a few. Some of the larger companies such as Volvo, SKF, ABB and Scania have taken advantage of the low cost of operations and strategic location of Southeast Asia to set up manufacturing and assembly facilities. Small and medium-sized companies have also enjoyed growth attributed to the region's conducive business environment and excellent connectivity to other Asian countries. Going forward, investments and commercial expansion in the region from Swedish corporations are likely to increase steadily due to an ongoing development demanding new solutions.

Swedish companies' main opportunities going further have been identified within several sectors, including but not limited to, ICT and IoT; fintech, infrastructure and logistics; smart and sustainable cities and smart housing; advanced manufacturing; and energy and environment.

In the field of energy and climate, ABB, AF, and SWECO stand out to be the biggest Swedish representatives in the region. While AF and SWECO provide consultancy services on their core competency areas such as energy, environment, and infrastructure, ABB has developed its own transformer and high/medium voltage power product factories in Northern Vietnam, as well as a country-wide sales channels that cover five business areas, one of which is Power Grid. Additional energy & environmental technologies companies currently present include Munters, Envac, Regin, SystemAir, and Camfil.

Current collaborations

In addition to a large establishment of Swedish companies in the region, there is an extensive and active exchange between Sweden and the Southeast Asian countries across all levels and the cooperation has been flourishing.

The Embassy has a regional program guided by a "Strategy for Sweden's Regional Development Cooperation in Asia and the Pacific Region 2016-2021", with major areas for the strategy in environment and climate, energy, urban planning, democracy and human rights. Implementation of the strategy entails collaboration with around 40 regional organisations.

Within the scope of Sida project, Sweden has supported local experts in various industries, ranging from forestry, paper, energy, biotechnology, medicine to culture and journalism. Universities and research institutes have established close cooperation in training and exchanging students, graduate students and academics.

Collaboration in Research

Triple helix collaboration of government, industry, and academia has taken place throughout the years between countries in Southeast Asia and Sweden. Research and academia exchange have been a major part of the collaboration within sectors such as healthcare and life sciences, infrastructure and transport, and energy.

Collaboration between Sweden and Indonesia is on-going, largely with the aim of driving the development of Indonesia heading towards sustainability. Some examples on joint research activities are a MoU between Sweden and Indonesia within research and to commemorate 70 years of bilateral relationship in year 2020. There are joint research activities that are expected take place within sustainable transport and waste management.

In Singapore there have been several partnerships between universities and Swedish companies for research purposes within the energy and climate sector. For example, The Knut and Alice Wallenberg Foundation donated to establish a new postdoctoral fellowship programme in Singapore 2018 for young scientists.

Thailand International Cooperation Agency (TICA), the Thailand Research Fund (TRF), and the Swedish International Development Cooperation Agency (Sida) co-sponsor various development cooperation programs aiming to undertake research in the scientific fields of Chemistry, Mathematics, Physics, and Biology.

Collaboration in Energy

The Indonesian-Swedish Initiative for Sustainable Energy Solutions (INSISTS) expected to support the Indonesian government develop policies on environmentally friendly, renewable energy. The initiative includes aiming to combat deforestation caused by oil palm planting, the result of which produces the raw material for biodiesel.

The Memorandum of Understanding in Indonesia between Sweden Energy Minister – Ibrahim Baylan and Indonesian Energy Minister – Ignatius Jonan on joint development on energy has become an umbrella for collaboration. Some partnerships that have been conducted by Swedish large companies with Indonesian stakeholder's worth highlighting include the construction of Sudirman hydropower plant in Banjarnegara. This was as collaboration between Sweco, Skanska, Balfour Beatty and the local partner Indonesia Power. ABB and its local partner PT have been collaborating in providing large-scale substations, transmission and distribution lines in Indonesia including solar PV installations and geothermal power plants. The Swedish International Development Agency and Biogas system has set up a waste-to-

energy power plant from municipal waste in Palu, Central Sulawesi. This cooperation is also supported by the Palu local government.

The Business Accelerator Program in Indonesia has also enabled cooperation between Sweden and Indonesia in renewable energy and energy efficiency. This program has been running since 2016 and some collaboration partners have been Indonesia Renewable Energy Society (METI), Indonesia Smart Grid Initiatives (PJCI), Indonesia Energy Conservation and Efficiency Society (MASKEEI), and Indonesia Employer Association (APINDO). The main agenda of the program is to support Swedish SMEs to penetrate the Indonesian market and to provide solutions and technology development towards sustainability. The activities have included seminars, exhibitions, pilot projects, business matchmaking and visiting programs.

Noteworthy instance in Malaysia is the collaboration of VOLVO with Road Safety Research Centre (RSRC) and University Putra Malaysia (UPM) to develop innovative solutions to reduce the number of accidents involving lorries and motorcycles in Malaysia. The partnership also involved Malaysian Institute of Road Safety Research (MIROS), Vehicle and Traffic Safety Centre (SAFER, Sweden) and Agency of Innovation Malaysia (AIM) offering expertise and advice on technical aspects.

In Singapore, Volvo Bus launched the world's first driverless electric bus together with Nanyang Technological University (NTU) and Land Transport Authority (LTA) in March 2019. The 12m-long bus has zero-emissions in its direct propulsion and consumes 80% less energy compared to a diesel bus. The 300kW smart fast charge system was developed by ABB. Both Volvo Bus and ABB opened innovation centres in Singapore in 2018 to complement Singapore's Smart Nation vision with sustainable solutions.

The Embassy of Sweden and Business Sweden Thailand jointly conducted a continuous Thailand-Sweden Smart City Collaboration, starting in 2016. Eleven world-leading companies, participants from academia and public representatives from Sweden in the field of energy, transport and safety participate with the purpose of enabling and strengthening knowledge sharing between Sweden and Thailand in order to build sustainable cities for the future.

Swedish International Development Cooperation Agency (Sida) has been supporting electrification in Vietnam's rural and mountainous areas using off-grid renewable energy systems and established the future framework for a broader implementation of off-grid renewable energy projects. As Vietnam has reached its middle-income status the aid from Sida has been phased out.

In Vietnam the An Giang and Piteå – Sustainable Municipality Project is funded by Sida through The Swedish International Centre for Local Democracy. The project was executed from 2012 to 2017 and divided into two phases. It has succeeded in raising awareness and participation of local people into waste-to-energy projects and established network clusters related to this program. It also prompted An Giang Provincial People's Committee to approve the Action plan for management and use of rice biomass till 2030. Continuing with the success of the previous projects, An Giang and Piteå have executed the upcoming collaboration "Implementation of action plan for an sustainable development of An Giang province" for the period of 2018-2020. The goal of the project is to develop An Giang province into a sustainable rice-producing agricultural community, and to establish a network cluster between An Giang Biotechnology Center, Department of Agriculture and Rural Development and Piteå Science Park, Grans Competence Center and related organisations.

Collaboration in Environment

In 2018, Sweden, UN Environment and the Coordinating Body on the Seas of East Asia (COBSEA) announced efforts to combat marine litter and plastic pollution in Southeast Asia over the coming four years, through a project that aims to ensure that less plastic leaks through waste management systems. This brings about opportunities for Sweden and respective country to join forces in combatting a serious global environmental challenge regarding the widespread plastic pollution in the oceans.

Initiatives between Indonesia and Sweden related to environment that has been conducted include the research institute collaboration between Indonesia and Sweden where the Indonesian-Swedish Initiative for Sustainable Energy Solutions (INSISTS), expected to support the Indonesian government in crafting policies on environmentally friendly, renewable energy. The initiative includes aims to reduce deforestation caused by oil palm planting, the result of which produces the raw material for biodiesel. Another project is a feasibility study on waste management for Probolinggo municipality as a collaboration between Swedish Energy Agency, IVL, Business Sweden and Embassy of Sweden. Noteworthy is also the IKEA bluebag projects with Mercy Corps Indonesia in providing septic tanks for slum areas in Jakarta. Further the smart city development project in Indonesia which has been supported by Swedish companies such as Ericsson, H&M, Bombardier, Scania, IVL, White arkitekter. Seminars and engagement discussions have been conducted with Indonesian academics, businessmen and government representatives.

Camfil in Singapore partnered up with NTU and its Energy Research Institute in 2017 to collaborate on developing innovative solutions to improve air filtration efficiency and indoor air quality. The partnership was said to test various air filter technologies on NTU's buildings, focusing on their performance in tropical weather. Camfil also launched its Experience Centre in Singapore back in 2017 as well, where it serves as a communication platform to bring the topic of clean air and its existential importance to life to their customers.

INDONESIA

EFFORTS TO RELIEVE FROM OIL DEPENDENCE

INDONESIA – EFFORTS TO RELIEVE FROM OIL DEPENDENCE

Country Summary

Indonesia is the largest country in the South East Asia with 260 million inhabitants and more than 17 000 islands. The country's growth still largely relies on extraction of natural resources such as oil, gas, and minerals extraction. Manufacturing constitutes around 20% of its GDP and is slated to grow.

In Indonesia's current energy mix, there is still a reliance on oil (38%), coal (33%) and natural gas (19%), with the situation forecasted to remain for the upcoming five years. However, the composition of these fossil fuels is likely to significantly change, as the country's oil resources are limited and forecasted to only last for twelve more years at the current extraction rate.

Indonesia has set targets on renewable energy implementation, energy efficiency, and greenhouse gas emission reductions. A roadmap and plan to achieve targets has also been prepared. However, the roadmap has received criticism regarding its proposed execution, with insufficient incentives for all stakeholders to switch from the current reliance on fossil fuels towards sustainable energy.

Located along the equator, this geographic situation provides advantages for Indonesia in terms of sunlight and solar power potential. However, currently only 0,02% of Indonesia's energy supply comes from this source, and investments remain limited. The government is attempting to push the development of solar power plants by implementing regulations on solar rooftops and encouraging the government and any institutions to install the technology. The country's biodiversity provides abundant resources of biomass energy. Still, a highly limited amount of biomass power is currently operational, the main reason being that Indonesia has limited technology in providing constant volume and quality of feedstock from its plantations.

The energy intensity and energy elasticity still have significant rooms for improvement. The country's energy-intensive industries, i.e. cement, steel, and textiles, are not energy efficient compared to in other peer countries.

The National Electricity Company (PLN), acting as the country's grid owner and main operator is now struggling in improving their energy losses during transmission and distribution. Technology that could increase these parameters are highly needed.

Concepts pertaining to green buildings and green industry are becoming more commonplace within commercial and industry development. Better HVAC systems, building materials and mobility solutions within buildings require more efficient technologies. In the industrial sector, heat-intensive technology including boilers and chillers can be seen as targets for Swedish companies with solutions to increase the efficiency.

Swedish companies are well suited to support Indonesia in achieving the targets set. Academies, businesses, and governmental cooperation between two countries are needed in achieving the ambitious targets.

Situation Overview

The Indonesian energy market is highly dynamic and has been growing at the same pace as the overall economic growth. The government has overestimated the economic growth trajectory and set up an energy plan, which is much higher than the actual growth of energy demand. Regardless, fossil fuels will remain the backbone of Indonesian energy source in the next five years.

Energy Utilisation

The country's economic growth is projected to remain stable at around 5-6% in the upcoming years, and the energy resources available should be sufficient to fuel this development at the projected pace. However, domestic fossil fuel resources are getting depleted, as can be seen in table 8.

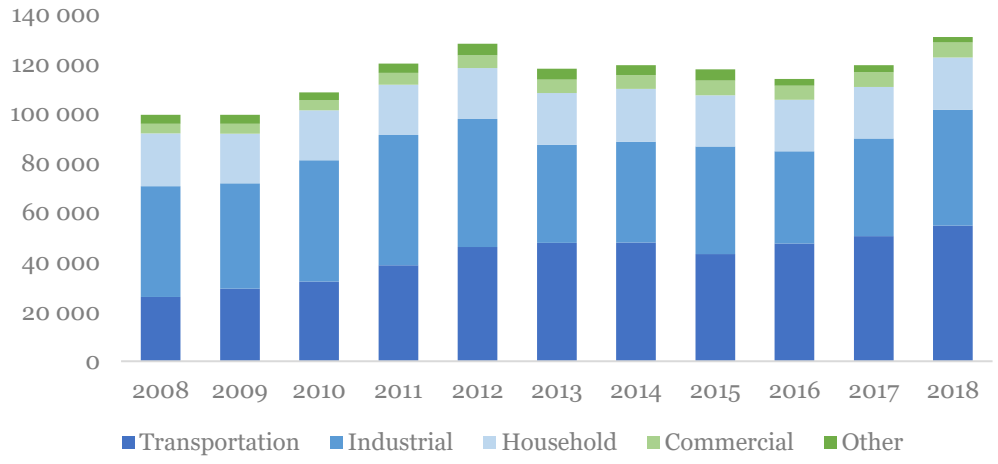
Table 8. Indonesia fossil fuel resource

Energy resource	Resource	Reserve	Production	Lifespan
Crude Oil	151 billion barrels	3,6 billion barrels	288 million barrels	12 years
Natural Gas	487 trillion cubic feet	98 trillion cubic feet	3 trillion cubic feet	33 years
Coal	120 billion tons	32 billion tons	393 million tons	82 years

Source: National Energy General Plan (RUEN), 2017

Prior to 2013, the industrial sector was the largest energy consumer. After 2013, the transportation sector's energy demand surpassed that of the industrial sector as shown in the figure below. In 2018, 42% of energy consumption was accounted for by transportation, and 36% was consumed by the industrial sector. During the last 10 years, the Indonesian energy consumption has grown by 3% yearly.

Figure 10. Indonesia's Energy Utilisation by Sector
(2008 - 2018, ktoe)



Energy consumption within transportation has surpassed the energy consumption for the industrial sector

Source: Handbook of Energy & Economic Statistics of Indonesia, 2018

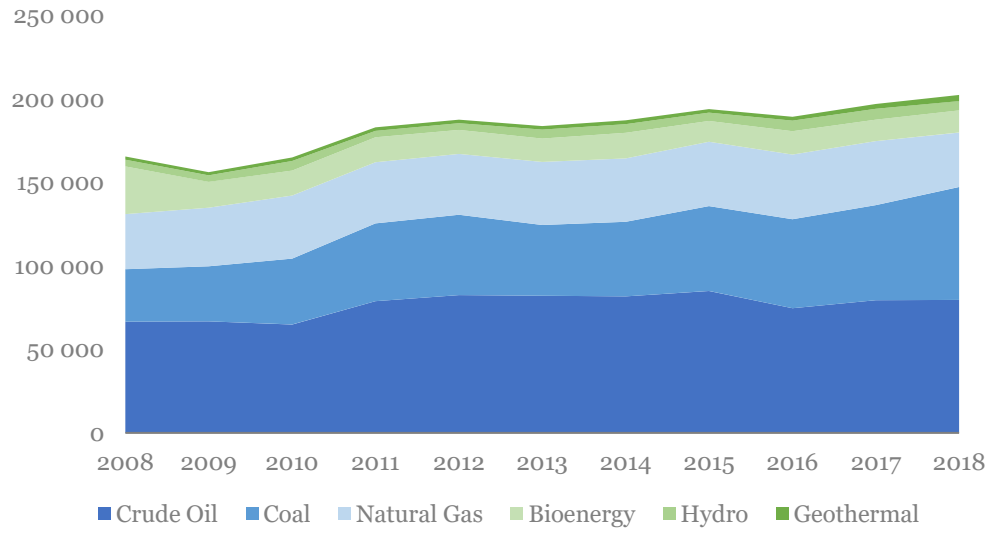
The composition of the fossil fuel-based energy supply has gradually changed. Indonesia was enjoying an oil boom in the 80s, but with depleting crude oil resources, the main fossil fuel sources have since shifted to coal and natural gas. This situation has yet to significantly shift the government's efforts to relieve the country from oil dependence. Starting in 2013, Indonesia has become a net-importer of oil. In 2018, 14% of oil were supplied by imports, and most of the imports is to supply the transportation sector.

As domestic oil is no longer the energy backbone, another fossil fuel – coal – has reached prominence in fuelling Indonesian power plants. While domestic coal resources account for approximately 2% of the total global figures, Indonesia is extracting coal extensively for exports, mainly to China and India. Coal is still considered as a commodity and not as a strategic energy resource. In 2014, coal exports reached 83% of the total production, and it has since decreased to 63% in 2018.

Beside oil and coal, Indonesia sees largely unexplored opportunities within natural gas. The total amount of natural gas resources in the country is estimated at 487 trillion cubic feet which is enough to supply Indonesia with energy at its current production level for the next upcoming 80 years. Around 31% of Indonesian natural gas production is exported, with Japan and Singapore being the key recipients.

Indonesia's National Energy Council reported that 92% of the energy production comes from fossil fuels, represented by crude oil (39%), coal (33%) and natural gas (20%) illustrated in figure 11. Indonesia also has abundant resources of renewable energy. It is estimated that the total potential of renewable energy is around 442 GW. However, it is as of yet not well explored and utilised, and only approximately 9 GW (equal to around 2% of potential supply) is utilised. The current renewable energy composition mainly comes from hydropower plants (slightly above 5 GW) and geothermal (2 GW). Solar, wind, tidal, biomass and other sources only constitute less than 2 GW.

Figure 11. Indonesia's Primary Energy Production by Fuel Type
(2008 - 2018, ktoe)



As domestic oil is no longer the energy backbone, another fossil fuel – coal – has reached prominence in fuelling Indonesian power plants

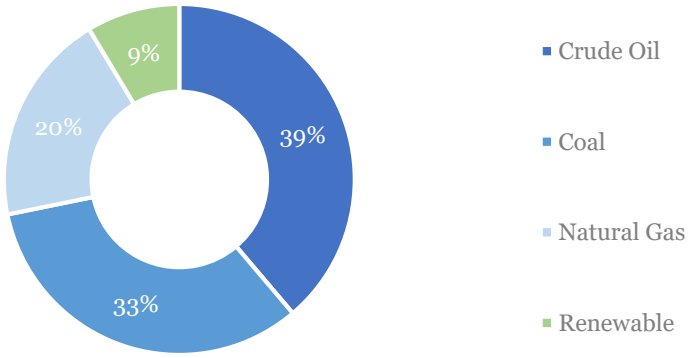
Source: Handbook of Energy & Economic Statistics of Indonesia, 2018

Current Energy Mix

The country's energy mix remains reliant on fossil fuels due to provision of abundant resources in the past, being relatively cheap and fitting in to the existing current consumption. Moreover, the government has unintentionally put some incentives to fossil fuels since these fuels are also contributing significantly to Indonesian exports and thereby combatting the current account deficit.

Indonesia's final energy consumption is dominated by petroleum (55%), electricity (17%), coal and its products (11%) whereas renewable energy resources are contributing 7% of the final energy consumption, see figure 12. The domination of non-renewable energy resources in combination with fossil energy resources becoming diminished in the near future makes the government set targets to accelerate the contribution of renewables.

Figure 12. Indonesia's Final Energy Consumption
(2018, percentage)



Source: Handbook of Energy & Economic Statistics of Indonesia, 2018

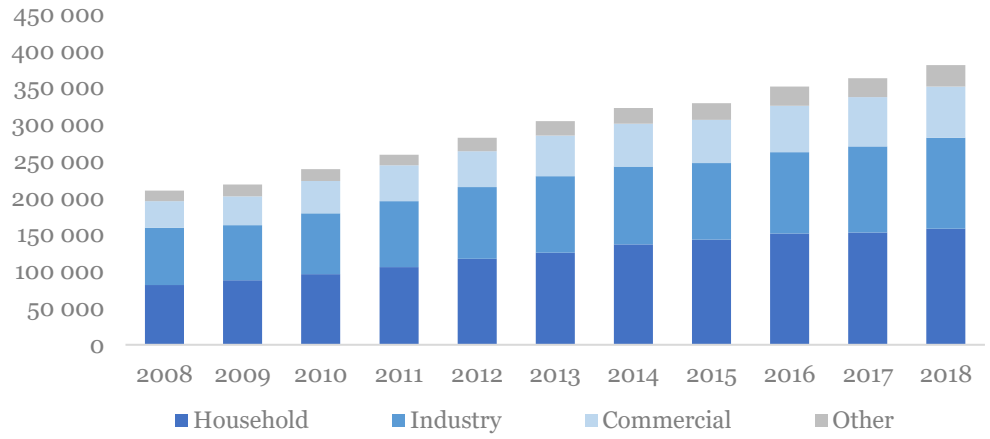
Indonesia's total energy mix is around 2,3 million GWh and is expected to double by 2025

Electric Power System

Indonesia's peak load has during recent years been growing at 6% per annum and reached a peak of 38 GW in 2018. The electric power system in Indonesia can be considered inefficient as the capacity factor only reaches 52% and loss in transmission constitutes around 10%. Indonesia is importing electricity from Malaysia for some areas across their shared border. Power imports are increasing rapidly with the figure amounting to 1.5 TWh in 2018.

Electricity consumption in Indonesia is mainly driven by non-productive electricity consumption from households that constitute 41% of total PLN sales as illustrated in figure 13. Meanwhile, the industry absorbs 32%, and the commercial sector accounts for 18%. The consumption itself has been growing at 6% yearly.

Figure 13. Electricity Consumption by Sector (on PLN's system)
(2008 - 2018, GWh)



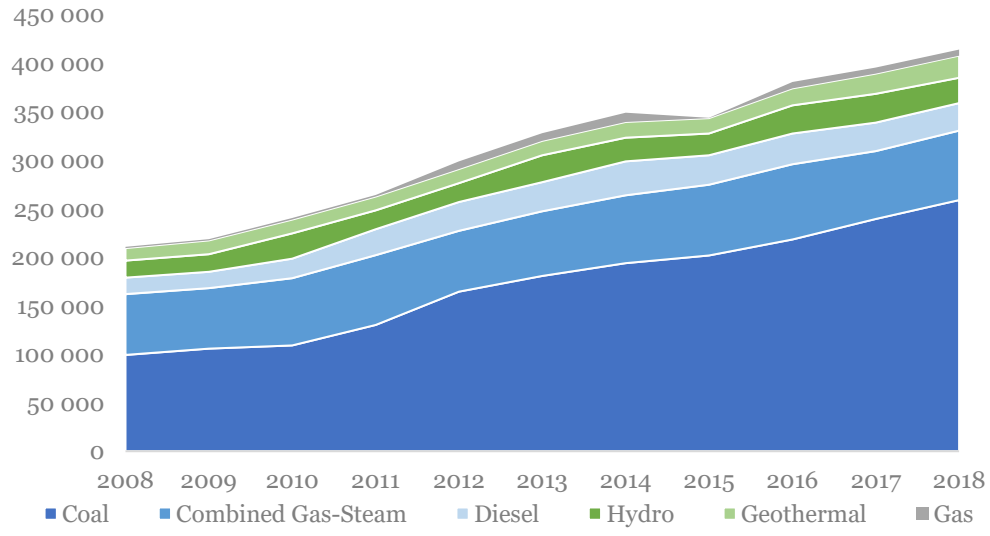
Household's electricity consumption still outpaces that of the industry

Source: Handbook of Energy & Economic Statistics of Indonesia, 2018

72% of Indonesia's electricity is generated by power plants owned by the National Electricity Company (PLN), while the rest is supplied by Independent Power Producers (IPPs). Electricity supplied by PLN and IPP are transmitted and distributed through the grid owned by PLN. PLN enjoys a monopoly in electricity trading, excluding limited concessions in captive power in industrial estates.

Figure 14. Electricity Generation by Energy Source (on PLN's system)

(2008 - 2018, GWh)



Coal is projected to remain the dominant source of power plant fuel in Indonesia

Source: Handbook of Energy & Economic Statistics of Indonesia, 2018

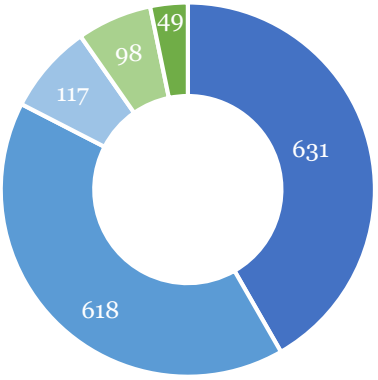
CO_2 Emissions

The fast-paced economic growth of Indonesia has instigated the conversion of natural forests into plantations, industries and new settlements. Unfortunately, the forest conversion has not been conducted sustainably. There have been cases where irresponsible entities used illegal and uncontrolled fire for land clearing, which further has led to high levels of greenhouse gas emissions.

In 2015, Indonesia was the 4th largest greenhouse gasses emitter globally. Deforestation due to palm oil plantations are the main contributor of Indonesia greenhouse gas emissions. Forest fire and peat-land fire are the main contributors to Indonesia's carbon emissions (42%) alongside energy (41%), agriculture (8%), waste (6%), industrial process and product consumption (3%) – figure 15.

Energy provision and utilisation have also contributed almost the same numbers of CO_2 equivalent emission as the forest and peat-land fire.

Figure 15. Indonesia's CO_2 Emissions by Economic Sector
(2018, tons of greenhouse gas CO_2 equivalent)



- Forest and Peat Fire
- Energy
- Agriculture
- Waste
- Industrial Process

857 thousand Ha (~45 times Stockholm area) **of Indonesian forest and peat-land was put on fire in 2019**

Source: Ministry of Environment and Forestry

Key National Energy Policies and Targets

There are three main energy targets set in Indonesia: energy sustainability, energy security and energy equity. The government of Indonesia has set ambitious energy targets to be achieved within the next 5 and 10 years.

Within energy sustainability, the target is for new and renewable energy to constitute 23% in 2025 and 31% in 2050. Indonesia's total energy mix in 2018 was 2.3 million GWh while the target in 2025 is 4.7 million GWh. With this projection, renewable energy is targeted to grow sevenfold within five years.

In terms of energy security, Indonesia is expected to still rely on fossil fuel for the next five years. The main backbone of the energy security will be coal and gas while crude oil is expected to reduce significantly. The reduction in using crude oil has been shown by the fact that Indonesia is no longer an oil exporter and in the slowing down of new exploration activity.

On energy equity, the target for 2025 is 100% electrification ratio and 1.4 tons of oil equivalent energy consumption per capita. Reaching the electrification target faces significant challenges because of its geographical nature as an archipelagic country. This

means that electrification is not achievable through several big grids but would require a proportional distribution of grids all over Indonesia.

As part of the Paris Agreement, Indonesia has pledged a commitment to reduce 29% of greenhouse gas emissions. This target is not impossible, and it is estimated that Indonesia can go even further and reduce emissions by 41% if it has international support.

Indonesia has established a task force to monitor and synergise all efforts within greenhouse gas emissions. The main task of this team is to set up guideline and manage local governments in developing their greenhouse gas emission reduction initiatives.

Key Public Institutions in the Energy Sector

The Government of Indonesia, through its ministries, agencies and state-owned enterprises have established a set of policies and regulations for energy management.

Energy is a strategic issue for Indonesia and the government plays a vital role in regulating and stimulating the market. Most of the important stakeholders within energy and the environmental market in Indonesia are government related institutions.

Ministry of Energy and Mineral Resources carries out formulation, stipulation, and implementation of policies in the energy sector, and mineral resources. There are four main Directorates General under the coordination of this Ministry: Directorate General of Oil and Gas, Directorate General of Electricity Power, Directorate General of Minerals and Coal, and Directorate General of New, Renewable Energy and Energy Conservation.

Key stakeholders for the development of renewable energy and energy efficiency are as follows:

- **Directorate General of New, Renewable Energy, and Energy Conservation** is responsible for formulating and conducting policy in the field of development, controlling, and supervision on geothermal energy, bioenergy, various new and renewable energy and energy conservation.
- **Directorate General of Electricity,** is responsible for formulating and implementing policies in the field of development, controlling, and supervision for any activities on electricity.

Ministry of National Planning (BAPPENAS), main responsibilities include formulating national development plan and drafting budget, acting as a think-tank, coordinating policies on various levels (cross-sectoral, cross-regional, national and regional) and administering planning documents, including loans and grants.

Ministry of Environment and Forestry, main tasks are in the formulation and establishment of policies in the field of organizing the stabilization of forest area, sustainable environmental development, and conservation management of natural resources and ecosystems.

National Energy Council was established in 2007 as counterpart of the Ministry of Energy and Mineral Resources, which mainly focuses on establishing the National Energy Policy (KEN), National Energy General Plan (RUEN), energy crisis response (Krisdaren), and cross sectoral coordination in energy issues.

Agency for the Assessment and Application of Technology (BPPT), a government agency whose main roles are engineering, technology assessment and audit, technology transfer, technology intermediation, science technology disbursement and technology commercialisation.

National Electricity Company (PLN) is the only utility company that controls the whole value chain of electricity in Indonesia. Its main missions are conducting

electricity business that improves the macro-economy as well as people's material wealth whilst safeguarding environmental concerns. PLN translates General Planning on National Energy (RUEN) to General Planning on Electricity Provision (RUPTL).

Energy Prices and Incentives

The government of Indonesia applies certain subsidies in energy such as in gasoline (RON 90), electricity (less than 450 kVA) and gas (3 kg containers). In 2019, the government was expected to spend around USD 11 billion on energy subsidies.

The subsidy could be higher in areas where transportation and logistics are challenging. The government started to implement one price for the whole nation to balance the growth of economy in Indonesia.

Coal prices are following the international market. However, there is a domestic market obligation and cap price applied to ensure the coal provision for existing power plants which are mainly coal fired.

Electricity price for end-users is around 0,1 USD. The price varies depending on the size of household or end user. Subsidies are applied for small capacity.

The only utility company in Indonesia, PLN, is the single buyer of electricity produced by private power plants. 72% of power plants are owned by PLN owns and the rest are owned by the private sector. Private companies that plan to provide electricity through the PLN grid require a Power Purchase Agreement with PLN.

To have a good distribution of power plants all over Indonesia, the government has set a regulation on power purchase prices for different locations. Areas with low price power generation (mostly coal fired plants that were built more than 20 years ago), tend to have a low price incentive as opposed to renewable energy power plants.

Regulation of Ministry of Energy and Mineral Resource No 70 2019 highlights the regulations on renewable energy tariffs. This regulation is marked as a major revision of the feed-in tariff mechanism enacted for renewable energy whose incentive is transformed from a quota-based and fixed feed-in tariff to production cost-based incentive. Ministry of Energy and Mineral Resource of Indonesia considers the new incentive under this regulation as not a pure feed-in tariff, but rather a different scheme of incentives given for the renewable energy generation purchased.

Key Policies in Energy Sector

Some polices has been cascading down within the energy sector – mainly sourced from Indonesia's 1945 constitution.

National Mid-Long-Term Plan (RPJMN), created by Ministry of National Planning (BAPPENAS), develops 5-year planning including within energy sectors, resources, and roadmaps in utilising these resources.

National Energy Policy, developed by National Energy Council which mainly focuses on energy resources and national energy demand, energy development prioritisation, national energy resource utilisation, and the national energy reserve. The latest National Energy Policy was established in 2014.

General Planning on National Energy (RUEN) developed by Ministry of Energy and Mineral Resources is established every five years based on the national planning. This planning also elaborates on the current and future energy states in Indonesia, vision, mission and targets, including strategies. This is then developed by National Electricity Company (PLN) which includes the development of power plants, transmission, distribution lines, sub-stations and other infrastructure.

Regulations on Renewable Energy

Indonesia has yet to set a specific law (Undang-undang) that acts as the umbrella for all policies within renewable energy. This law is still under draft under the political process and is set to be promulgated by 2020. The ultimate policy within renewable energy is the responsibility of the Minister of Energy and Mineral Resources and only covers energy. Some areas that require cross-ministry collaboration are not well covered in this regulation as PLN, Ministry of Industry, Ministry of Environment and Forestry and others are not part to this process.

In order to protect local business, the Indonesian Investment Coordinating Board (BKPM) has released a "Negative Investment List", which specifically mentions electricity provision. Foreign shareholding restrictions apply under Indonesia's current Negative Investment List as follows:

- <1 MW closed to foreign ownership
- 1–10 MW up to 49% foreign ownership
- >10 MW up to 95% foreign ownership or 100% foreign-owned if the project is procured under the Public Private Partnership (PPP) scheme.

The Minister of Energy and Mineral Resources regulates the cost of Generation Provision (BPP). The BPP figures represent PLN's cost of procuring power from different systems/sub-systems which is combination of self-generating, independent power producers and power rentals.

The national average BPP increased to USD 7.9 cents per kWh compared to 2017, mainly due to the IDR's (Indonesia's local currency) devaluation against USD. If the average cost of generation of the local grid is higher than the national average, the tariff may reach up to 100% of the local BPP for municipal waste, hydropower and geothermal and 85% of the local BPP for other renewable technologies. If the local BPP is less than or equal to the national average, the tariff will be determined by agreement between the developer and PLN on a bilateral basis. In practice, however, PLN seeks to cap the tariff in these scenarios as well.

The main restriction and drawback from these regulations is that PLN is the only off-taker of the renewable energy IPP. The cooperation scheme between PLN and the IPP is based on the Build, Operate, Owned, Transfer (BOOT) scheme. At the end of the Power Purchase Agreement (PPA), The IPP must transfer the ownership to PLN. Also, it is most likely that PLN will prioritise an IPP that uses local components as stated in the prevailing regulations.

Regulations on Energy Efficiency

Energy conservation is regulated under Government Regulation No 70-year 2009 which states that the accountability of the effort is under government (provincial and municipalities), private sector and greater society.

This law also mentions that energy utilisation more than 6 kilotons of oil equivalent (~70 GWh) are required to have energy management systems which cover the management, plan, audit, continuous improvement and reporting.

Some Ministry of Energy and Mineral Resources regulations are also identified in order to support the energy efficiency initiatives, such as:

- Energy efficiency in government buildings specifically for AC (temperature, operating hours, technical aspects) and lighting (Watt/Lumens, armature, locations)
- Energy saving labelling for home appliances as lamps, ACs, irons, refrigerators, TVs, fans, and rice cookers.

The Directorate General of Energy Conservation in the Ministry of Energy also complements the Ministry Regulation by implementing Minimum Energy Performance Standards (MEPS) for some home appliances, such as lamps and air conditioning systems. The Energy Plan has identified potential savings in various sectors, as follows:

Table 9. Indonesia's Potential Savings Identified by the Energy Plan

Sector	Energy Savings	Energy Saving Target (2025)
Industry	10-30%	19.7%
Commercial	10-30%	24.2%
Transportation	15-35%	19.4%
Household	15-30%	23.5%
Others (Farming, Construction and Mining)	25%	12.7%

Source: National Energy Council, General Energy Plan 2016

Renewable Energy

Oil, traditionally the energy backbone, is predicted to productively last for some 12 more years. On the other hand, coal and gas will last for not more than one generation. Indonesia's solar coverage exposes the area for around 10 hours per day all around the year. Located between Pacific Ocean and Indian ocean and having the 2nd longest coastline in the world means potential for wind and tidal energy. Some active volcanoes that are part of Pacific and Mediterranean volcano trench also provide potential for geothermal energy production.

However, the potential also needs to be exploited. An incentive structure to switch to green energy is needed, particularly ones that ensure that green energy is affordable for end customers. It is expected that along with economies of scale and technology development, green energy will become more affordable.

Situation Overview

Renewable energy in Indonesia is still underdeveloped in terms of policy, investments, and technology implementation. Solar energy comparatively is the most progressive one. Policies on solar rooftops, export import metering, and local content on solar panels have been implemented in Indonesia. The projects are also growing in number, especially within government buildings or in remotes area without grid connection. However, financial constraints still hinder the development of the industry and require government incentives to open the block.

Biomass can be seen as the second most interesting renewable energy source in Indonesia considering the vast amount of the resources, especially within agriculture and specifically palm oil. Certain palm oil companies have developed their own biomass power plant in order to supply their own energy demands in their palm oil mills. Affordable technologies that can be deployed in rural plantation areas would be likely market successes in Indonesia. Cooperation with plantation companies in deploying the technology is a must.

Some challenges also hinder the development of other sources of renewable energy such as geothermal, wind, biogas, hydropower, and waste-to-energy. Indonesia currently only has two wind farms. Geothermal is considered an expensive technology. Biogas utilisation is still limited and hydropower deployed technology is still very rudimentary.

Main Opportunities in Renewable Energy

Solar Energy

As a country situated around the equator, Indonesia is exposed to ample sunlight throughout the year. The duration of days and nights is almost equal during the whole year. These conditions have provided abundant solar energy potential for Indonesia.

Notwithstanding the decreasing price of solar panels, the solar power plant industry in Indonesia is immature. Less than 0.02% of Indonesia's electricity supply comes from solar power. Of the existing 135 MW installed capacity, 91% still comes from ground mounted solar power plants while the remainder comes from solar rooftops.

Solar panels could rise as a solution due to its ability to cover areas where power grids are not available. In order to achieve the full implementation of solar power, the government since 2018 encourages the development of solar rooftops through a set of policies and incentives.

Key Solar Energy Policy and Targets

Solar farms with capacity between 2 and 15 MW have been deployed in Indonesia. Most of the solar farms are in eastern parts of Indonesia, such as in East and West Nusa Tenggara, where grid coverage is not available.

Solar rooftops enable households and industry to reduce their electricity bill to PLN. Through export/import metering, the end users could also supply excess electricity from their solar system to the grid. By June 2019, there are 1059 solar rooftop connections, of which mostly are in urban areas in Jakarta and West Java.

Some cooperation targets have been set to realise the existing potential:

- Ministry of Energy and Mineral Resources signed a cooperation with the Indonesia Renewable Energy Society and Indonesian Real Estate to apply solar rooftop for the newly built real estate.
- Ministry of Energy, Ministry of Industry, Associations, research centres, chambers of commerce and universities also pledged a program called A Million Solar Photovoltaic Installation. This initiative includes executing installation of solar rooftops in all Ministry of Energy and Mineral Resources buildings, the presidential palace, military bases, and in some other government buildings.

In addition to achieving 23% renewable energy in the energy mix, Indonesia also needs to reduce the import dependency and enhance the local industry capacity. Regardless of the local industry readiness, the government has pushed the implementation of local content policy on solar energy systems.

Investment in the Solar Energy Sector

Most of the investments in solar energy are aimed at fulfilling the electricity provision (RUPTL) in the eastern part of Indonesia. Currently, the provision of solar power plants still relies on imports. It has now become the mission of the government to localise the supply chain in solar power plants. Currently, the investment is mainly aimed at solar wafers, as no local players have the capacity to produce solar cells themselves.

Opportunities and Challenges for Swedish Companies

The potential of solar energy and the government's ambition to achieve 23% renewable energy mix in 2025 has generated some potential opportunities for solar power plant businesses in Indonesia. The opportunities presented include, but are not limited to, solar panels, inverters, batteries, metering and safety systems.

As identified by the Indonesian Minister of Energy and Mineral Resources, the potential of solar power utilisation are as follows:

Table 10. Indonesia Solar Power Potentials

Cluster	Solar Power Potential (MW)
PLN Electrical Provision (RUPTL)	904
Solar rooftop	2 981
Floating solar system	2 207
Industrial Estate	1 508
Underdeveloped regions	1 042
Fishery	1 700

Source: Ministry of Energy and Mineral Resources

State Owned Enterprises are also expected to implement solar rooftop systems in its operational activities. 143 SOEs need to implement around 1.4 GW within 5 years. The implementation of solar rooftops includes airports, fuel stations, train station, mine site, factories, offices, ports and warehouses.

Some identified challenges that potentially hindered the development of Swedish companies within solar power plant in Indonesia are:

Technical challenges: Interconnectivity is now becoming an issue in Indonesia as PLN sees risks when they allow electricity from rooftops to the grid. This could generate uncertainty and power quality issues for the grid. PLN is susceptible to grid imbalance should they pursue to implement it.

Investment challenges: Low levels of investment is hindering the development of solar system in Indonesia as very few banks and financial institutions express interest in funding solar power systems. Unattractive interest rates may apply which further discourages investors to develop solar power plants.

Regulation challenges: Particularly in pricing, high local content and Build Owned Operate Transfer (BOOT) schemes. Pricing and local content is not supportive in the development of new implementation of technology. BOOT pushes the investor to transfer the ownership to the government after several years which makes the exit strategy difficult.

Biomass Energy

As a tropical country, the production of agricultural products in Indonesia involves large amounts of agricultural waste (i.e. biomass) being generated each year. That being said, only around 3% is being utilised.

In addition to these types of solid biomass, Indonesia also has around one million tons of raw garbage and other waste generated by its municipalities and industries each year. Industries like pulp and paper and palm oil have recently turned to utilise their waste to generate electricity for internal use.

Projects within biomass and biogas can only be conducted by Independent Power Producers (IPP) whose feedstock is enough for the entire operational period. The projects must also be conducted through the direct selection mechanism.

Indonesia has abundant resources of bioenergy, particularly biomass. While the country generates large amounts of agricultural waste, currently biomass energy is still mostly coming from waste instead of industrial farming.

Indonesia is the biggest palm oil producer in the world with forests being converted into palm oil plantations. Palm oil is expected to be a source of future green fuel, and its waste also could produce electricity. 91 MW of biomass power plant capacity is installed, and 90% of it is fuelled by palm-based plantation.

Key Biomass Energy Policy and Targets

The National Energy General Plan (RUEN) issued by the President in 2017 has established guidelines on energy provision including biomass as one of the fuel resources. The overall sources and potential can be seen in the following table.

Table 11. Indonesia Biomass Source

Raw Material	Part	Potential (MWe)	Remarks
Palm	Fiber, shell, empty fruit bunch, POME, frond	12,654	Mainly in Kalimantan and main source is from frond
Sugar Cane	Bagasse and Sucar cane leaves and shoot	1,295	Mainly in Java and Bali
Rubber	replanting	2,781	Mainly in Sumatera
Coconut	Fiber and Shell	177	
Paddy	husk and straw	9,808	Mainly in Java and Bali
Corn	Corncob, stems and leaves	1,733	
Cassava	liquid waste	271	
Wood	Black liquor and wood waste	1,335	Mainly in Sumatera
Cow	Manure	535	Mainly in Java and Bali

Source: Ministry of Energy and Mineral Resources, Strategic plan 2015-2019

Power Purchase Agreements from biomass power plants require ensuring the adequate feedstock supply during the contract period. In areas whose cost of power generation is above the national cost of power generation (mostly in eastern part of Indonesia), electricity from biomass power plants could be bought by PLN at maximum 85% of the area cost of generation. In areas whose cost of generation is lower than national cost of power generation (in 2019 at USD 7.9 cents per kWh), the electricity price is subject to negotiation between PLN and the power plant owner.

Investment in Biomass Energy Sector

Investments into biomass power plants are commonly financed by palm oil or other plantation companies that use the energy from the power plant for milling and other processing facilities. The excess power produced by the power plant could also be connected to powering the surrounding villages or even connected to the PLN grid.

An EPC company, which in some cases can be a subsidiary of a plantation company, will be the project owner who integrates the whole end-to-end process. The process includes feasibility study development, technology selection, engineering design, civil construction, fabrication, and even operation and maintenance.

However, this does not imply that the EPC company has all these capabilities. They usually engage with other sub-contractors and technology providers. Cooperation between Swedish companies and the EPC companies and the plantation owner would be crucial to further develop biomass power plants.

Opportunities and Challenges for Swedish Companies

There are limited technologies available to process feedstock (plant or waste) into electricity or heat in Indonesia. Therefore, solutions for this issue is in high demand. It is also crucial for the solution to be able to handle plantation or waste variability. Furthermore, pelletizing or bracketing technology is also needed for storage and transportation purposes.

Industrial waste, such as waste from palm and sugar processing industries, could produce fiber, fertiliser, or other derivatives which have higher value-add. An analysis and technology transfer in producing downstream products could also present opportunities for Swedish companies.

Most of the opportunities within biomass is in palm oil plantations. Indonesia is among the largest palm oil producers and some of the waste is being exported to certain countries such as China and Japan. These companies then process the waste into green fuel as pellets/briquettes to fuel their power plants.

Some coal mining companies, such as Adaro group, has announced their intention to move toward sustainability. It is now actively seeking for technology that could utilise their waste generation from their palm oil plantations. Palm oil is however not their major business as they use it as collateral to their coal mining business.

Some challenges identified when Swedish companies plan to develop a biomass power plant project in Indonesia are as follows:

Technical challenges: Most of the energy consumption of biomass is allocated to industry (64%) and households (34%), which means that only small portions of electricity generated is connected to the grid. An understanding of the industry energy demand, as well as a social and environment impact analysis, is needed.

Organic feedstock in Indonesia means variability within quality and quantity. Variability in quality means that the biomass power plant should have flexibility in terms of quality of the feedstock that fuels the process. Variability in quantity means that the industry requires a combination in sources of energy such as biomass and diesel/natural gas to mitigate this situation. Palm oil – which has high content of sulphur and potassium and could develop slag in the boiler – needs to be handled correctly without significantly adversely affecting the cost structure.

Investment challenges and regulation challenges: The government requires the development of biomass power plants to have sustainable supply of raw materials in the power purchase agreement contract with PLN. Local companies would likely require an active financial contribution of Swedish companies in the ownership of the JV company to mitigate their investment risk.

Feedstock ownership requirements and Build Owned Operate and Transfer (BOOT) schemes may hinder the execution of biomass projects in Indonesia. A collaboration with Indonesian companies with turnkey project capabilities is a must.

Other Opportunities in Renewable Energy

Wind Energy

The president of Indonesia inaugurated two wind power plants in Sulawesi, Sidrap (75MW) and Jeneponto (72 MW) in 2018. Historically, wind has not played an important role in Indonesia's fuel mix.

In general, Indonesia is not an ideal location for wind energy generation due to its geographical position. There are only around 19 locations that are identified to have sustained wind speeds above 5m/s with specific power around 5W/m^2. These locations are Jogjakarta, Central Java, South Sulawesi, East and West Nusa Tenggara and North Sulawesi.

Geothermal Energy

Indonesia is situated between two volcanic trenches to the East (Sulawesi, Nusa Tenggara and Bali) and to the West (Sumatera and Java). This locality provides the country with approximately 28.5 GW of potential energy. Nevertheless, the utilisation of this energy resource is only slightly less than 2 GW.

Geothermal is the most highly regulated energy sector in Indonesia. There are around 13 Minister regulations issued within the last 6 years which are comprised of geothermal activity, asset ownership status, electricity provision, exploration commitment, indirect geothermal utilisation, etc.

Biogas Energy

Biogas can be produced from organic materials, such as animal manure, organic waste (rice straws), water plants (hyacinth and seaweed), agricultural industrial waste (tofu palm, tapioca processing waste) and sludge (municipal as well as industrial).

Indonesia has a large number of farm animals as raw material for biogas, including 17.5 million dairy cows and beef cattle, as well as approximately 15.6 million cattle equivalents of 1 million household biogas digester units (3.9 TWh). Liquid organic waste from the oil industry (pome), and the tofu industry can also be harnessed into biogas. With all these sources, the untapped potential of liquid waste is to be seen as significant.

At the moment, the utilisation of biogas is very limited to cooking, lighting, and power plants. Byproducts of the process are also utilised as fertilisers and animal feed.

Hydropower

Indonesia's topography and water resources provide potential for further hydropower plant development. Hydropower plants contribute around 6.4% of total energy supply in Indonesia. Hydropower plants could be considered as base load and have relatively stable supply of energy. However, the development of hydropower plants requires a lot of stakeholder involvement and complex processes.

The most recent hydropower plant was built in Jatigede, West Java. This project has relocated 11,000 people and left problems within forest conversion among other environmental impacts.

Smaller micro hydropower plants (less than 200 kW) were built and distributed all over Indonesia. This concept is well developed for communities in rural areas that PLN could

not reach and cover. There are however still challenges, particularly during drought season which will result in low water levels.

As an archipelagic and maritime country, approximately 70% of the area in Indonesia is covered by water. The country has some narrow straits which ideal for tidal energy development.

The Ministry of Energy and Mineral Resources has calculated that there around 18 GW of energy potential that could be generated from ocean. Most of the tidal and wave energy power plants is still in pilot project phase under universities or research institutions.

Waste-to-Energy

A growing population, urbanisation and consumer lifestyles are several reasons behind why waste volume is significantly growing and becoming a big issue for Indonesia. The situation is worsened given that the capacity of waste treatment plants that are not sufficient considering the waste generation. Some cities are now facing issues where their waste landfills are over capacity.

As part of the SDG target no 11, Indonesia needs to reduce the amount of waste generation by 20% from current 65 million tons per year. This also includes increasing the waste handling by 80% (from collection to proper treatment).

To overcome this situation, President Jokowi has issued a regulation on waste-to-energy that give incentives to 12 main cities in Indonesia to develop their waste-to-energy plants. This regulation intends to accelerate the development of waste-to-energy power plant that is based on municipal waste.

The main purpose and priority of waste-to-energy power plant in Indonesia is not on generating electricity from the waste but rather on reducing the volume of waste. Incentives are given to these 12 main cities in the form of feed-in tariffs for electricity that is being produced by the power plant, as well as tipping fees for handling the waste.

Energy Efficiency

As the country's fossil fuel resources are limited and it takes time to transition toward renewable energy, energy efficiency arises as new area of focus. The government has set energy intensity targets and incentives for energy efficiency but has a long way to go in terms of implementation.

Situation Overview

Indonesia sees energy saving potential at various levels in different sectors as transportation, household and commercial. Transportation sector is the biggest energy consumer has energy saving potential at 15-35%. The savings could come from mass transport implementation, fuel switching and transport management systems. Households are expected to be able to reduce the energy consumption by 15-30% through the implementation of an energy efficiency standard (Label and MEPS) and increasing public awareness. Commercial sectors also have potential to fulfil energy saving at around 10-30% with some programs set by the government as energy audits, pilot projects, energy efficiency standards, and online reporting system.

Smart grid technology is on high demand for Indonesia situation where outages and losses still frequently happen. Specific areas which require a premium quality and reliability of electricity has given rise to niche opportunities for the development of smart grids in Indonesia.

Energy efficiency within buildings are of potential interest to Swedish companies. Jakarta as the capital city's high-rise building is growing at 7% annually. Innovative technologies within building envelopes, HVAC, and transportation within buildings are believed to increase the building energy efficiency.

Manufacturing in Indonesia contributes 20% of the GDP with F&B, automotive, chemicals and textile as the main sectors. UNIDO and Ministry of Energy and Mineral Resources have developed guidelines on applicable technologies for energy efficiency in industries. However, some enablers as financiers, policies on business models, and other incentives are still in the developing stage.

Main Opportunities in Energy Efficiency

Energy Generation and Transmission

Electricity generation, transmission, and distribution in Indonesia are dominated by a national electricity company, PLN. Within the power generation business, PLN has started to reduce its dominance as its limited financial capabilities do not allow for development of all power plants in Indonesia, which targets to build 35 MW of additional capacity in the period between 2015 to 2025.

The archipelagic topographical situation of Indonesia makes it impossible for the country to have connected grids. There are three main grids that has its own grid code, namely Jamali Grid, Sumatera Grid and Sulawesi Grid. The remaining areas are limited to small distribution coverage.

Indonesian transmission lines are often long and inefficient. The total transmission line is 47 thousand kilometres with 4.2 TWh (2.4%) loss in 2017. The same situation applies to distribution process whose losses around 12 TWh (7.2%) and System Average Interruption Duration Index (SAIDI) 14.6 hours and System Average Interruption Frequency Index (SAIFI) of 9.7 times.

Indonesia's main grids have grid codes that should be followed by users. However, it is neither well implemented nor enforced as there is no penalty applied or is subject to negotiation with the end users.

Jamali (Java, Madura and Bali) has the biggest grid in Indonesia. However, the Java blackout that recently happened in August 4th 2019, showed that even the biggest and most advanced grid in Indonesia is subject to vulnerabilities. This outage was on-going for almost 24 hours. Evaluation was subsequently made, and the government realised that there are still gaps of understanding on several issues, such as how to have a grid

responsive to fluctuation of supply and demand, asset management, grid automation, and other initiatives related to grid reliability.

Key Energy Generation and Transmission Policy and Targets

The Directorate General of Electricity in the Ministry of Energy and Mineral Resources has established certain corridors for the electricity provision in Indonesia, especially within the three main grids: Sumatera, Jamali, and Sulawesi. Grid codes have been set up, however enforcement on this is still challenging.

Energy loss in transmission and distribution is also an issue for PLN. However, there are no clear targets or roadmaps on how to reduce the total loss – that is estimated to have reached around 9.4% in 2019, which was worse than in 2018.

President Jokowi has issued regulations on the acceleration of the electric vehicle infrastructure in Indonesia. This regulation provides incentives for PLN to develop their grid reliability to cope with the electricity hikes due to a projected increasing fleet of electric vehicles.

Investment in Energy Generation and Transmission Sector

Investments in smart grid and other energy efficiency equipment within electricity generation and transmission is mainly done by PLN. Investment plans by PLN are stipulated in the Electricity Provision General Plan (RUPTL).

PLN requires companies to conduct a pilot project before implementation into the grid. The aim of the pilot projects would be to showcase the benefits and value of the technology including the possible up-scale implementation and the monetisation of the technology.

Smart grid technology in some specific microgrids has been implemented. The Government of France has signed an agreement with PLN on March 2019 to develop smart grid in Mandalika, East Nusa Tenggara. This project mainly focuses on integrating renewable energy power plants into the grid.

The Ministry of Energy and Mineral Resources, National Electricity Company, and NEDO Japan (New Energy and Industrial Technology Development Organization) have developed a smart grid system in one of the densest industrial estates; Suryacipta Karawang. Main technologies implemented are distributed automation systems, Uninterruptible Power System (UPS), and demand side management.

Opportunities and Challenges for Swedish Companies

The aims for a smart grid system are stipulated in PLN Electricity Power Provision General Plan (RUPTL) 2018-2027. The smart grid is expected to improve PLN performance in some respects and Swedish companies have discernible potential in developing the system with PLN:

- Electricity planning, a system that could monitor the whole grid and conducting predictive maintenance and asset management will be required
- Power reliability, fault preventive system, power quality monitoring and control, and communication systems
- Widened coverage – electrification ratio aligned with the economic growth demand. Distributed power plants from renewable energy that could easily be deployed would strengthen the PLN aim for 100% electrification ratio.
- Metering system – prepaid and advance metering infrastructure. Automatic meter reader, smart metering, and export-import metering that enable solar rooftops are also opportunities for the Swedish companies.

Besides PLN, there are some concession areas which cover niche industrial estates. The electricity in these areas are supplied by Integrated Utility Company, such as Bekasi

Power and Cikarang Listrindo. These companies are relatively open and adaptive to new solutions and set high standards of service to their customers.

Around 28% of power plants in Indonesia are owned by the private sector, which could become potential customers for Swedish companies. The private sector is more flexible in the adoption of new technologies if there is a strong business case that could guide them in the decision-making process.

Along with the opportunities, there are some challenges identified in grid improvements in Indonesia:

Technical challenges: PLN is a single player in electricity utilities, especially in transmission and distribution in Indonesia. This situation has made PLN less adaptive to new technologies and methodologies. For new technologies to be adapted by PLN, it generally needs a long and bureaucratic process of review and evaluation.

The domination of PLN also leads to the customer having low bargaining power in advocating for satisfactory power quantity and quality, making the implementation of smart grid less prioritised.

Regulation challenges: To some extent, PLN requires that solutions adapted to have local content. A foreign principal would need to partner up with a local distributor that is listed in PLN vendor list.

Investment challenges: European products in general are perceived as a good quality and premium. On the other hand, State Owned Enterprise like PLN suffer from budget constraints and are price sensitive. PLN budgets at the end of the year for the following year's procurement. This situation puts a long lead time to approach PLN, starting from introduction of the product to the procurement decision.

Commercial Buildings

In line with the growth of the economy, urbanisation in Indonesia has increased the demand for commercial buildings such as offices, apartments, shopping malls, schools and hospitals. Jakarta is still considered to be the centre for the commercial buildings in Indonesia with around 9.3 million m^2 supply and a yearly growth of around 7%.

This situation has put fierce competition between property providers and tenants. Property owners may attract their potential buyers by providing green concepts as one of the selling points. The green building concept for new and existing building has started to emerge into a trend.

Governmental institutions like Ministry of Public Works the Jakarta local government have promoted green building concepts and specific regulations on green buildings. This regulation is still not mandatory and there are no laws in the area currently being enforced.

One of the criteria for a green building is energy saving. The implementation of the green building concept is generally said to require a reduction in building's energy consumption up to 25% as opposed to an otherwise equivalent structure. Certain technical requirements on energy efficiency within commercial buildings are building envelope, ventilation, air conditioning, lighting, and electricity system.

In 2017, the urbanisation rate in Indonesia reached 55%. This means that approximately 144 million people lives in urban areas. This condition drives the demand on schools, apartments, offices, hospitals and shopping malls. Jakarta, with a population of around 10 million, is the leading city in terms of number of commercial buildings, followed by the next big cities, such as Bandung, Surabaya and Medan. The rising awareness of

sustainability creates a market for green buildings. Developers that construct green buildings promote values of living sustainably, which in turn increases the leasing fee.

Key Commercial Buildings Policy and Targets

The Green Building concept is mainly driven by the property developers and not by regulators. Some regulations attributable to Green Buildings can be found in the Ministry of Public Works regulations, Jakarta Government regulations and by The Green Building Council Indonesia (GBCI).

The local government of Jakarta mandates buildings with area of more than 50 000 m^2 to implement a green building concept. The green building concepts included are within energy efficiency, water efficiency, air quality, waste management, and construction management.

For energy efficiency specifically, there are some parameters that need to be managed in order to attain a Green Building standard, such as:

1. Building envelope, main parameter is OTTV with maximum 45 watt/m^2
2. Ventilation System, required to reduce the energy consumption within cooling and is to follow Indonesia National Standard (SNI) on Building HVAC
3. Air conditioning, minimum allowable temperature inside the building is 25◦C, 60% humidity. VAV (Variable Air Volume) and VSD (Variable Speed Drive)
4. Lighting requires to follow Indonesia Standard (SNI) on Lighting
5. Mobility requires implementation of traffic management system within the building

Jakarta has targeted 60% of high-rise buildings to be certified as Green Buildings by 2030.

Investment in Commercial Buildings Sector

International Finance Corporation (IFC), one of the World Bank subsidiaries, predicted that the investment potential within Green Buildings in Indonesia could reach USD 200 billion between 2020-2030.

IFC also took part in the development of Green Building in Indonesia. IFC invested 150 mUSD in the form of bonds that was issued by OCBC NISP (Indonesia – Singaporean Bank) to channel the funding to the development of Green Buildings. IFC has claimed that the cost of constructing Green Buildings is 17% higher than the conventional counterparts, but the savings from energy and other resources during the operational lifespan of the building could reach at least 20%.

Opportunities and Challenges for Swedish Companies

Opportunities for Swedish companies whose technology and services are providing better energy state in commercial buildings certainly do exist. Incoming technologies to Indonesia within Green Buildings are expected to be able to match regulations from Ministry of Public Works as below:

1. Building envelope, any technology that leads to building material and design keeping the building's energy consumption low for ventilation, lighting, and air conditioning
2. Ventilation and air conditioning systems that are efficient, integrated, and automated
3. Lighting that has lower energy consumption with the same light intensity
4. Inner building mobility such as energy efficient escalators, travellators, or lifts
5. Electricity system that ensures the reliability and stability of the electrical system in buildings

Some challenges were also identified in implementing energy efficiency technology within commercial buildings in Indonesia:

Technology challenges: Indonesia is not an early adopter of new technologies. Energy efficiency initiatives should showcase the amount of money saved to attract people. Pilot projects and continued market education will gradually shape the market.

Regulation challenges: Indonesia has some codes on Green Buildings which were issued by e.g. Ministry of Public Works, Jakarta Government province and Green Building Council Indonesia. However, these regulations require strong endorsement and law enforcement for the implementation. The current regulation is still voluntary but is expected to be increased to mandatory in certain developments in the future.

Investment challenges: the decision maker of the energy efficiency technology varies depending on its use case. The decision maker could be the building owner, the main contractor, or the building management. It requires understanding on the stakeholder structure and its roles. Regardless of the decision maker, a Return on Investment analysis which includes risks and its mitigation is also required. The market structure on ESCO (Energy Services Company) is still underdeveloped which leads to technology investment risks.

Industrial

Indonesia is today one of the top-10 largest manufacturing nations in the world. The manufacturing sector employs more than 25 million workers and accounted for ~20% of Indonesia's GDP in 2017, totalling roughly USD 203 billion. The sector has seen 6-7% annual growth for several years and is a backbone of the Indonesian economy.

The main contributions are coming from Food & Beverage (USD 63 billion), Petrochemicals (USD 22 billion), Electronics (USD 18 billion, Automotive (USD 18 billion), Chemicals (USD 18 billion), Textile (USD 21 billion), and Others (USD 55 billion).

The Ministry of Industry has identified eight high-energy-consumption industries, namely cement, fertiliser, petrochemicals, steel, pulp & paper, textile, ceramics, CPO mill and sugar. These eight industries have an energy consumption of more than 6,000 toe (tons of oil equivalent or equal to 69 GWh) and mandatorily needs to implement energy management as stipulated in Law no 70-year 2009 on Energy Conservation. This law defines energy management as integrated and structures activities to control energy consumption as effective and efficient in order to maximise the productive output.

Industry in Indonesia has become the backbone of the economic growth. These players are improving their energy intensity since some industries (e.g. textile and cement) in Indonesia are consuming more energy to produce the same amount of output when compared to e.g. India, China and Japan.

Certain policies are set and require cooperation of relevant stakeholders in developing the business environment of the market. Serious effort is needed to reduce the barrier of initial investment of energy efficiency.

Key Industrial Policy and Targets

Indonesia's National Energy Policy has set targets on;

- Energy elasticity (the comparison between the energy demand growth rate to the economic growth rate) achievement shall be less than 1 (one) in 2025 that complies with the economic growth.
- Reduction in final Energy Intensity of 1% per year up to 2025; energy intensity is the total quantity of energy consumption per unit of gross domestic product.

A clear energy conservation policy has been set, including to mandatorily have an energy management system for industries which consumes above 69 GWh per year.

Investment in Industrial Sector

Energy consumption in industry is around 217 mtoe (~ 1.5 billion barrels), with energy saving potential around 10-30% (~ 150 million barrels; ~USD 10 billion). Potential savings could be generated from activities such as energy audits, energy management systems (ISO5001), online reporting systems, energy manager and auditor certifications, awareness and pilot projects.

The Financial Services Authority (OJK) has issued a scheme on green lending to stimulate banks and the financial sectors to commence financing of energy efficiency projects in Indonesia. This condition will encourage banks to support the financing of energy efficiency equipment as for industrial equipment.

Local companies that are part of global supply chains are also pushed to implement energy efficiency initiatives. Japan offers carbon credit mechanisms (JCM) to stimulate the Japanese companies that run its operation in Indonesia to apply certified technology within energy efficiency. The carbon credit is then shared between Indonesian and Japanese stakeholders.

Opportunities and Challenges for Swedish Companies

Some identified technologies that could increase the energy efficiency within industry and opportunities for the Swedish companies are:

- Technology that could minimise the loss on energy within boiler operations is highly needed, such as heat recovery
- 70% of electricity within industry is consumed by electric motors (pump, compressor, conveyor belts, roll mills). Application of VSD could save around 20% of electricity consumption

UNIDO, United Nations Industrial Development, has identified technologies and potential energy savings as bellow:

Table 12. Energy Saving Technologies and Potential Energy Saving

	Energy Saving initiatives	Potential energy saving
BOILERS		
1	Boiler tune up	2-3%
2	Operating pressure reduction	1-5%
3	Preheater installation	4-7%
4	Economiser installation	3-15%
5	Condensate heat recovery	1%
6	Pressure optimisation	1%
7	Heat control instrumentation	1%
8	Heating surface cleaning	1%

WASTE HEAT GENERATOR		
1	Waste heat recovery	5-25%
2	Fuel additive	1-3%
3	Fuel preheating	15
AIR CONDITIONING SYSTEM		
1	VAV control installation	12.6%
2	Heat Exchanger for Incoming air installation	12%
3	AHU Filter, Cooling coil, cleaning maintenance	9.6%
4	Outdoor air intake minimisation	7.2%
5	Multiple chiller optimisation	6%
6	A/C condenser temperature increment	4.9%
7	Over-sized electrical motor replacement	4.1%
8	Set point increment to 25,5	3.8%
9	Office relocation to lower cooling load	3.6%
10	Airflow to condenser modification	3%
11	A/C equipment run down reduction	2.3%
12	Variable speed pumps installation	1.6%
13	Small A/C for separate space installation	1.3%
14	High efficiency pump installation	1.3%

Renewable energy that produces heating (or cooling) such as solar thermal or waste heat recovery engines have opportunity in reducing the fossil fuel consumption for boiler or chiller in the industry.

Some challenges area also identified on the implementation of energy efficiency technologies in industry sector as follow:

Technology challenges: Technologies within energy efficiency in industry are well developed. Big players from Japan, China and Germany are active in the market with their solutions. The main issue lies at the implementation of the technology.

Industries are reluctant to replace their current technology with more efficient technologies, especially when the lifetime of existing technology are still quite long. Besides, retrofitting is often avoided because it may require operational processes to shut down. Hence, there are a possibility of loss from production stops.

Regulation challenges and investment challenges: The business environment on energy efficiency needs to be developed further. Implementing energy efficiency requires stakeholders who act as energy auditors, financiers who understand energy efficiency, investment grade auditors and as an energy services company. The government has issued regulations on Energy Services Company (ESCO). However, the regulation was revoked because of processes ostensibly aimed at bureaucracy simplification.

Other Opportunities in Energy Efficiency

Residential Buildings

Energy efficiency within residential buildings are mostly in the utilisation of energy saving home appliances which has been standardised by the government and has a Minimum Energy Performance Standards (SKEM) label.

Figure 16. Indonesia Energy Label for Appliances

Source: Ministry of Energy and Mineral Resources

Home appliances that should follow SKEM are air conditioners, lamps, irons, refrigerators, TVs, fans and rice cookers. The air conditioner market in Indonesia is growing rapidly with prominent Japanese and Korean brands, such as LG, Samsung, and Daikin, dominating the market. European brands, such as Electrolux, are not performing as well as the aforementioned brands.

The larger real estate society and Ministry of Energy and Mineral Resources have signed an MoU on renewable energy development, particularly on solar rooftop applications in residential buildings. It is expected that by implementing solar rooftops, energy monitoring within housing could be implemented. Energy monitoring and evaluation are expected to raise the awareness of homeowners and further reduce house energy consumption.

The "Smart home" concept is still in very early stages and limited to high-end residential dwellings. Applications like smart control, smart energy monitoring, smart sensors are starting to be provided by some players.

Transportation

The oil boom in the 1970s significantly affected oil producer countries, including Indonesia. The high price of oil has driven Indonesia's economy growth and made the oil industry – together with its derivatives and related businesses – a significant cornerstone of the economy. Automotive, being one of the industries that have leveraged the oil boom the most, has also benefitted by the characteristic of Indonesian consumers that heavily favours private transportation. Heavy reliance on private transportation has put made Indonesia dependent on fossil fuels.

After Indonesia's financial crisis in 1998, the state budget suffered due to the overall downturn in the economy and left consumers depending on fuel subsidies by the government. The situation worsened with decreasing production of crude oil and limited number of successful new oil exploration activities. This has led Indonesia to be a net importer of oil.

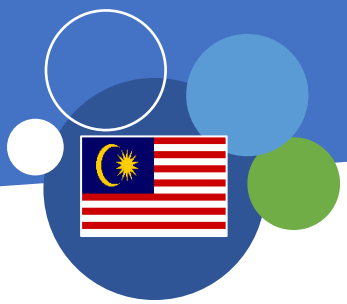
The government has gradually begun to cease the fuel subsidies and shifted the budget for other purposes as infrastructure, health, and public transport. Indonesia's public transportation systems, demanded by the high urbanisation rate and traffic congestion, is getting better. MRT, LRT, BRT, railway, are fairly developed, especially in Jakarta.

In order to relieve the dependency on fossil fuel, The government has put some regulations to accelerate biofuel and EV development. Biofuel is mainly produced from the supply of Crude Palm Oil (CPO) from Sumatera and Kalimantan. Meanwhile, the relative abundance of Nickel may constitute opportunities within the production of electric vehicle batteries.

MALAYSIA

TRANSFORMATION TOWARDS A SUSTAINABLE FUTURE

MALAYSIA – TRANSFORMATION TOWARDS A SUSTAINABLE FUTURE



Country Summary

Malaysia, a country that aspires to be a middle-income nation, is highly dependent on energy for its economic growth. Its variety of energy mix such as natural gas, coal, hydropower and renewable energy, has proven to be reliable in meeting energy needs thus far. As the nation continues to grow, the availability of reliable and affordable energy is not only crucial to drive the country's industrial and commercial developments, but also serves as a basic utility of social needs in ensuring a desirable quality of life for the people.

To provide adequate energy supply for the country amidst rising demand, the government is committed to developing sustainable energy sources through a series of key initiatives and actions to transform its energy supply towards future-proofing and sustainable development. The government has also dedicated efforts in enhancing energy efficiency across all sectors.

Although conventional sources such as natural gas and coal are still dominant for power generation in Malaysia, the share of renewable energy is on the course of increasing, with solar being the largest contributor followed by biomass, biogas and small hydropower.

Malaysia has set a target to increase its renewable energy in electricity generation from the current 2% to 20% by 2025, a majority of this would be driven by solar. It has a high potential for solar generation with the estimated potential for solar generation reaching 6.5 GW. To-date, solar has an installed capacity of 381 MW, which accounts for 61% of the total installed capacity for renewable energy in the country.

Furthermore, Malaysia is currently the third largest exporter of solar modules and solar cells in the world and these vibrant upstream activities present opportunities for Swedish companies with knowhow that is value-added to the manufacturing process including supply of technology, complimentary product and component, engineering, and automation.

Being the as the second largest country producing palm oil after Indonesia, Malaysia has a huge source of waste from palm oil that can potentially be used for biomass. It is estimated that biomass has the potential to generate up to 2.4 GW of electricity in Malaysia, out of which only about 79 MW have been harnessed under feed-in tariff system to-date. Swedish companies with commercially proven technologies for efficient production of power and heat from major biomass resources will stand a chance to gain by providing the right solutions to Malaysia's existing biomass combustion systems which still utilise low efficiency low-pressure boilers with the average overall cogeneration efficiency of merely 38%.

On the energy efficiency front, smart grid and smart meter are going to be the focal point for the sector as Tenaga Nasional Berhad (TNB), the only electric utility company in Peninsular Malaysia and also the largest publicly-listed power company in Southeast Asia, plans to roll out its initiative to build a "Grid of the Future" which includes the deployment 9.1 million smart electric meters to households across Peninsular Malaysia by 2026. The opportunities for Swedish companies are typically revolving around smart energy management system, sensors, ICT, IoT solutions and other energy related technology.

Situation Overview

Rapid industrialisation and urbanisation have inevitable impact on the environment especially the contribution to the carbon footprint. Malaysia's CO_2 emissions has been on the rise for the past 10 years at an annual growth rate of 2.4%. The Malaysian government, recognising the threat and the potential impacts of climate change on the country's development and its people, has vowed to reduce greenhouse gas emission per unit of GDP by 45% by 2030 from the level in 2005 and be fully carbon neutral by 2050.

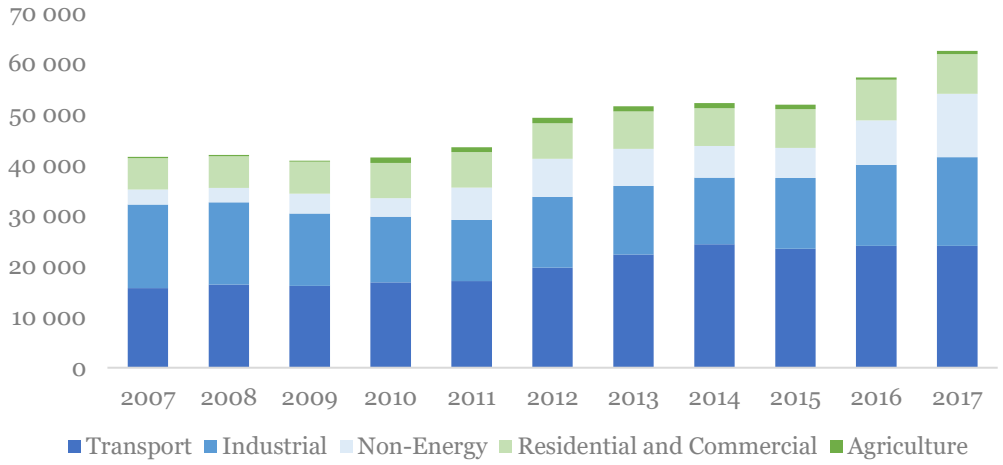
Realising that energy utilisation is the top contributor to CO_2 emissions, the government has pledged to improve energy efficiency via strategic planning and diversification of energy resources.

Energy Utilisation

Growing population and expansion of economic activities especially the fast-paced industrialisation and its vigorous manufacturing sector are the main drivers for the increasing demand in energy supply in Malaysia for the past 20 years. Historically, the nation's energy demand growth rates were higher than the growth rates of its GDP. The imbalance ratio between energy demand and GDP is indicative of the more energy-intensive economic activities driving the growth. Progressive industrial expansion often has unsevered tie with transportation activities in a developing country like Malaysia.

It is evidenced in Figure 17 that both industrial and transportation combined in the past decade accounted for 71% of the total energy use. The total final energy consumption has risen 62% from 38,569 ktoe (449 TWh) in 2007 to 62,488 ktoe (727 TWh) in 2017.

Figure 17. Malaysia's Energy Utilisation by Sector
(2007 – 2017, ktoe)

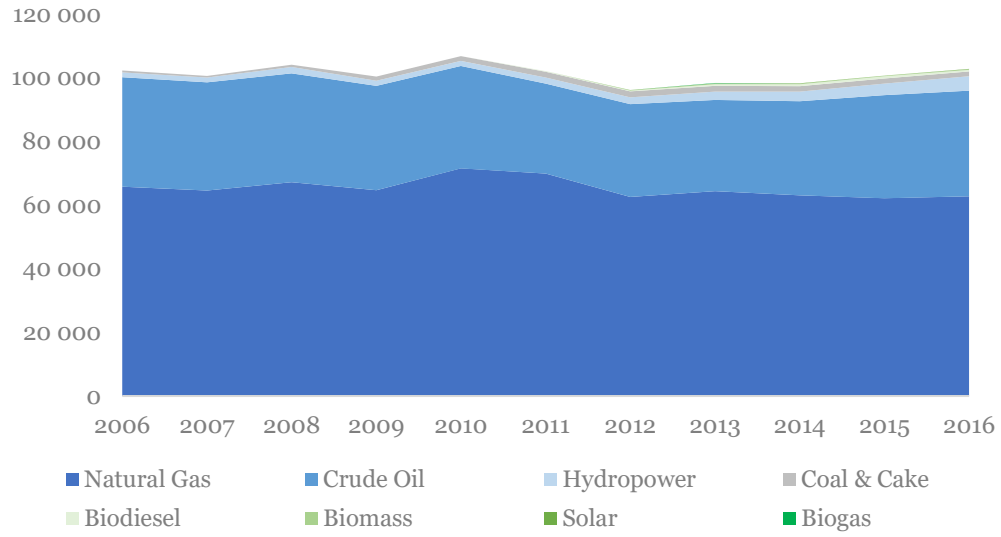


Malaysia's energy utilisation increased by 4.2% per year between 2007 to 2017

Source: Malaysia Energy Statistics Handbook 2018

Malaysia is well endowed with abundance of fossil fuels such as oil, gas, and coal, as well as renewables such as hydropower, biomass, biogas and solar energy. As of January 2013, reserves included 5.9 billion barrels of crude oil and condensates, 98.3 trillion cubic feet of natural gas, and 1.5 billion tons of coal. As illustrated in figure 18, both natural gas and crude oil production have marginally increased while hydropower has seen an annual 11% increase over the years. Despite a huge coal reserve available in Malaysia, the local production is relatively low due to inadequate infrastructure and high extraction cost that limit the exploitation of the fuel.

Figure 18. Malaysia's Primary Energy Production by Fuel Type
(2006 – 2016, ktoe)



Malaysia's reliance on fossil fuels remains on the same level while hydropower has increased double-digit yearly

Source: Malaysia Energy Statistics Handbook 2018

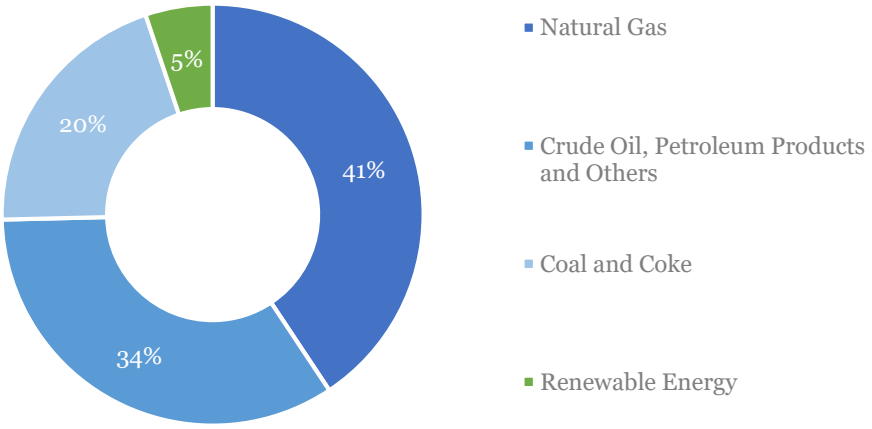
Current Energy Mix

Malaysia is blessed with a good generation mix of energy resources varying from fossil fuels such as oil, natural gas and coal to renewable energy resources from the likes of solar, biomass, hydropower and biogas. Nevertheless, conventional sources such as natural gas and coal are still dominant for energy generation in Malaysia.

According to Malaysia Energy Statistics, natural gas and oil contribute a combined 75% of energy mix whilst coal, hydropower and other renewable energy sources provide remaining 25% as illustrated in figure 19.

In terms of renewable energy, hydropower is essentially the largest contributor followed by biomass, biogas and solar. Despite prior initiatives by the government to explore potential of other renewable energy such as tidal, wind and geothermal, there has not been further development due to very limited resources in this respect.

Figure 19. Malaysia's Final Energy Consumption by fuel type
(2018, percentage)



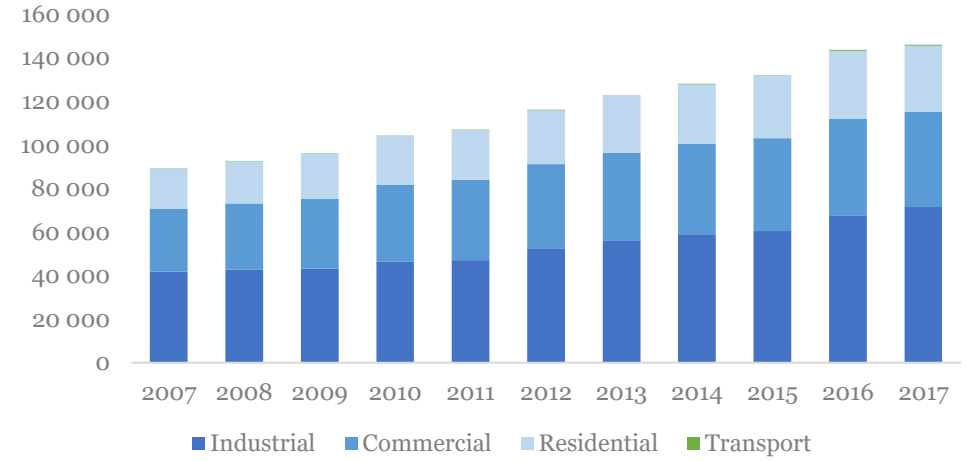
Natural gas and oil continue to be the main sources of energy contributing to a combined 75% of the energy mix

Source: Malaysia Energy Statistics Handbook 2018

Electric Power System

The continuous commercialisation and urbanisation have significantly increased electricity consumption with the annual growth rate of 5% per year over the last decade, particularly due to the increasing number of offices, factories, shopping malls and other entertainment outlets in operation. Electricity consumption has been primarily driven by industrial and commercial sectors as seen in figure 20. Malaysia's total electricity usage accounted for over 80% of consumption for Peninsular Malaysia, followed by Sabah and Sarawak.

Figure 20. Malaysia's Electricity Consumption by Sector
(2007 – 2017, GWh)



The industrial sector is the biggest consumer of electricity

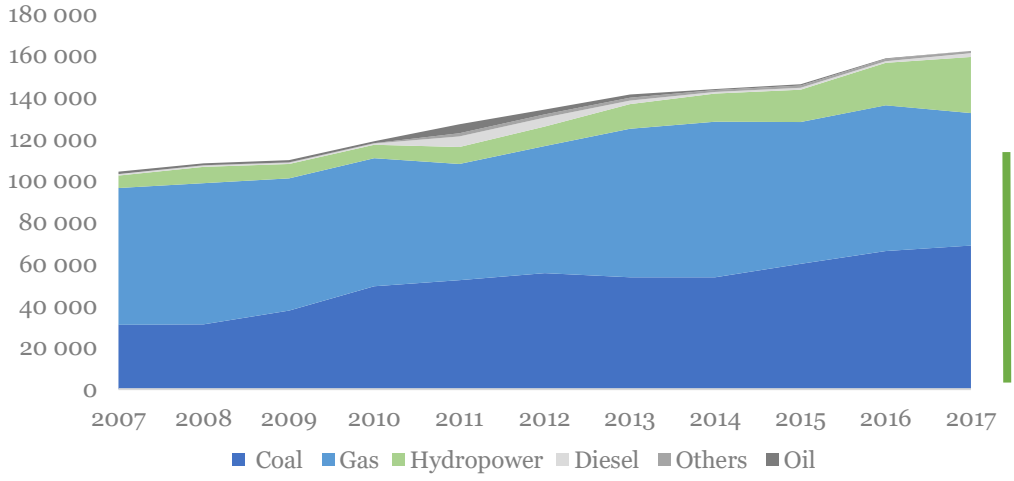
and the growth has been higher than the commercial and residential sector at 6% per year

Source: Malaysia Energy Statistics Handbook 2018

Malaysia's electricity generation has increased from 108,539 GWh in 2007 to 168,400 GWh in 2017. The production and demand hikes in the past two decades well reflect the country's rapid industrialisation and socioeconomic development.

As shown in figure 21, the electricity generation mix in Malaysia is essentially dominated by fossil fuels being natural gas and coal whereas renewable energy in terms of hydropower is increasing its share. For nuclear power, Malaysia has been consistent with the decision not to include this technology as one of the power generation sources in the country due to concerns over radioactive waste handling and impacts on environment.

Figure 21. Malaysia's Electricity Generation by Energy Source
(2007 – 2017, GWh)



Renewable energy such as hydropower is increasing its share of the electricity generation

Source: Malaysia Energy Statistics Handbook 2018

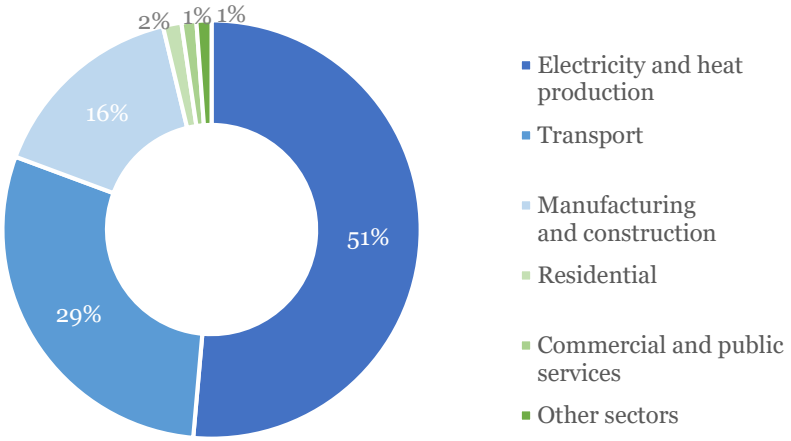
The electricity produced through various energy sources today is distributed through a well-developed power transmission network called the National Grid operated by Tenaga Nasional Berhad (TNB) in Peninsular Malaysia. It connects more than 420 major substations to 11,000 km of transmission lines, linking them together into a single delivery system. In East Malaysia, there are two other electrical grids operated by Sabah Electricity Sdn Bhd (SESB) and Sarawak Energy Berhad (SEB) respectively.

CO_2 Emissions

BP Statistical Review of World Energy 2019 shows that Malaysia has recorded a year on year growth of 2.4% CO_2 emissions between 2007-2017. Malaysia's CO_2 emissions amounted to 250.3 million tons in 2018, up from 241.6 million tons in 2017. As Malaysia is in pursuit to become a high-income economy, increasing energy demand puts pressure on the government to choose cheaper energy sources. Consequently, electricity generation is responsible for the largest share of CO_2 emissions in Malaysia. According to official data, CO_2 emissions accounted for 78% of the nation's greenhouse gas emissions, of which nearly half is produced by coal-heavy electricity generation sector. Land use, land-use change, and forestry (LULUCF) and waste sectors contribute to the remaining 22%.

As seen in figure 22 transportation recorded as the second largest CO_2 producer where the majority comes from road transport. Due to the high rate of personal automobile ownership, cars account for the largest contributor for emissions, followed by freight and motorcycles. The progressive infrastructure development and thrive of manufacturing sector also lead to substantial contribution to CO_2 emissions.

Figure 22. Malaysia's CO_2 Emissions by Economic Sector
(2018, percentage)



Half of Malaysia's CO_2 emissions are contributed by electricity and heat production activities

Source: International Energy Agency, 2019

Key National Energy Policies and Targets

Renewable energy and energy efficiency fall under the purview of Ministry of Energy, Science, Technology, Environment & Climate Change (MESTECC) which is the policy maker focusing on energy, green technology, environment management and climate change matters. The government agencies involved in championing energy efficiency in Malaysia are the Economic Planning Unit (EPU) of the Ministry of Economic Affairs, Ministry of Energy, Science, Technology, Environment & Climate Change (MESTECC), Ministry of Works, Ministry of Housing and Local Government and the Energy Commission.

Key Public Institutions in the Energy Sector

The Ministry of Energy, Science, Technology, Environment & Climate Change (MESTECC) is responsible to formulate and implement energy efficiency policy, in coordination with the Economic Planning Unit (EPU). The EPU's main role is to allocate enough resources for the implementation of energy efficiency programmes.

Energy Commission is the statutory body responsible for regulating the energy sector, specifically the electricity and piped gas supply industries, in Peninsular Malaysia and Sabah. It was established to ensure that the energy industry is developed in an efficient manner so that Malaysia will be ready to meet the new challenges of globalisation and liberalisation, particularly in the energy supply industry.

Sustainable Energy Development Authority (SEDA) is responsible to advise the government on all matters relating to renewable energy including recommendations on policies laws and actions to be applied to promote sustainable energy. It is also mandated to administer and manage the implementation of the feed-in tariff mechanism under the Renewable Energy Act.

Tenaga Nasional Berhad (TNB) is the only electricity utility company in Peninsular Malaysia overseeing the generation, transmission and distribution of electricity. The government linked company is also the largest publicly listed power company in Southeast Asia with USD billions worth of assets.

Key Policies in the Energy Sector

National Renewable Energy Policy and Action Plan (NREP)

The limited achievement from the Small Renewable Energy Power (SREP) Program from 2001 up to 2008, prompted the government to produce a new policy and action plan to overcome the main barriers to renewable energy deployment and to provide a secure and sustainable national electricity supply in Malaysia. NREP was then launched in 2009 to accelerate renewable energy development by enhancing the utilisation of indigenous renewable energy resources. The objectives of the NREP are to:

- Increase renewable energy contribution in the national power generation mix
- Facilitate the growth of the renewable energy industry
- Ensure reasonable renewable energy generation costs
- Conserve the environment for future generations
- Enhance awareness on the role and importance of renewable energy

The launch of the **National Green Technology Policy (NGTP)** in 2009 is a sign of determination of the Malaysian government in implementing green initiatives aimed at accelerating the national economy and promoting sustainable development. Under the policy, the country aims to fulfil the objectives towards minimising growth of energy use, facilitating the growth of green technology industry, increasing national capability and capacity for innovation in green technology development, enhancing Malaysia's competitiveness in the global arena and ensuring a sustainable development for the country. The key initiatives under the NGTP emphasise the use of green technology in four focus areas:

- Adoption of green technology in construction, management, maintenance and demolition of buildings
- Application of green technology in all energy utilisation sectors, power generation and in the energy supply management
- Incorporation of green technology in the transportation infrastructure & vehicles in general and biofuels & public road transport in particular
- Adoption of green technology in management & utilisation of water resources, waste water treatment, solid waste & sanitary landfill

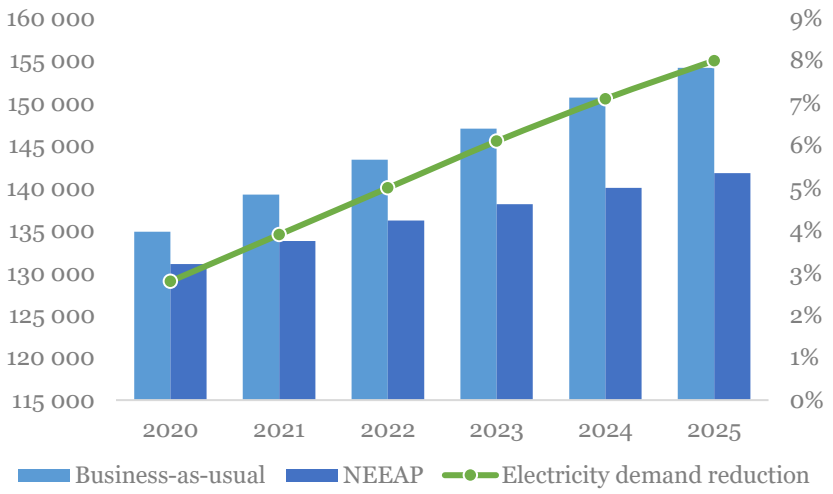
- Enhance public education and awareness on green technology and encourage its widespread use

Key Targets in the Energy Sector

Raise renewable energy from 2% to 20% in electricity generation – Malaysia has set an ambitious target to achieve 20% of renewable energy generation by 2025, which translates into adding some 3,900 MW in additional renewable energy capacity within the next six years. Currently a new roadmap called the Renewable Energy Transition Roadmap (RETR) 2035 is being developed to explore the possible strategies and action plans in order to reach the government's ambition. It is projected to attract green investment totaling USD 7.9 billion via government, public-private partnerships and private financing throughout the plan.

Improve energy efficiency – National Energy Efficiency Action Plan 2016-2025 (NEEAP) has been introduced to tackle issues pertaining to energy supply by managing demand efficiently. The guiding document aims to save a cumulative 52,233 GWh of electricity and reduce the electricity demand growth by 8% until 2025 business-as-usual scenario (figure 23).

Figure 23. Energy Savings and Electricity Demand Reduction under NEEAP
(2020 – 2025, GWh)



NEEAP aims to save a cumulative 52,233 GWh of electricity and reduce the electricity demand growth by 8% until 2025

Source: National Energy Efficiency Action Plan 2016 - 2025

Reduce greenhouse gas emission – Malaysia has pledged under the Paris Agreement 2016 to reduce 45% of the greenhouse gas emissions by intensity of the GDP by 2030 from the level in 2005. Latest development indicates that the Ministry of Energy, Science, Technology, Environment and Climate Change (MESTECC) has intention to improve its pledge by decoupling Malaysia's emissions reduction goals from the GDP to realize an absolute total emission cut.

Transformation towards low carbon cities – An initiative aims to establish low carbon zones in state capitals and major urban cities called Low Carbon Cities 2030 Challenge was launched in July 2019. The ultimate goal is to establish and designate 200 Low Carbon Zones across the country and have at least 1,000 Low Carbon Partners. These Low Carbon Zones and Low Carbon Partners will have reduced emissions from energy and water consumption of buildings and common areas, reduced emissions from petrol and diesel private vehicle use and reduced emissions from the generation of waste that end up in landfills.

Energy Prices and Incentives

As a move to encourage SMEs to grow the renewable energy market and to attract potential investors and industry players to invest in sustainable energy, the Malaysian government does provide incentives for the purchase of green technology equipment, besides giving tax exemption on the use of green technology services. There are three categories under the Green Technology Tax incentive namely Green Investment Tax Allowance (GITA) Assets, Green Investment Tax Allowance (GITA) Project and Green Income Tax Exemption (GITE) Services.

The qualifying beneficiaries for the incentives are the commercial and industrial business entities which undertake generation of energy in the form of electricity, steam, heat and chilled water using renewable energy resources such as solar, biomass, biogas, mini hydropower and geothermal as well as companies invest in energy efficient equipment or technologies and invest in energy saving equipment.

Electricity tariffs in Malaysia are largely determined by gas prices and foreign exchange rates especially when sourcing for coal since the fuel is 100% imported. In order to maintain its tariff stability and protect it from international volatility, the Malaysian government has adopted Imbalance Cost Pass Through (ICPT) mechanism back in 2014.

ICPT is part of a wider regulatory reform called Incentive-based Regulation (IBR). It enables the national utility company to reflect changes (either increase or reduction) in fuel and other generation-related costs in the electricity tariff after the reviews of the actual fuel price every six months. Currently, there is an ICPT surcharge of MYR 2,00 sen per kWh or USD 0,50 per kWh for non-domestic customers namely commercial, industrial customers and other non-residential customers. It does not affect the residential customers presently as the surcharges have been subsidised by the government through The Electricity Industry Fund.

The Electricity Industry Fund is a fund to keep savings from generation costs, as well as other possible cost savings under the new tariff setting mechanism, and it is contributed by domestic and non-domestic electricity consumers. Currently the Energy Commission has set the base tariff at MYR 0,39 or USD 0,09 per kWh for the three years of 2018, 2019 and 2020.

Regulation on Renewable Energy

The launch of the National Renewable Energy Policy and Action Plan laid the foundation for the introduction of the Renewable Energy Act 2011 (REA). It is the country's main regulatory instrument in prioritizing renewable energy over fossil fuels. In tandem with the REA, the Sustainable Energy Development Authority Act (SEDA Act) came into effect in 2011. The SEDA Act, among other things, established the Sustainable Energy Development Authority (SEDA) and made it responsible for the promotion and implementation of national policy objectives for renewable energy, the promotion of private sector investment in the sustainable energy sector. However, both REA and SEDA Act have yet to be enforced in Sarawak.

Key features of the REA are the establishment of the feed-in tariff (FiT) system and the renewable energy fund (RE Fund). Implemented and managed by SEDA, the FiT system provides a scheme where electricity generated using indigenous renewable resources can be sold at a premium to the utilities. Individuals and companies may apply to become eligible producers and those who qualify are granted approvals by SEDA. The feed-in approval holder enters into a renewable energy power purchase agreement with a utility for a duration that ranges from 10 to 21 years and at the FiT rates set out in the schedule to the REA. All electricity produced thereunder enjoys priority and must be purchased before electricity generated using fossil fuels.

The FiT system is financed through a surcharge imposed by the utilities on electricity consumers. A utility is required to pay into the RE Fund a sum equivalent to 1.6% of the tariffs collected from its consumers other than domestic customers with electricity

consumption of 300 kWh and below per month. Thus, the more electricity a consumer uses, the more it will contribute towards the RE Fund.

Apart from the REA, other legislations include Electricity Supply Act (Amendment) 2015 (ESA) which regulates the installation, generation and distribution of renewable energy, and along with the Energy Commission Act 2001 which governs matters related to renewable energy especially in relation to technical, safety and implementation of regulations related to the electricity sector.

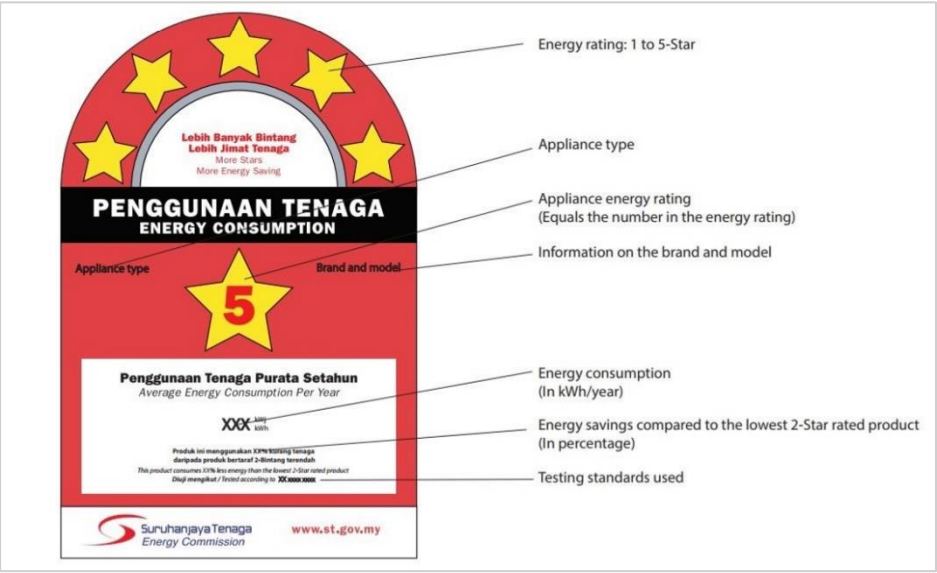
Regulations on Energy Efficiency

The main legal instrument on energy efficiency promotion is the Electricity Supply Act (Amendment) 2001 (ESA). The ESA empowers the Ministry of Energy, Science, Technology, Environment & Climate Change (MESTECC) to promote efficient use of electricity in the country.

Subsequently, the Efficient Management of Electrical Energy Regulations 2008 (EMEER) came into effect under the ESA. Under EMEER, all installations that consume or generate 3 million kWh or more of electricity over a period of six months are required to engage an electrical energy manager who will be responsible to analyse the total consumption of electrical energy, to advise on the development and implementation of measures to ensure efficient management of electrical energy as well as to monitor the effectiveness of the measures taken. The Energy Commission is mandated to enforce the EMEER.

Another regulatory instrument being enforced to promote energy efficiency improvement is the Electricity Regulations (Amendment) 2013. The regulations allow the implementation of Minimum Energy Performance Standards (MEPS), which has effect on selected electrical appliances and lighting for product energy efficiency rating. Under these regulations, refrigerators, air-conditioners, televisions, fans and lamps that enter the Malaysian market or are sold to consumers must meet the minimum energy performance standards as prescribed in the regulation. It is a mandatory requirement for appliances covered under MEPS to display information as shown in figure 24 by labelling.

Figure 24. Minimum Energy Performance Standards Label



Source: Energy Commission

Renewable Energy

The use of fossil fuel does not only contribute largely to greenhouse gas emissions, dependency on the depleting resources also poses risks for Malaysia's energy security and will deter its journey towards energy self-sufficient. Amidst rising opposition to exhaustible fuel source, Malaysia has begun shifting towards energy efficiency, energy saving and promoting clean, sustainable renewable energy projects that will increase access to electricity without polluting local air and water or contributing to climate change.

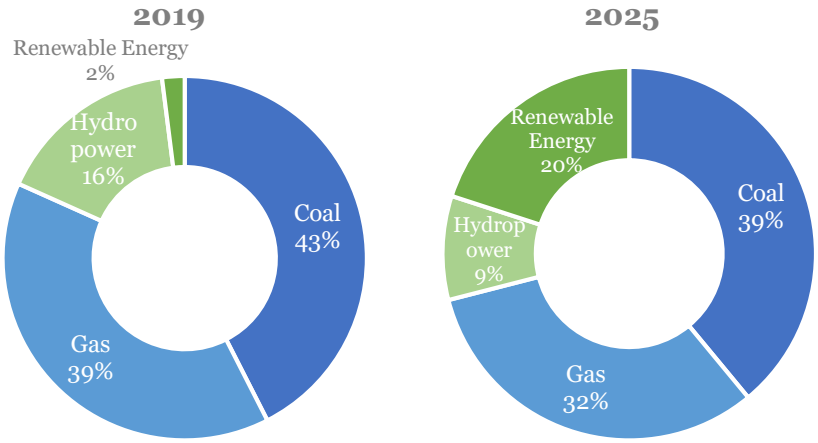
Situation Overview

In 2001, renewable energy has been introduced as the 5th fuel strategy in the energy-mix under the National Energy Policy. In the face of boundless potential of renewable energy resources in the form of solar, biomass, biogas and hydropower, the implementation was not up to expectation due to several barriers and challenges faced by the authorities and developers. By 2010, the government has a renewed commitment to meet renewable energy target of 985 MW by 2015 and 2 GW in 2020. Fast forward to present day, total installed capacity was 378 MW at the end of 2015; as of end of 2019, the actual achievement is about 30% of its target at 623 MW. The outcome indeed leaves a lot to be desired.

When Malaysia ushered in its first ever transfer of power in 2018, the new regime pledged to increase the installed capacity of renewable energy (excluding large hydropower schemes) to 20% by 2025 as illustrated in figure 25, which is significantly higher than the one set by the previous administration (13% by 2030). In fact, a lot of dynamic have been witnessed lately with the Ministry of Energy, Science, Technology, Environment and Climate Change (MESTECC) being the key actor not only proactive in promulgating the importance of green energy development but resolute to bring a true energy reform in the country.

The government's ambition has received commendation from the private sector and its folks. A new masterplan called the Renewable Energy Transition Roadmap (RETR) 2035 which is expected to launch by April 2020 has become much anticipated for all to observe how it will lead Malaysia to achieving its goals.

Figure 25. Malaysia's Current and Target Energy Installed Capacity
(2019 and 2025, percentage)



Malaysia aims to increase the installed capacity of renewable energy to 20% by 2025

Source: Energy Commission

Main Opportunities in Renewable Energy

Solar Energy

Malaysia has set a target to increase its renewable energy in electricity generation from the current 2% to 20% by 2025, a majority of this would be driven by solar. It has a high potential for solar generation taking into consideration its hot and sunny weather all year round. Monthly solar irradiation for Malaysia is estimated at 400–600 MJ/m and the estimated potential for solar generation can reach up to 6.5 GW.

The Malaysian government has indeed leveraged on its abundance solar irradiation to develop sustainable energy. Two important schemes that have been specifically implemented by the government to accelerate growth of solar energy are the Net Energy Metering (NEM) and Large-Scale Solar (LSS) which were introduced in 2016.

To date, solar has an installed capacity of 381 MW, which accounts for 61% of the total installed capacity for renewable energy in the country. The total solar installed capacity is forecast to reach 3.3 GW in 2023.

Key Solar Energy Policy and Targets

In Malaysia, no policy has been specifically devised for solar energy per se but rather renewable energy as a whole. Nevertheless, there are policies that have significant impact on the development of solar energy over the years, such as:

National Green Technology Policy (2009): Strengthen institutional framework, provide a favourable environment for green energy technology R&D and increase awareness of renewable energy technologies.

National Renewable Energy Policy and Action Plan (2010): Promote the use of locally generated renewable energy, ensure energy security and fuel supply independence. Address market failures and policy inconsistencies and increase share of renewable energy in the energy mix.

Renewable Energy Act (2011): Ensure growth and development of renewable energy technologies in Malaysia, increase funds for R&D projects, and establish feed-in tariff scheme.

11th Malaysia Plan (2016): Promote the use of sustainable energy for growth and development in Malaysia. Ensure energy security and management of resources in the country by 2020.

Other efforts by the government towards solar energy development can be seen through the **National Green Technology Master Plan (2017 – 2030)**, which aims to achieve 500 MW of solar energy to be connected to the grid by 2020.

Several key initiatives implemented by the government to promote solar energy in recent years are:

Net Energy Metering: NEM is a mechanism which allows electricity consumers in Peninsular Malaysia and Sabah to sell excess electricity generated from their solar photovoltaic systems back to the grid. In October 2018, Ministry of Energy, Science, Technology, Environment and Climate Change (MESTECC) announced the new Net Energy Metering (NEM) policy, an improved version of the policy since 2016, where excess electricity generated by rooftop solar installations injected back to the grid would offset the intake from the national utility Tenaga Nasional Berhad (TNB) on a one-to-one basis, making the proposition of installing rooftop solar far more financially attractive.

Large Scale Solar: LSS is a competitive open bidding tender system that allows private sector companies to build, own and operate large-scale solar photovoltaic plants to generate and sell energy to distribution licensees under long term power purchase agreements. Since its inception in 2016, the scheme has received overwhelming response from the industry. It has reached its third bidding round with a cumulative capacity totalling 1458 MW by end of 2019.

Peer-to-Peer (P2P) Energy Trading: The latest initiatives introduced by the government to promote the generation of solar energy. The programme which was launched in October 2019, enables those who generate excess energy through their solar photovoltaic panels to sell the additional power to other consumers. Malaysia is the second Asian country after Thailand that launched such energy trading platform. The programme which is still under pilot test is undergoing a two-month "alpha run" to test the operational capability of energy trading, followed by a six-month "beta run" that will see financial settlements between prosumers and consumers through their utility bills.

Investment in Solar Energy Sector

Malaysia has achieved significant progress in the solar photovoltaic industry over the last decade that has resulted in the growth of new businesses and creation of jobs. As at 2015, total of 48 solar projects have been implemented with total investments of about USD 8 billion, to produce solar wafers, cells, modules and balance of system components. Of this, 95,3% was from foreign investments, while another 4,7% was from domestic sources. Such momentum has carried on in the following years, according to the statistic published by Malaysia Investment Development Authority, in 2018 the approved investments in solar energy amounted to USD 625 million over 161 projects. In June 2019, the International Renewable Energy Agency (IRENA) named Malaysia as the Southeast Asia's biggest solar photovoltaics employer with a total of more than 54,300 people working in the industry.

Opportunities and Challenges for Swedish Companies

There are currently 8 companies engaged in the manufacturing of solar modules and solar cells in the country. That makes Malaysia the third largest exporter in the world and the biggest exporter to the United States. In 2016, the export value of solar manufacturing companies was USD 3.2 billion while local sourcing activities were valued at USD 400 million. The vibrant upstream activities present opportunities for Swedish companies with knowhow that is value-added to the manufacturing process including supply of technology, complimentary product and component, engineering, and automation.

The other potential segment where Swedish companies can consider tapping into is the large-scale solar project where foreign participation is allowed via bidding consortiums with local partners. The total quota for each bidding round in the past has been consistent at about 500 MW while the quota offered to each developer has been increased to 100 MW compared to 30 MW previously. However, foreign participation in large-scale solar project has certain constraints. A foreign entity is restricted to own up to 49% of the equity interest in a project consortium with their local partner. Besides, the limitation on foreign participation also extends to EPC (Engineering, Procurement and Construction), where the role of the EPC contractor and onshore EPC works are reserved for local contractors.

The government is drafting a new policy for developers to incorporate solar photovoltaic systems in new buildings and to encourage installations of rooftop solar photovoltaic panels on existing buildings. There are approximately 4,12 million buildings in the country, and it provides the opportunity for company with the solutions in terms of solar cell, solar panel and panel mounting system to benefit from the development.

Since early 2019, a programme called Registered Solar PV Investor (RPVI) was launched to encourage investors who provide Solar Power Purchase Agreement (PPA) or solar leasing services to Net Energy Meeting (NEM) customers. Investor can earn monthly return through direct payment from customer or utility company who does the billing, collection and remittance of payment by customers in return for a service fee. However, the threshold for foreign-owned company to participate has been set at a high paid up capital of RM 10 million or USD 2.5 million.

Biomass Energy

Malaysia produces approximately 168 million tons of biomass annually, including resources from palm oil waste, rice husks, coconut trunk fibres, sugar cane waste, livestock waste, municipal waste and forestry waste. Malaysia as the second largest country producing palm oil after Indonesia has a huge source of waste from palm oil that can potentially be used for biomass.

In 2011, an initiative called National Biomass Strategy 2020 was launched to promote the utilisation of oil palm wastes in order to reduce greenhouse gas emissions, meet renewable energy targets and create more job opportunities. It is estimated that biomass has the potential to generate up to 2.4 GW of electricity in Malaysia, out of which only about 79 MW have been harnessed under feed-in tariff system to date.

Key Biomass Energy Policy and Targets

Being an active producer of agricultural commodity and one of the largest exporters of palm oil, Malaysia is blessed with abundant biomass resources which can be converted into alternative energy or useful eco-products. The major sources of biomass resources in Malaysia include:

- Agricultural crops e.g. sugarcane, cassava, corn
- Agricultural residues e.g. rice straw, cassava rhizome, corncobs
- Woody biomass e.g. fast-growing trees, wood waste from wood mill, sawdust
- Agro-Industrial wastes e.g. rice husks from rice mills, molasses and bagasse from sugar refineries, residues from palm oil mills
- Municipal solid waste
- Animal manure and poultry litter

According to the National Biomass Strategy (NBS) 2020 launched in 2011, the palm oil sector was identified as the largest producer of biomass, estimated at 83 million dry tons in 2011 and eventually growing to about 100 million dry tons in 2020. In general, palm oil waste accounts for 84,7% of biomass feedstock while the remaining sources are agricultural and forestry by-products, such as rice (3,2%), wood residues (1,6%), and

municipal solid waste (10,5%). The NBS aims to achieve 800 MW and 54 MW installed capacity from biomass and municipal solid waste by 2020 respectively and by 2030, the biomass installed capacity is projected to increase 67,5% with 1.3 GW installed capacity.

Presently, the installed capacity under feed-in tariff scheme stood at 58 MW for biomass and municipal solid waste at 22 MW. By 2021, the installed capacity is expected to reach 103 MW and 44 MW respectively, which is still far behind from the target set out in NBS. Despite its ambitious aspiration, the development of biomass energy has encountered a couple of setbacks that hindered it from realising the NBS's vision. Some of the main barriers faced are:

- A lot of policies developed to facilitate the uptake on biomass and renewable energy among local companies are still underway, limiting the efficiencies of coordination among local agencies and biomass industry in Malaysia.
- There is no reliable and clear data on the potential of biomass in the market
- Irregular biomass feedstock supply and unattractive electricity tariffs
- Limited incentives and funding support are provided to bear the high cost of initial investment

Investment in Biomass Energy Sector

Between 2011 and 2016, there were 226 biomass projects with investments worth USD 768 million were recorded, 67% of which were from domestic contributions. In 2018, seven projects with investments worth USD 61 million were approved, which has tripled the investments of USD 19.6 million in 2017.

This represented a significant increase in capital investments per project. Foreign investments amounting to USD 37.8 million represented 62% of total investments, with domestic investments making up the remaining 38%.

As the government pledged to achieve 20% renewable energy in the capacity mix by 2025, continuous and increased investment on biomass energy is expected in the next few years.

Opportunities and Challenges for Swedish Companies

Palm oil mills have abundant biomass waste resources, yet their energy systems were designed to be cheap rather than efficient. Most of the existing biomass combustion systems in Malaysia utilise low efficiency low-pressure boilers. The average overall cogeneration efficiency is 38%. Swedish companies with commercially proven technologies for efficient production of power and heat from major biomass resources will stand a chance to gain by providing the right solutions.

Biomass conversion has been over reliant on the use of mesocarp fibre and palm kernel shell for boiler feedstock in Malaysia due to high calorific value and low moisture content, which is widely used as fuel without pre-treatment. Diversification of fuels is a sensible solution to enhance stability of feedstock supply such as utilisation of other residues like empty fruit bunch, oil palm fronds, oil palm trunks and palm oil mill effluent. Swedish company possesses pre-treatment technology that is able to process these residues into fuel is poised to succeed.

Since 2014, the government has mandated new palm oil mills as well as palm oil mills that are expanding their capacity to install methane avoidance facilities in a bid to reduce greenhouse gas emissions. Mill operators are encouraged to harness biogas for electricity generation to the grid, power supply to rural areas and internal use. As of 2017, there are 454 palm oil mills in operation in Malaysia, of which 94 palm oil mills have installed biogas facilities while 144 under planning. There is abundance potential on the remaining untapped mills from consultancy, engineering, efficiency optimisation to system integration.

Malaysia's oil palm plantations are largely based on private estate, independent smallholder, state schemes or government agencies such as the Federal Land Development Authority (FELDA), Federal Land Consolidation and Rehabilitation Authority (FELCRA) and Rubber Industry Smallholders Development Authority (RISDA).

In order to make inroads to the market, Swedish companies are expected to adapt to the local regulations and market condition, as well as establish relations with stakeholders especially government agencies and the dominant large oil palm companies such as Sime Darby and IOI. Collaborating with a local partner is the recommended approach for new comer to navigate through the complex market situation.

Other Opportunities in Renewable Energy

Wind Energy

Malaysia is considered as a low wind speed area with an average mean annual wind speed of 1.8 m/s. Generally, strong wind in Malaysia is blown from the Indian Ocean and the South China Sea. In the past, there were several studies conducted in regard to wind energy potential at selected areas in Malaysia and the findings showed that Mersing, Johor is considered as high wind areas in Peninsular Malaysia while in East Malaysia, Kudat in Sabah is the highest wind potential area. Both potential sites have recorded an average of 3 m/s at 60 meters heights.

However, it is still insufficient to attain the minimum wind speed required for windmills that is between 3 to 5 m/s, and not to mention the minimum wind speed for commercial viability of 7 m/s, which as a result, hinders the development of wind energy. Moreover, the absence of wind power technology in the feed-in tariff categories makes it difficult to achieve project viability.

Geothermal Energy

Sabah and Perak have been identified as geothermal hotspot in Malaysia according to an extensive research, followed by geology, geophysics and geochemistry analysis and modelling by experts from the United States and New Zealand.

In 2015, Sustainable Energy Development Authority (SEDA) announced geothermal energy as the 5th renewable energy resource under the feed-in tariff (FiT) portfolio, and within the year, a local company secured feed-in approval to build and operate the very first 37 MW geothermal power plant in the country, the project was scraped in 2018 due to failure of the company to carry out the project. There has not been any new development of geothermal project since then.

Biogas Energy

In Malaysia, landfills are the major source of methane emission (53%), followed by palm oil mill effluent (38%); animal manure (6%); and other methane gas from industrial effluent (3%). Methane generation in Malaysia is projected to reach 370,000 tons by 2020. With that amount of methane gas estimated to be generated, there is great potential to develop biogas-to-energy.

Despite the fact that landfills have the largest emissions of methane, biogas production in Malaysia is mainly focused on the palm oil industry. Malaysia as one of the largest producers of palm oil has enormous amount of palm oil mill effluent that can be harnessed to generate biogas. Approximately 58 million tons of palm oil mill effluent is produced annually in Malaysia, which has the potential to generate an estimated 15 billion m^3 of biogas.

As of January 2018, there are 94 palm oil mills equipped with biogas plants, a significant increase from 28 mills in 2010. However, most of these biogas plants are located in rural area which is far away from the point of demand. The limitation of transporting biogas from the plant to the location of demand has hampered the application of biogas. Majority of these mills flare the excess biogas to prevent over accumulation or use it to fuel their boilers, only 24 of them are generating electricity and sending surplus energy to the grid under the feed-in tariff programme,

Waste-to-Energy

With a population of more than 32 million in Malaysia, the municipal solid waste generation in Malaysia is estimated at 37,466 tons per day or at a 1.2 kg average rate per capita per day originated from household, commercial, industrial and institution. It has been projected a 3,3% year-on-year increase in generation rate.

Currently, landfilling is the common exercise of municipal solid disposal in Malaysia due to cheaper cost while incineration is mostly used for scheduled and clinical waste treatment. It is estimated that by 2030, over 80% of the Malaysian open dumping landfill sites are to be shut down since they are reaching their full capacity. Hence, turning municipal solid waste into energy is deemed as a solution to cope with the increase of waste.

In Malaysia, energy recovery from municipal solid waste are focused on incineration for production of refuse-derived fuel (RDF) technologies and landfill gas capture. However, the use of incineration as waste-to-energy is only present in a very limited quantity at a small scale. Currently, an integrated solid waste facility dubbed the country's first waste-to-energy incineration plant at Ladang Tanah Merah, Negeri Sembilan, with a capacity to handle 600 tons of mechanically segregated and processed municipal solid waste per day is reaching its final phase of completion. It is able to produce up to 25 MW of electricity when it is operational.

Hydropower

Malaysia is rich in hydropower potential, with high temperature and humidity all year round plus a high rainfall volume. Malaysia has utilised its hydropower potential mainly in the range of large hydropower, with about 5.5 GW installed as of 2016. In 2012, the government expressed a goal that the energy provided by small hydropower schemes be increased substantially. In Malaysia, small hydropower refers to run-of-river schemes up to 30 MW in capacity. There is also smaller scale hydropower from 5 kilowatts to 500 kilowatts called micro hydropower which does not supply the national grid but produce just enough power to provide domestic lighting to a group of houses through charging a battery.

In Malaysia, there is still a lot more untapped potential for small and micro hydropower. Through feed-in tariff scheme, the development has been incentivised by allowing small power producers to sell electricity to the national utility through the grid. As a result, small hydropower projects are contributing to Malaysia's electricity supply, especially in rural areas.

According to the Sustainable Energy Development Authority, small hydropower has an installed capacity of 70 MW in 2019 and an additional 255 MW will be added to the grid by 2023.

Energy Efficiency

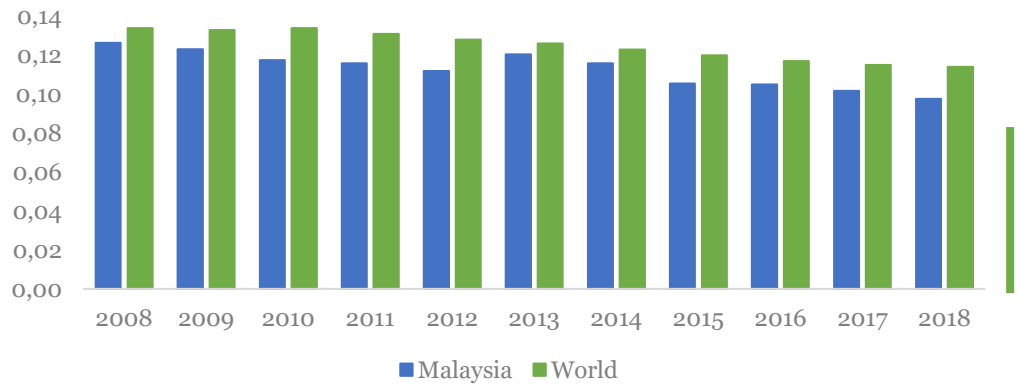
In Malaysia, the awareness to be energy efficient is growing in all sectors including residential & commercial buildings, industries, and transportation since the government took aggressive steps in the battle against climate change about a decade ago. Energy efficiency has been a top priority in its national agenda as Malaysia propels towards sustainable development for its future generations. A series of actions have been taken by the government to materialise its vision. It is estimated that Malaysia can benefit from the saving of USD 11.4 billion in energy spending between 2016 and 2030, should all the energy efficiency initiatives be fully implemented nationwide.

Situation Overview

In 2017, Malaysia produced up to 98,298 ktoe (1,143 TWh) of energy which 62,488 ktoe (727 TWh) or 63,5% was consumed. Malaysia's final energy consumption has shown an annual 4,2% growth rate for the past 10 years. It is projected Malaysia's energy demand will increase by an annual growth rate of 4,8% from 2017 to 2030.

Despite many strategic approaches and planning in its energy security and sustainability development, Malaysia has been inconsistent in achieving its desired performance in energy consumption when the results showed that the growth of its final energy consumption were higher than the growth of GDP for several years. In terms of energy intensity, Malaysia has experienced a slightly fluctuating trend over the past 10 years. It has shown a steady decline since 2008 yet it did not prolong, as it spiked again in 2013 as exhibited in figure 26, attributed mainly to the increase in industrial energy intensity.

Figure 26. Malaysia's Energy Intensity
(2008 - 2018, koe/$2015p)



Malaysia's energy intensity has tended to decrease through 2008-2018

Source: Global Energy Statistical Yearbook, 2019

Despites aggressive efforts to drive energy efficiency for the past two decades, Malaysia has not seen significant improvements in terms of energy consumption and conservation. The lower than anticipated results under previous energy efficiency initiatives have compelled the Malaysian government to launch a ten-year masterplan called National Energy Efficiency Action Plan (NEEAP) in 2015. The five key initiatives to be implemented and expected electricity savings over the plan period are shown in table 13.

Table 13. Key Initiatives and Projected Energy Savings under NEEAP

Key Initiative	Programme Related to Electricity Sector	Programme Description	Savings in 10 Years (GWh)
Promotion of 5-star rated appliance	5-star refrigerator campaign	Promotion of 5-star rating and label for refrigerators to transform the market into more efficient models	2,706
	5-star air conditioner campaign	Promotion of 5-star rating and label for air-conditioners to transform the market into more efficient models	7,014
Minimum Energy Performance Standards (MEPS)	Energy efficient lighting campaign	Promotion of energy efficient lighting through awareness programmes, enforcement of MEPS and labelling	2,216
	High efficiency motors	Promotion and awareness programme that will lead to mandatory MEPS and labelling for motors by 2020	2,175
Energy audits and energy management in buildings and industries	Large and medium commercial buildings	Matching grants where free energy audit will be provided to large and medium sized commercial buildings, industries, large government facilities provided that the business owner is willing to invest an amount of energy saving measures equal to the cost of the energy audit	5,066
	Large and medium industries		26,969
	Large government facilities		881
	Medium sized commercial buildings		1,916
Cogeneration	Cogeneration in industries and commercial buildings	To promote cogeneration in industries and commercial buildings by implementing key strategic measures to reduce barriers	3,150
Energy Efficient Building Design	Incorporating Energy Efficiency in new building designs and constructions	Energy Efficiency in New Buildings	15

Source: National Energy Efficiency Action Plan 2016 - 2025

The NEEAP projected a total electricity saving of 52,233 GWh and electricity demand growth can be reduced by 8% against a business-as-usual scenario by 2025, should it be executed effectively and supported with sufficient resources.

According to the Ministry of Energy, Science, Technology, Environment and Climate Change (MESTECC), a new bill called the Energy Efficiency and Conservation Act (EECA) set to reinvigorate the NEEAP has been reviewed by the parliament in June 2019 and will soon to be tabled for final approval. It is learnt that the new law will have introduce a holistic legal and regulatory framework on Demand Side Management (DSM) for better energy resource planning.

Main Opportunities in Energy Efficiency

Energy Distribution and Transmission

Smart grids and smart metering are going to be the focal point for the sector. Since the Tenaga Nasional Berhad's (TNB) successful launch of its 1000-unit smart meter pilot smart grid project funded by the government across Melaka and Putrajaya in 2013, followed by an additional 300,000 smart meters installed in Melaka between 2016 and 2018, the utility company is planning to deploy the electronic device to 1.2 million customers in Klang Valley between 2019 and 2020. By 2026, a total of 9.1 million households across Peninsular Malaysia are expected to be equipped with a Tenaga Nasional Berhad (TNB) smart electric meter.

Key Energy Distribution and Transmission Policy and Targets

The government has in September 2019 approved a 10-year masterplan dubbed as Malaysia Electricity Supply Industry 2.0 (MESI 2.0) to introduce liberalisation across the industry from fuel sources, generation to transmission and distribution and retail in Peninsula Malaysia. The masterplan sets to reform the domestic power industry, in which the government will now stop approving new independent power production projects that come with power purchase agreements (PPA). The key initiatives under MESI 2.0 are:

- Allow generators to source own fuel to optimise cost
- Move from power purchase agreement regime to capacity and energy market
- Establish third party access framework and network charges for grid to allow third party using the infrastructures
- Facilitate green energy producers and consumers

The liberalisation may potentially bring down fuel costs as independent power producers (IPPs) can source coal and gas from third parties instead of getting the supply from Tenaga Nasional Bhd (TNB) under the PPAs. Fuel costs make up 42% of Malaysia's electricity tariffs. In 2018, coal represented 58% in electricity generation mix in the peninsula, followed by natural gas 39% which is sourced from Petroliam Nasional Bhd (Petronas).

Presently, the Single Buyer structure remains in place until TNB's transmission and distribution assets is opened for third-party access (TPA) by non-renewable power producers. The open up of the retail segment to supply electricity to end-users is expected to commence in the second quarter of 2021, pending the installation of smart meters and other necessary infrastructures.

Investment in Distribution and Transmission Sector

The government will upgrade the electricity grid in Sabah to increase electricity supply from the west coast to the east coast. For that purpose, six projects for the grid reinforcement and upgrading were identified as critical projects to ensure that the distribution capacity of between 200 to 400 MW could be achieved. The total investment cost of the project is expected to be USD 210 million and the completion of all the projects are expected by the end of 2021 or early 2022.

The federal government is considering the need to implement several other projects to improve electricity supply in Sabah to reduce the System Average Interruption Duration Index (SAIDI) in the state. Among the projects being considered is the Southern Link project with an investment costing USD 312 million, which is the electricity line in the south (Sabah) to connect the west coast to the east coast by connecting the Kalumpang-Mengalong grid.

Opportunities and Challenges for Swedish Companies

The largest utility company Tenaga Nasional Behad (TNB) has begun work on a 'Grid of the Future' which relies on the use Advance Metering Infrastructure (AMI) as a value delivery method to the end user. TNB is the largest electricity provider in the country, and such upgrades would go a long way in attending to electricity demands. The 'Grid of the Future' introduces automation and smart solutions with lower grid costs and is set to cost the utility USD 6.6 billion. The opportunities for Swedish companies are typically revolving around smart energy management system, sensors, ICT, IoT solutions and other energy related technology.

The planned smart meter installations for all households in Peninsular Malaysia until 2026 will also offer opportunities for Swedish company with relevant products and expertise to undertake supply contract. However, it is important to note that there will be fierce competitions among contenders from country such as China and Korea that are offering attractive pricing yet acceptable quality products, who have already appeared to be frontrunner in many industries including the energy sector. Swedish companies that intend to enter the market must have a unique value proposition that is appealing to the customer.

The reform through MESI 2.0 is likely to encourage and facilitate the supply of green energy in the country. It paves the way for the migration of the current power purchase system towards a wholesale market in the future, in other words renewable energy suppliers will also be able to compete directly in the retail market. Generally, Swedish companies offering technologies and services in the renewable energy space will be able to take advantage of the increasing demand on green technology.

Commercial Buildings

Typically, weather in Malaysia is as in other Southeast Asian countries, which have a hot and humid tropical climate, and conventional office buildings consumes more than half of energy usage in electricity. Electricity usage in Malaysian office buildings consist of air-conditioning load with the highest percentage (58%), lighting (20%), office equipment (19%) and others (3%). Many existing buildings was constructed with conventional designs, thus contributing to inefficient energy consumption and negative impact on the total energy performance throughout the operation stage of the buildings. Commercial sector accounted for the second highest electricity consumer among other sectors at 32% for the past decade.

A rating tool called the Green Building Index (GBI) has been developed to promote green technology in the buildings sector. A GBI certificate is granted to developers and building owners who have meet the standards in six areas: energy efficiency, indoor environmental quality, sustainable site planning and management, materials and resources, water efficiency, and innovation. Since its introduction in 2009, some 500 buildings have been certified to-date and nearly the same amount are currently undergoing construction. These 500 GBI-certified buildings have managed to reduce 1.1 million tons of carbon dioxide.

Key Commercial Buildings Policy and Targets

In Malaysia, the highest energy consumed by commercial buildings is electricity. According to the Electricity Supply Act 1990 under Efficient Management of Electrical Energy Regulations 2008 (EMEER), any installations which receives electrical energy from a licensee or supply authority with total electricity consumption equal to or exceeding 3 MW as measured at one metering point or more over any period of six consecutive months are required to conduct an energy audit by an authorised individual known as Register Electrical Energy Manager. According to National Energy Efficiency Action Plan (NEEAP), the effective execution of energy audits and energy management

in commercial buildings can potentially achieve energy savings up to 6,982 GWh in a 10-year period from 2016 to 2025.

Complementing to the EMEER, subsequently in 2016, there were targets set forth under the Eleventh Malaysia Plan (2016 – 2020) to further optimise energy efficiency of commercial buildings including government buildings, such as:

- Achieve a target of 700 Registered Electrical Energy Managers (REEMs)
- Extend Energy Performance Contracting (EPC) to other government buildings
- All new government buildings to adopt energy efficient designs
- Retrofit 100 government buildings
- Register 70 energy service companies (ESCOs)
- Target 100 companies to implement ISO 50001
- Wider adoption of the Green Building Index to benchmark energy consumption in new and existing buildings

Investment in Commercial Buildings Sector

The Housing and Local Government Ministry has launched the Malaysia Smart City Framework in September 2019, a book that will serve as a guideline for local governments all across the country to develop cities into smart cities. Five pilot cities will undergo projects to be upgraded into smart cities namely Kuala Lumpur, Johor Baru, Kota Kinabalu, Kulim and Kuching. These future smart cities that are integrated with sustainable technologies and services such as 5G connectivity, cashless community, autonomous public transport, drone delivery, energy-efficient buildings, smart treatment of water and waste management and others will unleash unlimited potential on the investments of commercial buildings.

Opportunities and Challenges for Swedish Companies

Since the inception of Green Building Index (GBI) 10 years ago, GBI has thus far achieved encouraging progress with approximately 500 new buildings currently under constructions attempting to obtain GBI certification. These new constructions may offer opportunities for Swedish companies to provide products from energy savings such as energy performance monitoring, smart sensors, solar photovoltaic system to services like consultancy and engineering.

A caveat is that building an environmentally sound building and adhering to GBI standards may be perceived as being too expensive for many developers. New technologies are costly, as are the eco-friendly construction materials and the planning time it takes to put up a truly green building in Malaysia. Developers stuck in the mindset of short-term gain see cheaper and faster construction as the quickest way to profit, and are reluctant, despite government incentives is available to change their way of business and go the extra mile for green building. Thus, navigating through the cost sensitive market condition will be a challenge for Swedish companies.

Other Opportunities in Energy Efficiency

Residential Buildings

In Malaysia, energy use of the residential buildings accounts for about 15% of that consumed by all sectors. Although it is ranked at the fourth place after other major sectors such as industrial, transport and non-energy, energy conservation in the household sector has become important. In this sector, energy is essentially used for cooling and lighting, to operate electrical appliances and machines, water heating and cooking.

Recognising the importance of energy conservation in reducing carbon footprints, the Malaysian government has introduced corrective measures such as energy efficiency

labelling for electrical appliances and energy awareness campaign. Some of the notable initiatives also include phasing out incandescent light bulbs and promote the use of LED light bulbs to reduce CO_2 emissions by an estimated 732,000 tons a year, expanding energy performance labelling from four (air conditioner, refrigerator, television and fan) to ten electrical appliances (six appliances – rice cooker, electric kettle, washing machine, microwave, clothes dryer and dishwasher).

Industrial

Malaysia has embarked on many energy efficiency initiatives, such as energy efficiency labelling, and pushed for more regulations for industry, such as Efficient Management of Electrical Energy Regulations 2008, whereby installations that consumed or generated electrical energy for own consumption equal to or more than 3 GWh for six consecutive months are mandated to comply with the efficiency regulation. However, the efforts have produced a limited success to improve energy efficiency in the economy. Industrial sector accounted for the highest electricity consumption in the past 10 years at about 46%.

Transportation

Since the announcement of National Automotive Policy (NAP) in 2014, it aims to turn Malaysia into an energy efficient vehicle (EEV) hub in Southeast Asia. The plan encompasses strategies and measures to strengthen the entire value chain of the automotive industry and will also lead to environment conservation, high-income job creation, transfer of technology and new economic opportunities for local companies. Based on the current Malaysian car market, EEV accounted for around 33% of the total vehicle sales in 2015 and is forecast to reach 85% in 2020.

Oil is essentially the most consumed fuel particularly in the transport sector, accounting for 56% of total final energy consumption. The large use of energy by the sector is attributed to high usage of private cars for passenger transport, even in the densely built urban areas. The transport energy demand is growing at an annual average growth rate of 4.3% per year for the 2005-2015 period. In an effort to tackle the sector's high energy consumption, the Malaysian government has taken measures to improve public transportation by introducing new rail lines such as Mass Rapid Transit (MRT) 1 and 2 (in Kuala Lumpur). The MRT 1 was completed in July 2017 while MRT 2 is expected to be fully operational by 2022. In addition to expanding public transport systems, further opportunities remain to capture additional energy efficiency potentials in the transport sector.

PHILIPPINES

NEW INFRASTRUCTURE TO POWER THE COUNTRY

PHILIPPINES – NEW INFRASTRUCTURE TO POWER THE COUNTRY

Country Summary

Power demand continues to rise, and the country is racing against time to meet the energy needs of the country, especially as the Manamplaya Gas Fields is close to depletion. Energy access and development in the Philippines varies in the different islands, with Mindanao behind the rest of the country, largely due to decades of political instability.

Although there is a need for stronger implementation on the country's set standards and targets for electrifications, sustainable energy, and CO_2 emissions reductions, investments in the energy sector has remained positive over the years. The Philippines is still considered as an attractive country for energy projects, mostly because the energy prices is still one of the highest in Southeast Asia and relatively higher growth of energy demand, which stood at 4% per year during 2007 - 2017 with the highest growth of 9% being witnessed in the commercial sector.

Coal and natural gas remain the predominant indigenous fossil fuel resources in the Philippines, accounting for two-third of the total energy supply. However, the share of renewable energy continues to rise, owing to a long-standing use of geothermal and hydropower resources for electricity generation and the use of biomass by the industrial and residential sector. The installed capacity target of renewable energy set by the Department of Energy is 15.3 GW by 2030 and 20 GW by 2040.

With the influx of cheaper solar energy systems, solar energy in the country is one of the cheapest sources of renewable energy in the market. As the solar rooftop technology become more and more available and cheaper over the years, households and commercial establishments as well as industries have started the adoption of solar rooftop technology and connect it to the grid. However, battery storage technology and the development of micro-grids are the two areas of solar energy that have yet to be fully-developed in the Philippines where over 7,600 islands are located. Swedish companies with solutions to these issues will find the Philippines an attractive country to expand into.

The Philippines is also regarded as a potential destination for investments towards waste-to-energy, mostly due to the favourable foreign investment incentives present for waste-to-energy projects such as 100% foreign ownership, unlike other renewable energy source.

Technologies on improving power loss in the transmission and distribution sector will be also be welcomed by the National Grid Corporation Philippines (NGCP), which is privately owned corporation in-charge of operating, maintaining and developing the Philippines' state-owned power grid, an interconnected system that transmits electricity to the nation. With around 20 typhoons battering the country each year, underwater cabling, smart-grids and micro-grids, which are the technologies that the country does not have a strong local background will represent an area of opportunities for Swedish companies.

Situation Overview

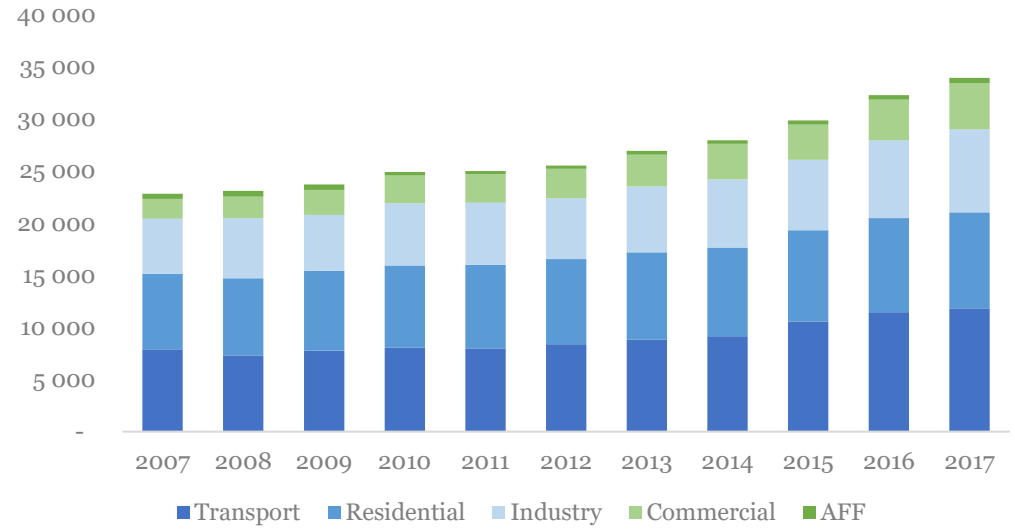
The Philippines' energy sector has been largely dominated by coal and fuel imports, however, more companies have begun to realise the cost and environmental benefits of renewables. The country's energy sector, being largely private, are driven by a number of powerhouse companies who are not only big in the Philippines but have an expanded energy portfolio in the region. The Philippines government has been trying to promote renewable energy projects to foreign investors by providing fiscal incentives, with more favourability on biomass and waste-to-energy projects due to the lack of local technological expertise. However, implementing rules and regulations of existing policies and programs needs to be further emphasised and be taken into action.

Energy Utilisation

The Philippines is one of the top five biggest countries in Southeast Asia in terms of gross domestic product (GDP) growth. In Q3 of 2019, the country's GDP was at 6.2%, one of the fastest growing economies globally. The major economic drivers are the growing middle class, growing population and large infrastructure investments. The Philippines has a fast-growing population, among the fastest in the world, growing at 2 million every year, and currently at 108 million people.

Energy demand growth and economic growth in the Philippines have shared similar underlying drivers, energy demand increases are from the growth in the industrial, commercial, and domestic sectors. From 2007 to 2017, the country's energy demand has increased by 4% per year with the highest growth of 9% being witnessed in the commercial sector. The transport sector accounts for 35% of the total energy consumption followed by the residential sector (27%) and industrial sector (23%) – figure 27.

Figure 27. Philippines' Energy Utilisation by Sector
(2007 - 2017, ktoe)



The increase of energy demand is at 4% per year

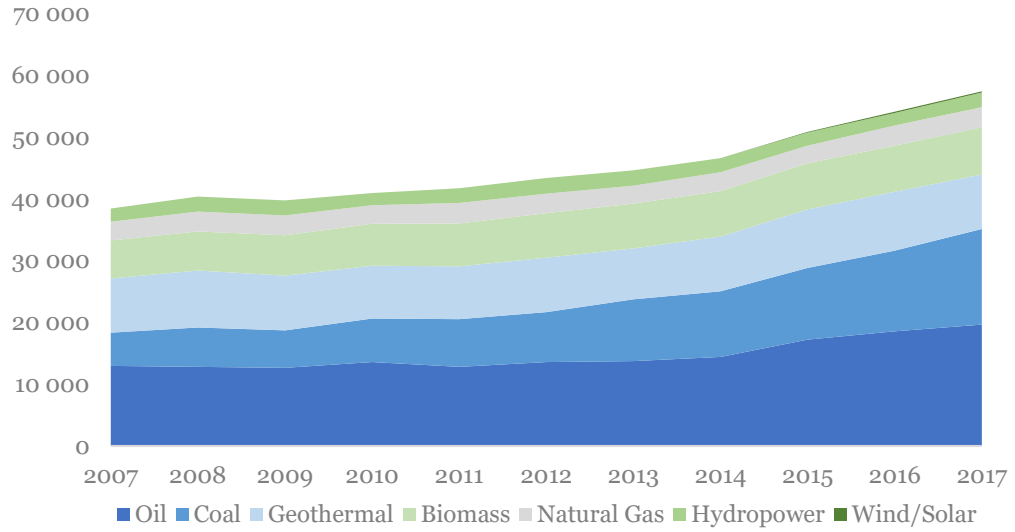
The demand increment has been witnessed across all sectors with the commercial sector growing the fastest

Source: Department of Energy, Key Energy Statistics, 2018

Coal and natural gas remain the predominant indigenous fossil fuel resources in the Philippines with proven gas reserves at 98.5 billion cubic meters, proven oil reserves at 100 million barrels, and economically recoverable coal at 316 million tons. Total primary energy supply (TPES) stood at 58 million tons of oil equivalent (mtoe) in 2017.

Fossil fuels accounted for two-third of the total energy supply, but the share of renewable energy continues to rise, owing to a long-standing use of geothermal and hydropower resources for electricity generation and the use of biomass by the industrial and residential sector (figure 28).

Figure 28. Philippines' Primary Energy Production by Fuel Type
(2007 - 2017, ktoe)



Primary energy supply is dominated by oil and coal

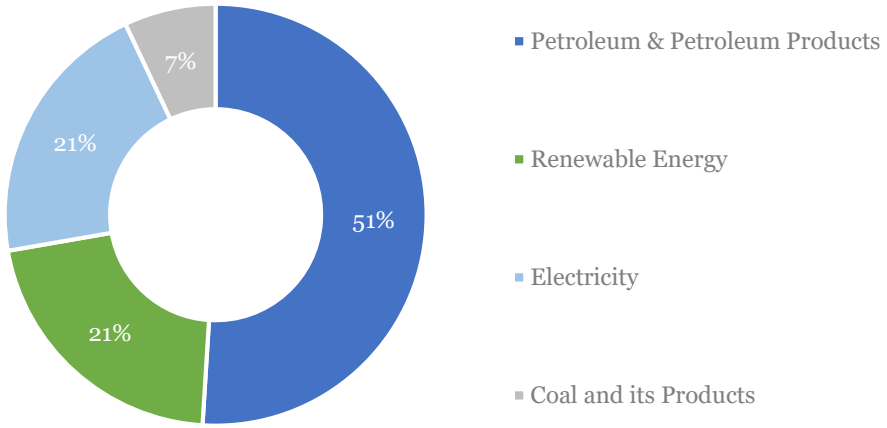
Whereas renewable energy sources are contributing 33% to the total production (2017)

Source: Department of Energy, Key Energy Statistics, 2018

Current Energy Mix

In 2018, final energy consumption in the Philippines was about 34,300 ktoe or 399 TWh whereas oil constituted roughly 51% of the final energy consumption. As seen in figure 29, renewable energy consisting of biomass made up 21% about the same level as electricity 21%, and the remainder came from coal. The largest share of final energy is used by the transport sector (34 %) followed by residential (27%).

Figure 29. Philippine's Final Energy Consumption by fuel type
(2018, percentage)



Around 21% of the final energy consumption comes from biomass and is mostly used in the residential sector

Source: Department of Energy, Key Energy Statistics, 2018

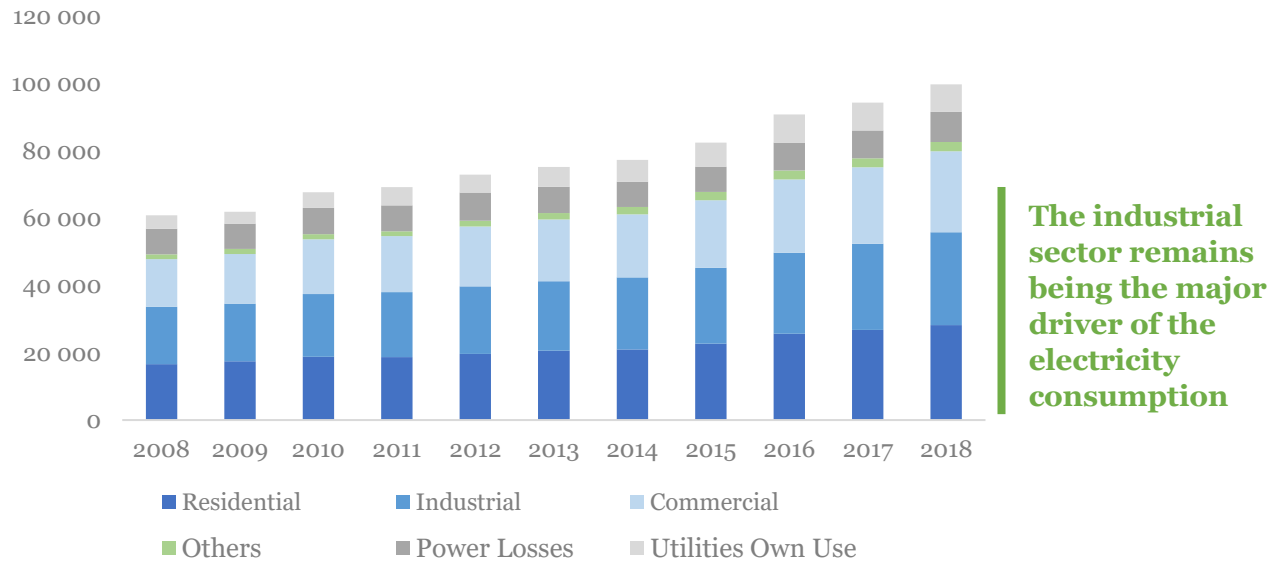
Electric Power System

The Philippines is still in the process of meeting the electrification target of 100% by 2020, but electrification is not the only problem. Electrical energy is generally more expensive for those who have less access to it. In off-grid locations, there's the problem of high electricity costs and disruptive power supply.

The government, through the Power Sector Assets and Liabilities Management Corporation (PSALM), implements the Universal Charge for Missionary Electrification (UC-ME) which is a universal charge to all grid connected consumers to fund the payments for stranded debts and contract costs, for watershed rehabilitation and management (watersheds owned by the government), equalisation of taxes and royalties applied to indigenous renewable sources versus imported fuels, fund for electricity services rendered in off-grid areas, and for all other cross-subsidies. The UC-ME program has been through a lot of scrutiny from the public since essentially poor electricity consumers in the main grids are also paying for the electricity consumption of large commercial and even industrial consumers in off-grid areas. To address this the Department of Energy (DOE) aspires to replace diesel and bunker fuel-fired power plants with low-cost, clean, indigenous and renewable power system in off-grid areas. DOE aims to phase out traditional diesel power plants with renewable energy plants which can significantly reduce cost of generation in off-grid areas. However, these all remain aspirational for now in the Philippine Energy Plans and have no concrete timeline of completion. DOE also aim to promote the modernisation of small grids and distribution systems with new technologies. The department argues that the removal of subsidies to all consumers in the off-grid area will be difficult but is considering the removal of automatic subsidies to commercial and industrial customers in the off-grid areas. In medium-term, the DOE is also looking at further interconnection of small grids into the main grid to further lower electricity costs.

The Philippines' electricity consumption is on the rise and will continue to increase in line with the growing population, increased temperature, economic growth and continued establishment of electricity generating plants. Figure 30 illustrates the major sectors driving the usage which are Residential, Industrial and Commercial.

Figure 30. Philippines' Electricity Consumption by Sector
(2008 - 2018, GWh)



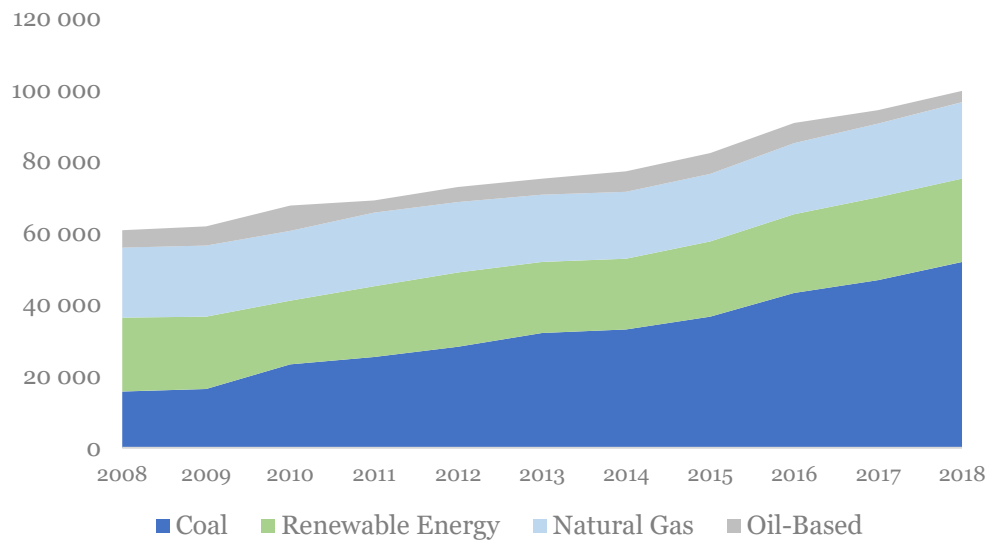
Source: Department of Energy, Power Statistics

The Philippines' is heavily reliant on coal, imported oil and natural gas with a total installed capacity of more than 8.8 GW for coal, 4.2 GW for oil-based and 3.4 GW for natural gas. The country's oil industry has remained relatively small with minor production opportunities, since the country is heavily reliant on imported oil. In 2016, 87% of the country's supply of oil were imported from the middle-east. In terms of natural gas, the Manamplaya field remains the only significant indigenous gas source in the country, which supplies half of the electricity supply of Luzon, the main island where Metro Manila is located. Fuel wood, coal and biomass for cooking is also estimated to be used by more than half of the population, especially in rural areas.

The Philippines has also a long-standing history of the use of renewables such as geothermal and hydropower. The Philippines is the 3rd largest geothermal producer in the world, with an installed capacity of almost 2 GW, or 17% of the country's total electricity requirements. In terms of hydropower, the Philippines boasts some of the largest hydropower plants in Southeast Asia with a total combined installed capacity at more than 3.7 GW.

The electricity generation is supplementing the increase in consumption with the main source continuing to be coal as seen in figure 31. To meet the constant increase in demand the DOE is encouraging investments in electricity generation.

Figure 31. Electricity Generation by Energy Source
(2008 - 2018, GWh)



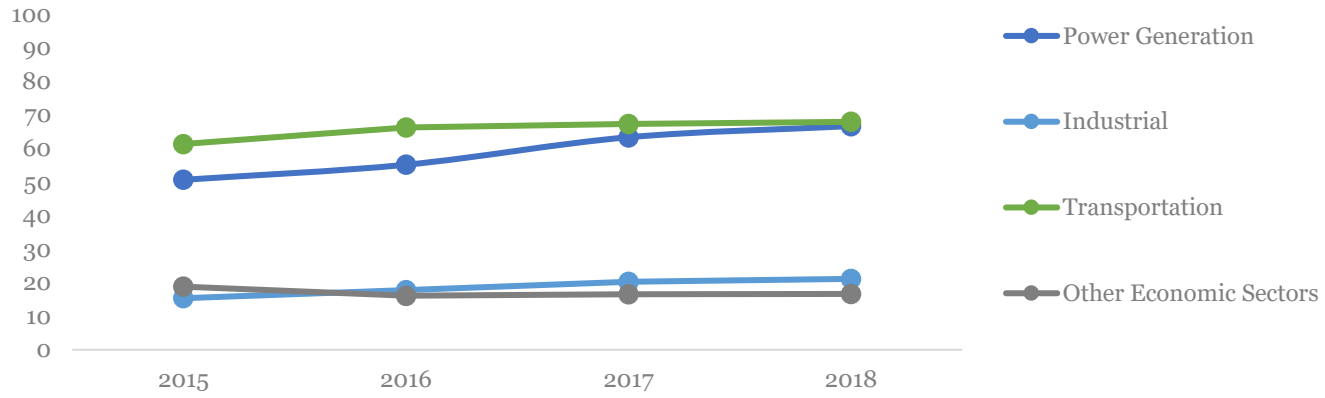
Around one-fourth of total electricity is generated by renewable energy sources in which geothermal is the largest contributor

Source: Department of Energy, Power Statistics

CO_2 Emissions

If the Philippines retains coal as its largest and least cost of source of power, this will result in higher CO2 emissions that is expected to reach more than 390 million metric tons of CO_2 in 2040. Should the country continue in a business-as-usual scenario, total greenhouse gases (GHG) emission from fossil fuels is foreseen to increase an average 6% per year, half of which is from coal fuels. Currently the Philippines CO_2 emissions is at 1.1 mt/capita. The Philippines is not oblivious to the effects of climate change, being a country exposed to typhoons and other natural calamities. The country has pledged to cut 70% of its carbon emissions by 2030 in the 2015 Paris Climate Conference. This was ratified by current President Rodrigo Duterte in March 2017.

Figure 32. Philippines' CO_2 Emissions by Economic Sector
(2015 - 2018, million tons)



Source: Emission Database for Global Atmospheric Research, 2019

Key National Energy Policies and Targets

Key Public Institutions in the Energy Sector

The Philippines has 3 policy and regulatory bodies in the Philippines which are **the Department of Energy (DOE), the Energy Regulatory Commission (ERC)** and **the National Electrification Administration (NEA).** The DOE sets the overall goals and targets of the Philippines energy sector while the ERC is in-charge with regulation in the energy sector. The DOE reports directly to the Office of the President and is responsible for energy policy and planning. The ERC is an independent body that regulates the power industry and is responsible for approving bilateral power supply agreements, ancillary service procurement agreements, and setting the distribution rates of distribution utilities and electric cooperatives. The NEA is a state-owned enterprise that provides loans and subsidies to electric cooperatives in less developed areas to promote electrification.

The DOE formulates all energy plans and programs of the Philippines, consistent to the country's short, medium, and long-term goals. The DOE evaluates the implementation of all energy programs, evaluates the energy balance and mix, and conducts the research and development of energy technologies. Currently, the latest energy plan of the Philippines is the "Philippine Energy Plan 2017-2040".

In terms of generation, the two main actors are the **Independent Power Producers (IPPs)**, which are privately-owned power producers, and the **Power Sector Assets and Liabilities Management Corporation (PSALM)** which is the government agency tasked of selling out government-owned power sector assets. Over the years, PSALM has slowed down its selling of its assets, but continues to engage in long-term power purchase agreements. Every transaction involves decision from Congress and PSALM's Board Policy Direction.

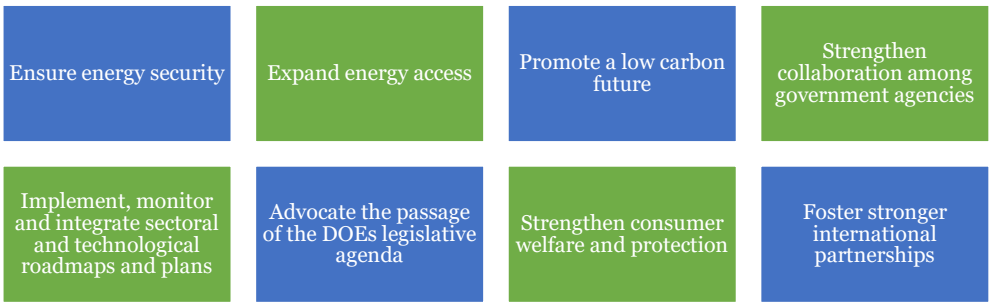
Transmission in the Philippines is purely privatised. In 2008, a 25-year concession franchise was awarded to the **National Grid Corporation of the Philippines (NGCP)**, where China's State Grid Corporation has a 40% stake. They are regulated by the ERC.

In terms of distribution and retail, the biggest player in distribution and retail is the **Manila Electric Company (MERALCO)** which is a private-investor owned facility supplying to the whole of Metro Manila. Second retail electricity supplier is Aboitiz Power. There are also electric cooperatives who service rural communities connected to the grid, which are owned by the members of which it services.

Key Policies in the Energy Sector

Compared to the Philippines' neighbouring countries in Southeast Asia, the Philippines' energy sector is largely privatised. Due to the Electric Power Industry Reform Act (EPIRA) in 2001, the generation and transmission sectors has been largely sold to the private sector. Prior to EPIRA, the National Power Corporation (NAPOCOR), a government-owned and controlled corporation, was engaged in the production, transmission and distribution of electric power and used to be the largest generator and provider of electricity in the Philippines. This meant that the power sector then was largely under government monopoly. Currently, NAPOCOR manages the country's 17 dams and 11 watersheds for power generation and is tasked to provide electricity to all off-grid rural areas by 2025 through the Small Power Utilities Group (SPUG). The aim of the EPIRA was to eventually lower the cost of power to consumers by making the price competitive through the implementation of the Wholesale Electricity Spot Market (WESM). This is the Philippines free trade market of electricity. However, the Philippines' remains the country with one of the most expensive electricity prices in Southeast Asia, one reason is that the country has the most expensive electricity tariff rates in the region.

Key Targets in the Energy Sector



The Philippine government set out eight strategic directions in the Philippine Energy Plan for 2017-2040. This is to support its electrification targets of 100% by 2022, from 90% in 2017, in targeted and identified households that have access to the grid. For off-grid areas, 100% electrification target is extended to 2040.

The current administration also signalled an intention to reduce coal dependency in a directive last July 2019, however, this somehow contradicts the Coal Roadmap which aims to produce 282 million metric tons (MMMT) by 2040, from the medium-term goal of producing 52 MMMT 2019-2022 and short-term goal of 23 MMMT last 2017-2018. In 2018, the Philippines generated 52 TWh of power from coal.

For the first six years of the Philippine Energy Plan, the DOE plans to implement a nine-point agenda:

- Access to basic electricity by 2020
- Technology neutrality
- Meet demands for reliable power by 2040
- Develop liquefied natural gas
- Complete all transmission projects by 2020
- Develop a more affordable, transparent, and pro-consumer framework for electricity distribution
- Promoting the efficient use of power among consumers through education and information campaigns
- Streamlining domestic policy by cutting red tape
- Continued privatisation of the Power Sector Assets and Liabilities Management Corporation (PSALM) assets. PSALM is the government institution in-charge of privatising government power assets

To support this, the government adopted several sectoral roadmaps for 2017-2040 in the latest Philippine Energy Plan. Below are highlights:

Upstream oil and gas	• Further exploration of oil and gas reserves
Downstream natural gas	• Increase the natural gas mix through expansion of use and investments on domestic supply and imported LNG
Downstream oil industry	• Development of fuel standards (less olefi, aromatic contents and metallic additives) • Development of non-coconut biodiesel, exploration of new feedstocks • Higher bioethanol levels, introduction of EURO V and VI and hydrolysed fuel
Coal	• Increase delineated coal reserves at 766 MMMT by 2040 • Produce 282 MMMT of coal by 2040
Electric power industry	• Encouraging more private investments and pursuing new technologies fo the generation sector such as nuclear, energy storage, fuel cells and ocean thermal energy conversion • Completion of national transmission infrastructure by 2020, continued rehabilitation and expansion of existing substations, tranmission lines and development of climate-resilient transmission technologies • Investing in new distribution technologies (e.g. smart grids), establishment of competitive electricity market in Mindanao, and continues resiliency improvement and upgrades on distribution network
Renweable energy road map	• Continued implementation of the Renewable Act of 2008 which aims to triple the 2010 installed capacity for renewables from 5.4 GW to 15.3 GW in 2030 • Increase renewable energy capacity to 20 GW
Alternative fuels and energy technologies	• Promotion of new energy technologies especially in the transport sector such as electric vehicles (EV), liquefied petroleum gas (LPG) vehicles, compressed natural gas (CNG) vehicles, LNG vehicles and hybrid vehicles.
Biofuels	• Re-evaluation of to increase current biofuel blending of 5% coconut-derived biodiesel and 10% sugarcane-derived bioethanol • Research on other potential feedstock
Energy efficiency and conservation	• Enhancing energy database systems to monitor market demand • Cross sectoral energy performance ratings • Standardization of Energy Efficiency and Conservation (EE&C) Act measures in the country

Energy Prices and Incentives

The Philippines has one of the highest electricity rates in Southeast Asia at an average rate of USD 0.20 per kWh or PhP 9-10 per kWh for a typical household consuming 200 kWh monthly. Increase in electricity prices are largely affected by factors such as, but not limited to, peso value depreciation, high-demand for electricity consumptions during summer season (April-May), Christmas season (November-December), and of course, electricity supply shortage issues.

The energy sector is not subsidised by the government and applies cost-reflective electricity rates.

Under the Executive Order 226 on Incentives, the Philippines gives out incentives to energy projects under the Board of Investments (BOI) such as:

- Income Tax Holiday
- Duty-free importation of capital equipment
- Tax exemption on carbon credits
- Special Realty Tax Rate on Equipment & Machinery
- Zero Percent Value-Added Tax Rate on sale of renewable energy
- Tax Credit on Domestic Capital Equipment and Services (100% of custom duties and value-added tax)
- Lower corporate tax rate
- Net Operating Loss Carry-Over

Regulations on Renewable Energy

The Philippines has two major policies on renewables: The Biofuels Act of 2006 (Republic Act (RA): 9367) and the Renewable Energy Act of 2008 (RA: 9513).

The Renewable Energy Act of 2008 (RA: 9513): Effective in 30 January 2009, the Philippines implemented the Renewable Energy Act of 2008 which aims to expand the renewable energy mix in the country in order to reduce coal dependency and lower oil imports. The ambition is to increase the total installed capacity of renewables to 15.3 GW by 2030, which is equal to 50% of the country's electricity capacity. To achieve this goal the government set an ambitious National Renewable Energy Program that aims at the following:

- Increase geothermal capacity by 75%
- Increase hydropower capacity by 160%
- Additional 277 MW of biomass power capacity
- 2.3 GW additional wind power capacity
- 1.5 GW solar capacity
- Establish the first ocean energy facility

Even though the Renewable Energy Act was supposed to take effect within a year of its approval, it was only in 2019 that DOE announced two of its key renewable energy policies: The Renewable Portfolio Standard (RPS) and the Green Energy Option (GEO). The RPS aims to accelerate the renewable energy mix in off-grid areas in the country by obliging utilities to generate a set of percentage of their electricity from renewables. There's a clear demand however, the system of competitive selection is largely unproven. GEO allows the end-users to choose renewables as their source of power. However, GEO is still an optional market.

The Philippines also has a feed-in tariff (FiT) program, which was implemented in 2013 under the Renewable Energy Act, giving incentives to companies who produce renewable energy by giving renewable energy companies a fixed rate for their electricity generation sold to the grid for no less than 12 years, priority connections and priority access to the grid. However, apart from Run of River, hydropower, biomass and waste-to-energy, the program for the rest of the renewable source expires this year with no clear intention for an extension. Almost all of the installation targets have now been subscribed. Part of the mechanisms of the Renewable Energy Act is also the Net-Metering System which allows solar power owners to sell excess energy to the grid.

The Biofuels Act of 2006 (RA: 9367): The Philippines was the first country in Southeast Asia to legislate a biofuel blending in all petroleum fuels. The Biofuels Act of 2006 aims to lower the country's dependency on oil imports, as well as promote renewable and clean fuel energy sources. The mandate is to include 10% bioethanol and 5% biodiesel in the current fuel blending. However, the country is still struggling to meet the 5% biodiesel blending mostly due to the high price of coconut oil, the country's main feedstock for biodiesel. The current biodiesel blending is at 2%. This legislation also stated that the DOE should explore additional feedstocks to promote sustainability in the biofuel blending, however, the current feedstock still has been limited to sugarcane and molasses for bioethanol and coconut oil for biodiesel. By 2030, the aspirational goal of DOE is to increase both biofuels to 20% blending.

Regulations on Energy Efficiency

The Philippines has one main program for energy efficiency which is the "National Energy Efficiency and Conservation Program", which was created in 2005. However, the program then was weak in its goals and objectives with no clear penalties and incentives. There is also room for development in the roadmap for Energy Efficiency and Conservation (EE&C) in the 2017-2040 Philippine Energy Plan which mostly discuss mainstreaming the knowledge on energy efficiency and conservation to the public, the local government units with no clear goals and programs apart from the Energy Labelling and Efficiency standards for appliances such as refrigerators, air

conditioners, fluorescent lamps, and ballast. However, the government has been emphasising on change and improvements which provides confidence to the sector.

In April 2019, President Duterte signed the Energy Efficiency and Conservation Act (R.A. 11285). This prompt the creation of the Inter-agency Energy Efficiency Committee whose primary role is to evaluate and approve government energy efficiency projects and provide strategic direction in the implementation of the Government Energy Management Program to reduce the government agencies' consumption of electricity and petroleum. This will also create incentives for energy efficiency projects. The aim of the law is, "institutionalise energy efficiency and conservation as a national way of life geared towards the efficient and judicious utilisation of energy by formulating, developing, and implementing energy efficiency and conservation plans and programs." With this law, which mostly impacts businesses and establishments, "Guidelines on Energy Conserving on Design on Buildings" must be followed, as well as other energy conservation practices. Certain incentives await compliant businesses such as income tax holidays and duty-free importation.

The Philippines' Private Energy Sector

The private sector players have been the main movers of the energy sector in the Philippines. There is more that can be developed when it comes to the incentives and policies that are currently in place to better promote renewable energy projects and investments in the country. Despite this, the private sector makes investments because the project can be profitable long-term, and to some extent also to act as good citizens provided there is a long-term potential. Some examples:

Ayala Corporation is planning to expand its renewables from 600 MW (of 1.6 GW) to 1 GW in the next 12 months with focus on wind, solar and geothermal. Currently, it has installations in the Philippines and Thailand. Future investment in the Philippines, Australia, Vietnam and potentially Indonesia.

Metro Pacific Corporation, one of the country's leading developers, have also ventured into the renewable energy business with waste-to-energy projects in the Philippines, and now has plans to invest in waste-to-energy in Vietnam.

The joint Venture between Aboitiz Power Corporation and SN Power Norway, SN Aboitiz Power Group (SNAP) is one of the leading developers of renewable energy in the country, particularly hydropower. SNAP has also started to venture outside of the Philippines with projects in Myanmar and Indonesia. Aboitiz Power have also continuously expanded their renewable energy portfolio outside the country by entering the international renewable energy market, through the purchase of Mekong Wind, a Vietnamese wind power facility.

Solar Philippines Power Project Holdings has recently ventured into the solar power industry in India and aims construct a 500 MW solar farm in the country. Solar Power Philippines is the largest solar energy provider in the Philippines and owns the first solar power factory in the country.

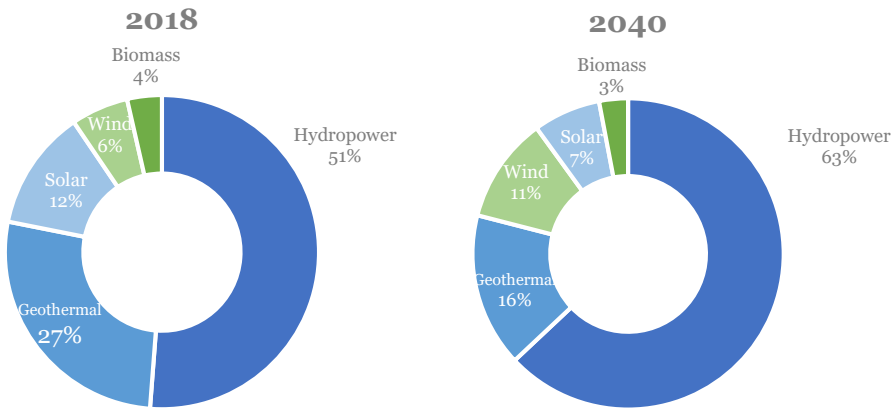
This year 2019, San Miguel Corporation has announced that it targets to install 10 GW of renewable energy in the next 10 years, mostly from solar, wind and pumped hydropower.

Renewable Energy

Situation Overview

The Philippines has been falling short of its renewable energy targets for the past years, with generated energy from renewables varying from year to year. The DOE target is 15.3 GW by 2030 and a long-term target of 20 GW by 2040. In 2018, the installed generating capacity for renewable energy is at 7.3 GW. The Philippines aims to reduce its dependency on fossil fuels and adapt the use of cleaner energy sources by doubling the share of renewable energy, from 30% to 60%, by 2040. To facilitate renewable energy projects, the government has established the Energy Investment Coordinating Council (EICC) which aims to remove bureaucratic hurdles and by law, should be able to process permits for projects amounting to more than USD 70 million in 30 days. In terms of installed capacity, the renewable energy source with the biggest share is currently hydropower taking up 16% of the total installed generating capacity on all energy sources or 51% of the renewable energy sources as shown in figure 33. Renewable energy projects are highly driven by the private sector with power giants such as AC Energy (Ayala Corporation), Aboitiz Power, Energy Development Corporation (EDC), and Manila Electric Power Corporation (MERALCO), San Miguel Corporation, to name a few, who are moving and driving the renewable energy landscape of the country.

Figure 33. Philippines' Current and Target Renewable Energy Installed Capacity
(2018 and 2040, percentage)



Philippines places an ambitious target on hydropower reaching 63% of renewable energy sources by 2040

Source: Department of Energy, 2018

The renewable energy sector also faces challenges in the country. The renewable energy levels differ across the Philippines due to varying support from the local governments, accessibility, 40% foreign-ownership restrictions to renewable energy projects (except for biomass and waste-to-energy), restrictions on foreign ownership to land, and despite the EICC, bureaucracy and red tape, and a largely underdeveloped grid network. This implies that the Philippines might continue to rely and invest in coal powered energy, as the more affordable source of power to meet its electrification targets in 2022.

Main Opportunities in Renewable Energy

Solar Energy

With the influx of cheaper solar energy systems, solar energy in the country is one of the cheapest sources of renewable energy in the market. In 2018, the recorded installed generating capacity for solar energy is at 896 MW. Solar power has the highest FiT rate in the country at PhP 8.7 per kWh or USD 0.2 per kWh. However, large-scale solar projects are limited in the country's pipeline, with smaller projects mostly either in private establishments, households, and off-grid rural electrifications. Notable companies leading in this sector are Solar Philippines, with their first 8,429 sqm solar factory in the country, Aboitiz Power, AC Energy and Helios Solar Energy Corp. with their 133 MW solar power plant in Negros Occidental, the biggest in Southeast Asia. In 2018, Winnergy Holdings Corporation also launched the country's very first pilot floating solar project. Although fairly small, with only 10 kilowatt-peak, this opens the possibilities in the country's bodies of waters especially in small islands around the country. One of the Philippines' leading renewable energy companies SN Aboitiz Power-Magat (SNAP) has also ventured into the floating solar power technology with their first non-hydropower project, a 200 MW floating solar power plant built by Norwegian floating solar technology provider Ocean Sun and Chinese solar manufacturer GCL-SI. The Philippines is currently one of the top countries in Asia when it comes to the use of solar photovoltaic systems for energy generation.

Key Solar Energy Policy and Targets

The aspirational target for the solar energy in the Philippines in the National Renewable Energy Plan (NREP) of 2030 is 1.5 GW. The current FiT rate for solar power is PhP 8.7 per kWh or USD 0.2 per kWh with an installation target of 500 MW. However, the target is already fully subscribed. The government has not signalled any intention to expand the installation targets for solar.

Investment in Solar Energy Sector

The DOE implemented a transparent open and competitive selection process (OCSP) in the award of service contracts for identified areas open to renewable energy development in the country. This hopes to signify competitiveness among renewable energy players in the country.

In October 2019, Meralco is funding PhP 10 billion (USD 197 million) worth of funds to MGen Renewable Energy Inc. (MGreen), part of the Meralco group, for a 210 MW solar power project.

In 2018, the Bureau of Investments approved PhP 86 billion (USD 1.7 billion) worth of solar power investments from Solar Philippines.

In 2017, the DOE's list of pending solar power projects have totalled more than 80 projects nationwide. There are about 232 awarded solar projects recorded with a potential capacity of 6.9 GW, while 83 projects are still pending.

Challenges and Opportunities for Swedish Companies

As the solar rooftop technology become more and more available and cheaper over the years through the influx of local manufacturers and Chinese brands, households, commercial establishments and industries have found it more accessible to use solar rooftop technology and connect it to the grid. With the Net-Metering Program, solar energy users are also able to sell back excess energy generated to the grid.

However, battery storage technology and the development of micro-grids are two areas of solar energy that has yet to be fully-developed in the country. In a country divided by more than 7,600 islands, micro-grids are one of the subsectors of solar energy that the government is looking at that will help achieve its electrification targets of 100% by 2020. The 40% foreign-ownership rate for solar energy projects, as well as land ownership, may however be discouraging for foreign investors.

Wind Energy

The estimated potential energy from wind mainly due to the prevailing monsoons of the Philippines is estimated to be around 76 GW, which shows that the Philippine wind energy potential has yet to be fully tapped. The Philippines is the first country in Southeast Asia to establish a commercial wind farm. The country currently has the biggest wind farm in the region. Completed in 2014, the Burgos Wind Farm in Ilocos Norte, with 50 wind turbines and 150 MW installed capacity. Over the recent years, the country has been slowly garnering a much stronger pipeline for wind energy, but more can be done. Climate resilient off-shore wind technology is an untapped subsector of wind energy that has potential in the country. Companies such as AC Energy aims to increase its renewable energy portfolio with a number of their projects involving acquisition of companies involved in wind energy and MERALCO is expanding its renewable energy portfolio by exploring off-shore wind projects.

Key Wind Energy Policy and Targets

The country has yet to reach its short-term plan of 1.6 GW installed capacity for wind power, with current installed capacity of 427 MW.

The current FiT rate for wind power is at PhP 8.5 per kWh or USD 0.2 per kWh, the second highest FiT rate next to solar power with an initial installation target of 400 MW in the Renewable Energy Act of 2008. No known installation target extensions have been announced yet for wind power in the FiT program. The target has also been subscribed.

Investment in Wind Energy Sector

The DOE recorded a total of 66 awarded projects for wind energy with a total potential capacity of 2.5 GW, while 16 are still pending. Companies such as AC Energy have been aggressively building their wind power portfolio in the Philippines and in nearby Southeast Asian countries through Green Bonds, which have also been in partnership with Asian Development Bank (ADB).

Opportunities and Challenges for Swedish Companies

The Philippines do not produce wind turbines, smart-grids for wind power, and most of the wind technology in the country is imported. Climate-resilient wind turbines (typhoon-proof) would also be beneficial in the country. The 40% foreign-ownership also applies to wind power projects in the country. With the large amount of lands required for wind power, limited foreign-ownership on land to be used for wind power projects are unfavourable to foreign investors.

Biomass and Waste-to-Energy

The country has a big potential for biomass energy with abundant supplies of biomass resources such as agricultural and forest residues, animal waste, municipal solid waste, aquatic biomass, used cooking oil, and other agro-industrial wastes. Currently the common agricultural wastes in the country are rice husk, bagasse, coconut shell husk and coir. However, challenges remain on the lack of standards for consolidations for agricultural wastes in the country. Currently, biomass technologies used in the country includes bagasse boiler fuel, rice and coconut husks dryers, and biomass gasifiers. Half of the population, especially in rural areas, still utilise biomass for household cooking through burning wood for cooking, which contributes to the country's CO_2 emissions. In 2017, the DOE recorded a total of 55 awarded projects for commercial use and 24 for private use of biomass energy. The 2018 installed capacity for biomass energy is at 258 MW. The current players in the biomass industry are, to name a few, Aboitiz Power, Pöyry (Consulting), AC Energy, Metro Pacific, and Victoria's Milling Company (VMC).

In terms of biofuels, the country is the first in Southeast Asia to implement a biofuels legislation. However, the Philippines are now slowly being left behind by its Asian neighbours. The Biofuels Act of 2008 set the bioethanol blending target to 10% with sugarcane and molasses as its main feedstock, while coconut oil-based biodiesel's blending target is at 5%. The country falls short on its own mandate with bioethanol blending fluctuating on a case-to-case basis and with biodiesel blending only at 2%. A 2011 mandate increased the blending target for bioethanol to 20% by 2020. There are about 11 biodiesel and 10 bioethanol plants in the country with a total capacity of 282 million litres of bioethanol, and 575 million litres of biodiesel in 2017.

There are countries who have started to look at the Philippines as a potential destination for investments towards waste-to-energy, mostly due to the favourable foreign investment incentives present for waste-to-energy projects such as 100% foreign ownership, unlike other renewable energy source. Examples of projects that are making headlines are the Calahunan Engineered Sanitary Landfill in Mandurriao district, Iloilo City, as well as the PhP 4.5 billion (USD 89 million) waste-to-energy facility planned in Pangasinan by Green Atom Renewable Energy Corporation. A Malaysian company is also planning to put up 12 waste-to-energy facilities worth USD 2 billion, in partnership with Integrated Green Technology Inc., and a French technology provider.

Key Biomass and Waste-to-Energy Policy and Targets

The biomass sector has a FiT rate of PhP 6.6 per kWh or USD 0.1 per kWh. In 2018, the ERC extended the biomass installation target in the FiT program of 200 MW for another two years, or until it reaches the unsubscribed balance of around 30 MW. The DOE is also prioritising the exploration of biomass and waste-to-energy projects, however, if the project involves incineration, there needs to be a directive and approval first from the Department of Energy and Natural Resources (DENR), which may be a challenge. According to DOE acquiring permits and approval for projects involving methane capture, and biodigesters have been much easier. All energy projects are required to comply to the environmental emission standards of the country.

Investment in Biomass and Waste-to-Energy Sector

The government has opened fiscal incentives and investment opportunities favourable to foreign investments more so in these two sectors than any of the other renewable energy sources. Rice is a staple food in the country and the most common crops grown are rice, coconut, bananas, pineapples and sugarcane, which also happens to be major biofuel and biomass feedstocks. Milling companies have started to realise the potential of biomass energy. Victoria's Milling Co. Inc. owns the biggest biomass plant with a total capacity of 40 MW. British company MacKay Green Energy (MGE), in partnership with MERALCO, is also building three biomass plants with a total capacity of 32 MW. These plants are mostly in Negros Occidental, where a large portion of the country's rice and sugar industry are concentrated.

Opportunities and Challenges for Swedish Companies

The country's Biomass and waste-to-energy sectors have been more favourable among foreign investors compared to other renewable energies. This year 2019, the DOE opened biomass and waste-to-energy to foreign investors by removing the 40% foreign-ownership mandate, giving foreign investors the chance to own 100% of biomass and waste-to-energy projects in the country, subject to conditions. The Philippine government believes that the country does not have a strong local technology on biomass and waste-to-energy yet, so the government is encouraging foreign investments.

Inadequate transmission infrastructure to accommodate additional grid connection of biomass power is a challenge. There's no set standard on how to sustainably utilise feedstocks and there's a lack of harmony among government agencies in terms of how to properly utilise agro-forestry feedstocks. In terms of biofuel, push backs from the coconut industry has largely affected the use of other sources of feedstocks for biofuels. The country's only sources of biofuels are sugarcane and molasses for bioethanol and coconut oil for biodiesel.

Other Opportunities in Renewable Energy

Geothermal Energy

The Philippines is currently the 3rd largest producer of geothermal energy in the world. The 2018 installed generating capacity of geothermal energy is 1.9 GW, largely unchanged for the past five years. Geothermal energy generation is already well-established in the Philippines. The DOE estimates that geothermal resources have the potential to support over 4 GW of geothermal capacity, however, only two projects are currently under development and the rest are in exploration stage. In 2018, the government launched signed 10 contracts with companies who are looking to drill exploratory wells.

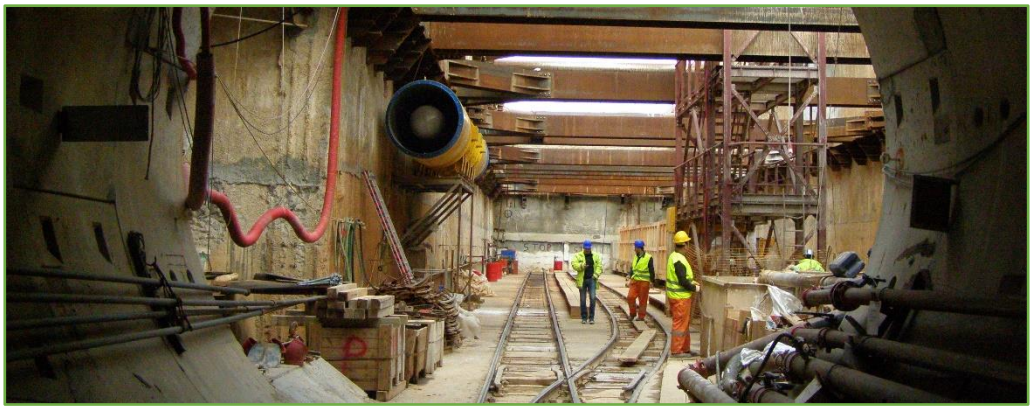
Biogas Energy

The technology on biogas is still largely untapped in the Philippines. The first pilot biogas plant that is underway is the USD 9.7 million First Quezon Biogas Corp., with its Singapore-based partner Yamato Technologies Pte Ltd., and technology partner ABB. This was launched in 2018. However, smaller companies and the government have been introducing the technology to the public much earlier. The Department of Science and Technology (DOST) have introduced biogas digesters to produce fertilisers in two regions of Luzon a few years back. This year 2019, a United Kingdom-based company Straw Innovations Ltd., also launched the 5,000 sqm Rice Straw to Biogas (R2B) project in Laguna, through funding from UK aid.

Hydropower

Hydropower is the biggest source of renewable energy for the Philippines in terms of installed generating capacity. It provides 18% of the country's energy mix, with a total of 3.7 GW installed generating capacity in 2018. Hydropower in the Philippines comes mainly in three forms, storage hydropower, run-of-river (RoR), and pumped storage. Most of the hydropower facilities in the country are already private except for the remaining two which are two large hydropower complexes in Mindanao, Agus and Pulangi, with a combined installed capacity of 982 MW under NAPOCORs responsibility. Privatisation is challenging in this area since located in the Bangsamoro area, an area in Mindanao that is considered high-risk of political and civil unrest. One of the biggest players in hydropower is Aboitiz Power. Harvesting ocean energy is still new to the country, with the first Ocean Tidal Power Plant announced only in 2018.

French firm SABELLA SAS and Filipino company H&WB Asia Pacific (Pte Ltd) Corp. teamed up to develop and finance the 5 MW power plant in Sorsogon Province.



Energy Efficiency

Situation Overview

The Philippines has an overarching program on energy efficiency and conservation (EE&C) which was launched in 2005, the National Energy Efficiency and Conservation Program. The government showed a continuous commitment to the implementation of EE&C through the Energy Efficiency and Conservation Roadmap 2017 – 2040. However, the action plan and roadmap are high-level and are more aspirational rather than binding. The government's objective is to achieve a cumulative reduction in final energy demand of 10% by the end of 2030. There are proposed measures such as enforcing vehicle standards and specific energy efficiency programs for low-income households and the promotion of stronger coordination among government agencies.

The recent enactment of the Republic Act (RA) No. 11285 or the Energy Efficiency and Conservation Act will hopefully help put a stronger focus on implementation to the governments EE&C aspirations. The law aims to promote the development and use of renewable energy as well as grants incentives to energy efficiency projects in the country. Under this law, a National Energy Efficiency Conservation Plan (NEECP) was created, which is a national framework that includes targets, strategies and monitoring and evaluation plans for EE&C. Some of the highlights of RA 11285 are:

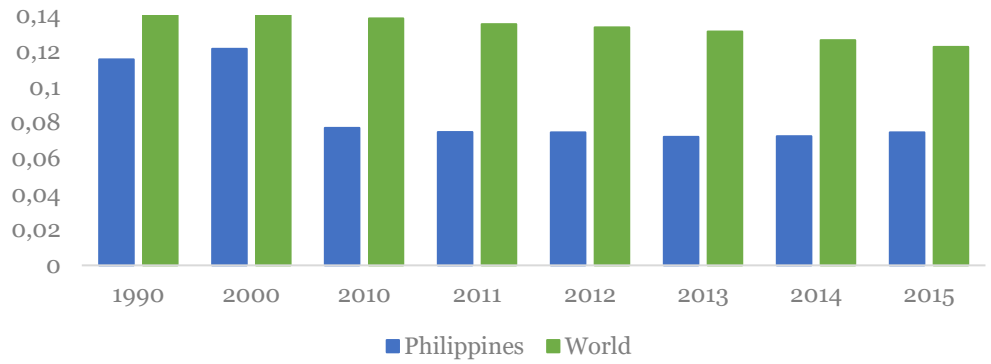
- The establishment of a National Energy Efficiency and Conservation Database, which is a national unified database for energy use and application of energy efficient technologies.
- The establishment of a Local Energy Efficiency and Conservation Plan for all government agencies in order to ensure efficient energy use.
- The establishment of the Energy Efficiency and Conservation Committee which will evaluate and approve government energy efficiency projects, as well as provide strategic direction in the implementation of the Government Energy Management Program which aims to reduce the governments use of electricity and petroleum.
- Continue the promotion of Alternative Energy Technologies and Systems.
- The development of the Minimum Energy Performance (MEP) standards for common energy-consuming household products such as, but not limited to, refrigerators, air-conditioning units, microwave ovens, etc. The law requires manufacturers, importers and dealers to comply with MEP and display the label

on energy requirement and consumption efficiency on the packaging of their products.

- New vehicles must be compliant to the fuel economy performance set by the government, in this case, EURO-4 standard.
- New and existing buildings are now required to comply with certain standards for energy efficiency.
- Fiscal incentives have also been included for energy efficient projects as priorities in the annual investments priorities plan of the Board of Investments (BOI).
- Awards and recognitions for energy-efficient establishments as well as technical assistance on the application of energy efficient technologies.
- Failure to comply will now be subjected to punishments and penalties.

As seen in figure 34, the Philippines' energy intensity has lowered down over the years, signalling effectivity in its commitments to lower down GHG emissions. The DOE has been actively promoting not only the increased installed capacity of renewable energy sources but compressed natural gas, liquefied petroleum gas, and e-vehicles through the Alternative Fuels for Transportation Program, being that the transportation sector is the biggest energy consumer in terms of sector (fuel consumption).

Figure 34. Philippines' Energy Intensity
(1990-2015, (koe/$2011)



Source: World Bank, Data Bank

Main Opportunities in Energy Efficiency

Energy Generation and Transmission

The National Transmission Corporation, a Philippine government company owns the Philippines' power grid which is an interconnected system that transmits electricity to the nation. A privately-owned corporation, The National Grid Corporation Philippines (NGCP), is however in-charge of operating, maintaining and developing the power grid. NGCP is owned by a consortium of three corporations, Monte Oro Grid Resources Corporation, Calaca High Power Corporation, and the State Grid Corporation of China.

The Distribution side of energy *in the Philippines is no different, as it is also privatised. The larger cities are operated by big private investor-owned companies such as Meralco, while smaller cities are operated by Distribution Utilities which are mostly cooperatives that are private, independent electric utilities, owned by the members it serves. These Distribution Utilities are granted franchises by the ERC and are given the mandate to operate by the NEA. In remote areas that are inaccessible to the grid, the control lies with the National Power Corporation – Small Power Utilities Group (SPUG). SPUG operates less than 300 MW of mostly diesel power plants, with*

electricity rates being subsidised by the government. Nationwide, SPUG has 276 gensets mostly in remote islands of Luzon.

Key Energy Generation and Transmission Policy and Targets

In the main island of Luzon, the NGCP's focus is to strengthen the transmission system and improving reliability and resilience especially in the face of typhoons. For Visayas, NGCP aims to strengthen the grid to allow further projects to enter the systems. In Mindanao, it still mostly on expansion. The current roadmap on transmission also aims to facilitate interconnection of the three major grids of Luzon, Visayas, and Mindanao, and the interconnection of emerging island grids.

In terms of distribution, grid reliability has largely improved over the years, increasing capacity to meet demand, and expansion of distribution are still two of the priorities of the distributors. Electrification in remote islands is also a priority target of the government.

Investment in Energy Generation and Transmission Sector

With the continuous increase in the demand for power, coupled with rising number of power generation plants that are on the way, the NGCP is currently undertaking a PhP 17.9 billion (USD 352 million) investment on five transmission projects. All five projects have been categorised as energy projects with national significance (EPNS). Projects categorised under EPNS experience a more simplified approval process and harmonise the relevant rules and regulations of all government agencies involved in the permitting process, helping the project implementation to move faster.

Opportunities and Challenges for Swedish Companies

Technologies on reducing power loss in the transmission and distribution sector will be largely beneficial to the country. The stakeholders have also been constantly making changes to become reliable and climate resilient to natural disasters. On average, the Philippines is hit by 20 typhoons each year. Underwater cabling, smart-grids, micro-grids, are technologies where the country does not have a strong local knowledge but will benefit from to achieve energy targets.

Transportation

Transportation is the biggest consumer of energy in the Philippines, with oil as the major source of fuel. The country is currently a major automotive market in Southeast Asia mostly due to the lack of adequate public transportation system in the country and the entry of the Transport Network Vehicle Service (TNVS) providers such as Grab. Congestion continue to rise in the Philippines, as well as the demand for oil, in which case for the country is largely imported. Biofuel blending has still not reached its peak, with limited choices for feedstocks. There are urban masterplans in transport projects such as BRT, MRT and subways, through the country's ambitious 'Build, Build, Build' (BBB) program. There are no incentives for transportation projects in the country. The government however, has been welcoming the potential for hybrid buses, and electric vehicles. The Philippines' have explored electric jeepneys and electric tricycles in past projects with the Asian Development Bank, but currently, the Philippines has no infrastructure yet in place for electric vehicles.

Key Transportation Policy and Targets

In terms of promoting EE&C, the government's short-term goals (2017-2020) involves e-mobility conversions for e-jeepneys and e-tricycles, and Fuel Efficiency Ratings for light-duty vehicles, vans/jeepneys, tricycles and heavy vehicles (trucks). However, the reality is that majority of the jeepneys and tricycles in the country are still far from electric, and fuel efficiency ratings have only been applied in private vehicles. In 2021-2030, the medium-term goals of the government are to have fiscal incentives for energy efficiency through road taxes and penalties during vehicle registration for vehicles that

meet or do not meet prescribed standards. Congestion taxes in dense urban areas might also be explored. The long term (2031-2040) goals of the government is to apply energy efficiency programs beyond road transport as well as reintegrate transport planning in the urban planning across all local government units. Emission taxes might also be explored in major urban cities.

Investment in Transportation Sector

The BBB program is a PhP 4.3 trillion (USD 84.7 billion) infrastructure program of the current administration that spans the sectors of transport, water, urban development, information and communications technology and power. The administration has recently updated the pipeline from 75 to 100 projects in the coming years.

Opportunities and Challenges for Swedish Companies

The Philippines is estimated to have lost an average of USD 69 million daily due to traffic congestion especially in Manila area. The government's roll-out of infrastructure projects hopes to contribute to the alleviation of Metro Manila's traffic issue with metro projects, subway, and more than 1,000 km of railway projects in the next few years. Transportation in the logistics sector is also offering a variety of opportunities, from motorcycles in high-traffic areas for carton-sized deliveries, to newer, more reliable and bigger vessels for domestic shipping of commodities. However, same as Metro Manila's roads, major port congestions are also an issue in the country, which provides opportunities to companies who can offer modern packaging, transport systems, and equipment to avoid cargo risks such as spoilage in perishables (modern cold storage systems).

Multibillion opportunities awaits Swedish companies in transport and energy sectors offering high-tech, innovative solutions, which depending on the business case, can potentially apply for fiscal incentives from the government. For most of the transport projects there are however no incentives in place currently. There is also a strong competition from Japanese, Chinese and Korean firms who are aggressively bidding for contracts and projects in the BBB pipeline.

Other Opportunities in Energy Efficiency

Residential Buildings

The Philippine population is expected to grow approximately 32% from 2017-2040, which leads to an energy demand forecast growth of 80% until 2040. However, the EE&C targets set out for residential buildings needs to be further developed to assure that the country meets the 20% energy efficiency target by 2040. The short-term goals of the Philippine government in terms of EE&C includes minimum energy standards for key energy-using residential appliances such as air-conditioners, refrigerators, televisions, washing machines and microwaves, as well as the promotion of lighting retrofit and energy efficient insulation and roofing materials. In terms of medium-term goals, DOE aims to reach out to utilities providers to efficiently disseminate information on energy efficiency and awareness since they have a more regular customer interaction with consumers. DOE also mentioned an interest to develop specific EE programs for low-income households. In the long-term, the government aspires to include residential measures in the building code, which is currently only enforced in the commercial and industrial level.

Commercial Buildings

For commercial buildings, the short-term and medium-term goals mostly involve reformulation and implementation of EE measures in the national building code, promotion of retro-commissioning program for existing buildings through seminars and trainings, and the promotion of benchmarking and ratings to specify thresholds for

building performance in the Philippine Building Code. In the longer term, the government envisions to have an EE Incentive funds, as well as private financiers to establish a revolving fund that creates a funding pathway for building retrofits. The government also aims to mandatory require disclosure of building performance on the sale and lease of a building.

Industrial

For industrial, the short-term goals are to require Minimum Energy Performance (MEP) for electric motors and other industrial devices like pumps. The facilities that are utilizing energy above certain designated thresholds will also be required to create reports and plans involving energy efficiency measures. The government also aims to develop targeted programs to energy intensive industries such as sugar processing and cement/construction. The medium-term goals are to update MEP for industrial devices such as fans, chillers, boilers, furnaces and industrial ventilation, air-conditioning and cooling (VAC) systems, among others, to meet international standards. The government also wants to introduce business models for energy service companies (ESCOs). ESCOs are companies who develops, installs, and arranges financing for projects designed to improve the energy efficiency and maintenance costs for facilities over a seven to twenty-year time period depending on the viability of the proposed project. The DOE will serve as the accreditation body for ESCOs. Implementation of demand side management programs that lowers tariff rates is also seen to encourage less power usage during peak hours. The issue of high-electricity tariffs is also addressed in the medium-term plans through a potential review of the current energy pricing models.

SINGAPORE

THE PURSUIT OF ENERGY SECURITY

SINGAPORE – THE PURSUIT OF ENERGY SECURITY

Country Summary

Singapore is a high-income economy and regarded as one of the world's most competitive economies. With its strategic position in Southeast Asia, Singapore has the status of being an international hub and remains an important location for large companies seeking establishment in the region. Main industries include manufacturing and its financial sector, two main pillars of Singapore's high value-added economy.

Singapore's current energy mix is dominated by natural gas (95%). There are limited renewable energy sources available due to Singapore's small land area and resource constraints, where solar has been identified with highest potential. Singapore has the highest carbon emission level per capita in Southeast Asia.

Limited land for possible deployment within solar energy has introduced a demand for new technologies and solutions, including floating, building-integrated, and mobile solar photovoltaic panels. In addition to the deployment of solar panels, Swedish companies could leverage innovative technological solutions within transmission and distribution systems, energy storage systems, grid interactions and solar radiation forecast with advanced forecasting algorithms solutions.

Singapore currently has four waste-to-energy plants and plans to build additional ones. Consultancy for feasibility studies, energy efficiency solutions for processes such as pneumatic, separation and thermochemical, and larger turnkey electrical and automation solutions are main areas of opportunities for Swedish companies.

Regarding energy generation & transmission, the nationwide deployment of Energy Storage Systems (ESS) has a target of 200 MW beyond 2025. Technological solutions within smart energy storage systems, power system applications, smart power transmission and distribution grids and microgrids for integration of solar panels are areas of opportunities for Swedish companies.

Another area of opportunity is within residential & commercial buildings whereas Singapore is currently initiating two main areas in the Smart Nation project -– innovation districts and smart towns. Main opportunities can be found within the large development projects, including solutions for district cooling and ventilation as well as smart metering and lighting.

Swedish companies can enter the Singaporean markets in various ways and there are no restrictions present. Two common ways of doing so is local establishment or using distributors. Establishment is a rather easy and efficient way of entering the market, which is evident in Singapore's ranking for ease of doing business. Singapore has a vast network of distributors and importers, where Swedish companies can work directly with relevant partners.

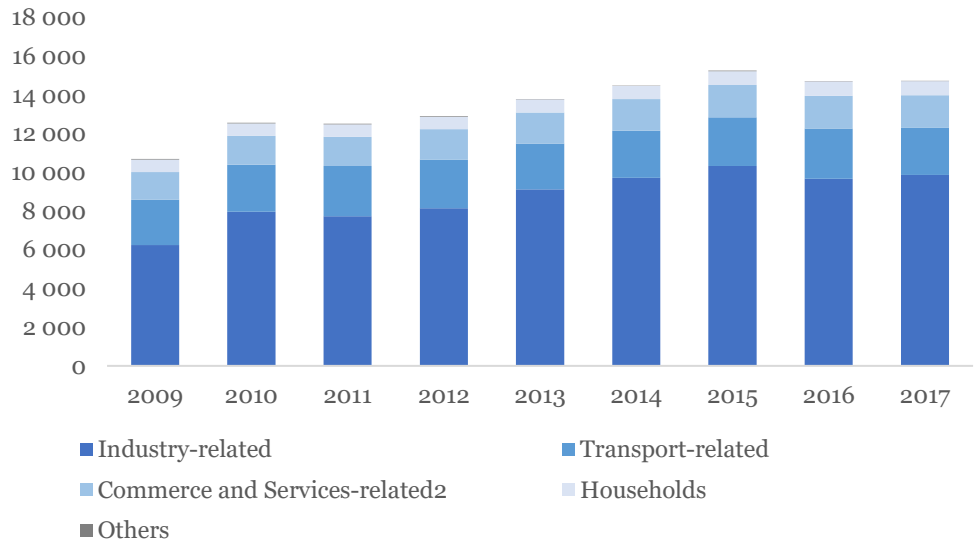
Situation Overview

Singapore with its small land area and limited natural resources imports most of its energy products for generation, resulting in the country's almost entirely reliance on energy imports to meet its domestic energy needs. Singapore's economy continues to expand which in turns increase demand for energy. This brings about a surge in importing energy resources and costs due to a lack of availability of energy resources. As Singapore develops toward ensuring its energy security and decreasing its carbon emissions, there will be challenges that need to be overcome and there will also be opportunities to grabbed.

Energy Utilisation

Main utilisation of energy is within the industry sector, both for oil and natural gas, see figure 35. Total oil consumption in 2017 was 8,840 ktoe or 103 TWh, where the majority was used by industrial-related sectors and transports. Manufacturing is the sub-industry within the industrial sector using the main share of natural gas.

Figure 35. Singapore's Energy Utilisation by Sector
(2009 - 2017, ktoe)



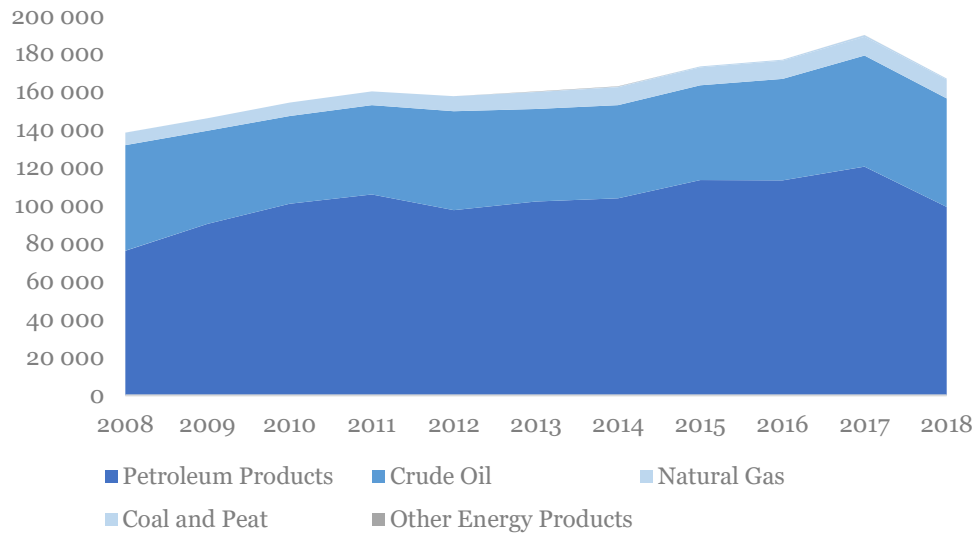
Demand from industrial sector accounts for more than 2/3 of the total demand, with the highest growth of 6% per year during 2009 - 2017

Source: Energy Market Authority (EMA), Enterprise Singapore, National Environment Agency (NEA) and Department of Statistics (DOS), 2019

The total final energy consumption (TFEC) in Singapore in 2016 was 14,715 ktoe or 171 TWh, a decrease of 3.5% from 2015. TFEC from 2017 and 2018 is yet to be released.

According to the Energy Market Authority (EMA) of Singapore, import of fuels is critical for Singapore to secure a reliable and diversified supply of energy. In 2018, Singapore's imports of energy products decreased by 12.1% from 2017, where the preceding years have in comparison shown a steady growth. The decrease of imports was due to lower imports of petroleum products, crude oil, and coal and peat. However, petroleum products remain the main source of import at 59.5%. As seen in figure 36, total natural gas imports increased by 0.9% in 2018, driven by the growth of Liquefied Natural Gas (LNG) imports. LNG is imported from all around the world using ships rather than the traditional pipelines from Malaysia and Indonesia.

Figure 36. Singapore's Imports of Energy Products
(2008 - 2018, ktoe)

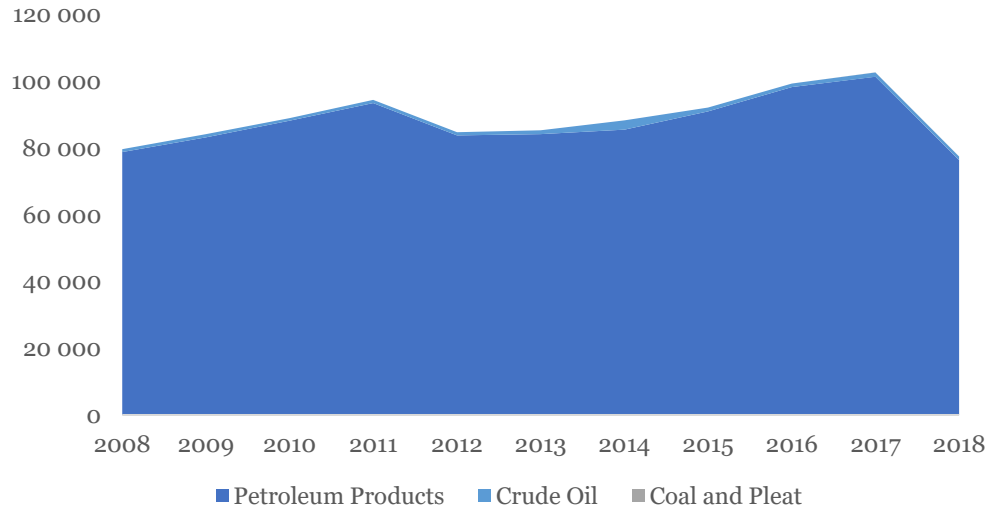


Singapore's imports of energy have increased in line with the increment in economic activity

Source: Singapore Energy Statistics 2019

Singapore's main export of energy products is petroleum products as illustrated in figure 37. Between 2017 and 2018, the exports fell by 24.5% to 78 mtoe due to a lower demand of exports for gasoline and fuel oil. Refinery input in the oil refining sector was 54,785 ktoe or 637 TWh in 2017 whereas refinery output was 52,904 ktoe or 615 TWh.

Figure 37. Singapore's Exports of Energy Products
(2008 - 2018, ktoe)



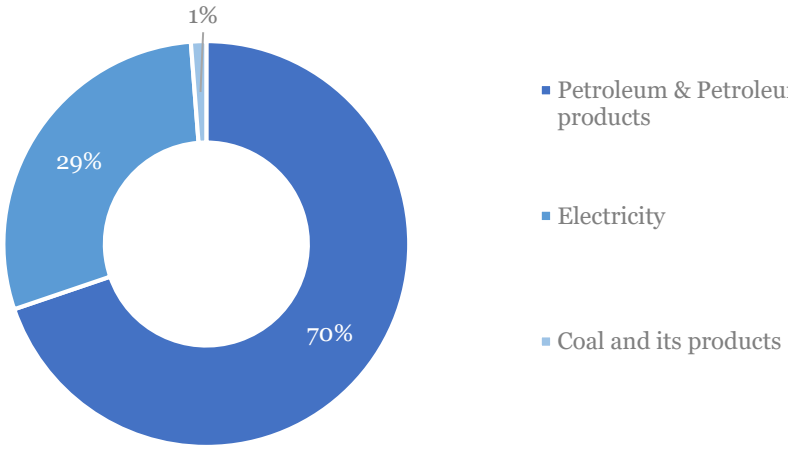
The energy exports fell in 2018 due to a lower global demand for gasoline and fuel oil.

Source: Singapore Energy Statistics 2019

Current Energy Mix

Singapore's Total Final Energy Consumption (TFEC) continues to decline with the decrease of 3%, from 15,312 ktoe (178 TWh) in 2015 to 14,802 ktoe (172 TWh) in 2016 and the further drop of 1% to 14,726 ktoe (171 TWh) in 2017. Almost two-thirds of the final energy consumption is accounted for by the Industrial-related sector. This is predominantly in the form of petroleum products (figure 38). The decline has been contributed primarily by the lower consumption of petroleum products while electricity consumption has slightly grown over the past years.

Figure 38. Singapore's Final Energy Consumption
(2017, percentage)



Singapore's energy consumption is predominantly in the form of petroleum products

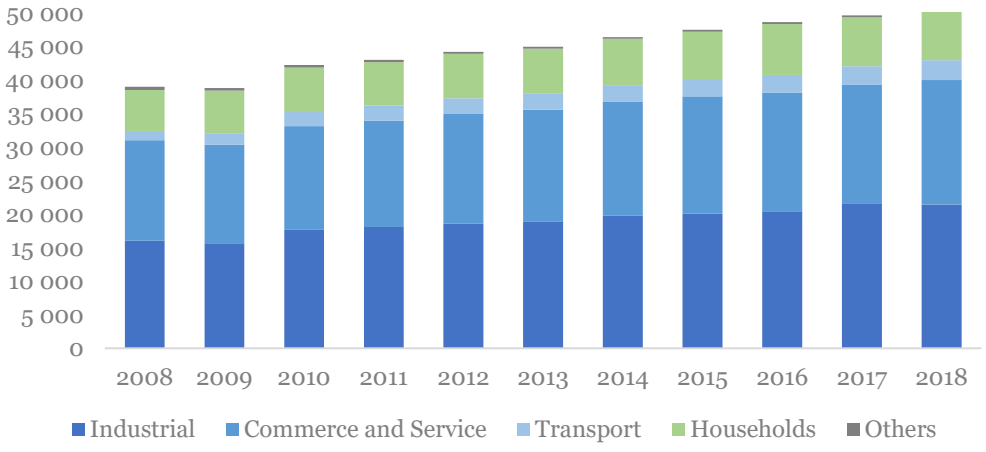
Source: Energy Market Authority, 2018

Electric Power System

The electricity industry was restructured 2018 to 2019 to an open market with the generation and retail of electricity separated from the natural monopoly of electricity transmission at the ownership level. State-owned SP Group is currently operating the national grid.

Overall electricity consumption in Singapore grew by 2.1% between 2017 and 2018 where the main consumption comes from industrial-related sector, commerce & services-related sector and households (figure 39). Main power producers in Singapore accounted for 92.4% of total electricity generated where the remaining was attributed to autoproducers. Autoproduction is the case where energy is produced and transformed in a unit where energy production and transformation are not its main activity, e.g. industrial establishments.

Figure 39. Singapore's Electricity Consumption by Sector
(2008 - 2018, GWh)



In line with the energy utilisation, **the main electricity consumption comes from industrial-related sector**

Source: Department of Statistics Singapore

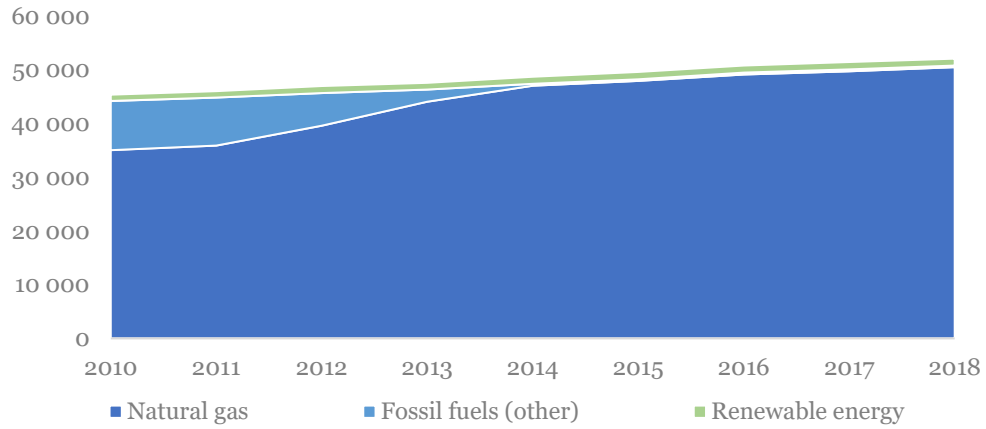
Singapore's fuel mix for electricity generation is dominated by natural gas (NG), accounting for 96% in 2018. Singapore was previously dependent on steam turbine plants for electricity generation, but this has gradually declined over the years with the introduction of new Combined Cycle Gas Turbine (CCGT) plants. As a result, there has been an increase in the share of natural gas in Singapore's fuel mix.

Municipal Waste, Biomass and Solar products accounted for 2.5% of Singapore's annual fuel mix for electricity generation according to the Energy Market Authority (EMA) in 2018, increasing slightly to 3% in the first quarter of 2019. Solar Energy continues to be the main investment in terms of sustainable energy sources for Singapore, with an increasing number of solar projects from public sector agencies taking place across the country. The grid-connected installed capacity of solar PV installations grew from 206 MW to 262 MW in the second quarter of 2019.

Other energy products in the fuel mix of Singapore include petroleum products (mainly diesel and fuel oil) and Coal (0.5%) – see figure 40.

Figure 40. Singapore's Electricity Generation by Energy Source

(2010-2018, GWh)

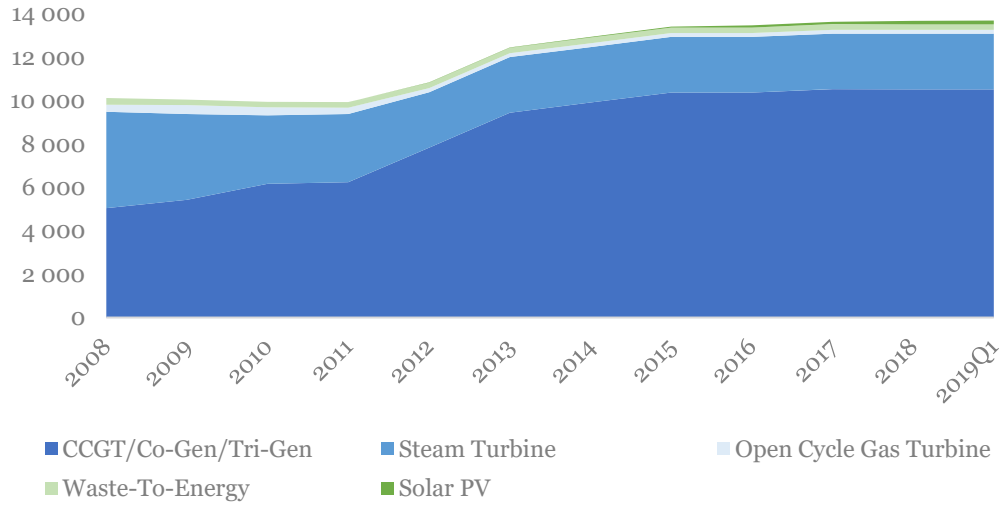


Despite efforts to increase the share of renewable energy, natural gas remains the dominant source in Singapore.

Source: Climatescope, 2018

9,578 ktoe or 111 TWh energy was put into electricity generators in 2018, generating 4,549 ktoe or 53 TWh in total gross electricity. Due to a rise in the generation capacity of solar photovoltaics, the total electricity generation capacity in Singapore grew in the first quarter of 2019 to 13.7 GW (figure 41).

Figure 41. Singapore's Electricity Generation Capacity by Technology Type
(2008 - 2019, MW)



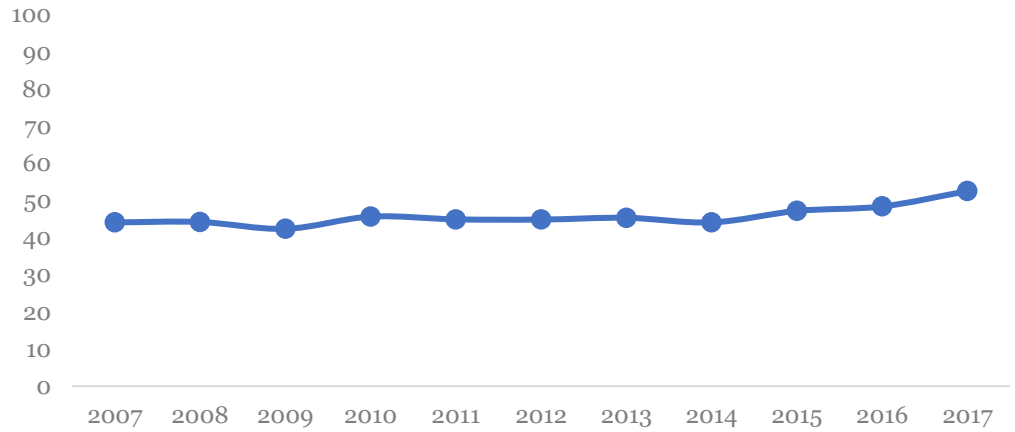
Thanks to the increasing capacity of solar PV, Singapore total electricity generation capacity is growing

Source: Energy Market Authority 2019

CO_2 Emissions

Whereas Singapore is a very small country in Southeast Asia, its position as a key regional port along the East-West trade routes have led Singapore to be a natural location for oil storage and refining facilities in the region. While Singapore contributes to 0.11% to global emissions, it is ranked as 27th out of 142 countries in terms of emissions per capita – 1st in Southeast Asia. According to IAE, Singapore's total emissions per capita was 8.5 tons in 2017. The refining and petrochemical sector is a large source of the carbon emissions in Singapore. Projected total 2020 greenhouse gas emissions are 77 million tons.

Figure 42. Singapore's CO_2 Emissions by Economic Sector
(2007 - 2017, million tons)



Singapore generated 52.5 million tons of CO_2 in 2017, about 0.11 per cent of global emissions

Source: Emission Database for Global Atmospheric Research (EDGAR), 2018

Key National Energy Policies and Targets

Singapore has pledged to reduce the greenhouse gas emissions by 16% below business-as-usual-levels (BAU) by 2020 with a vision of becoming a Zero Waste Nation. By 2030, the BAU-levels – which measures the emissions with a historic forecast with the current technologies in mind – is set at a reduction of 36%.

Key Public Institutions in the Energy Sector

The Ministry of National Development (MND) is the key government ministry responsible for national land use planning and development. The ministry guides Singapore's land use planning, urban redevelopment and building conversations.

The Ministry of the Environment and Water Resources (MEWR), with the statutory boards of National Environment Agency and others, establishes the priorities for a sustainable Singapore, including the Zero Waste Nation objective and the transition to a low-carbon future.

Energy Market Authority (EMA) is the regulator of the electricity industry and develops the electricity industry policy for Singapore through regulations, codes of practice and licenses. New and revised policies are set out in EMA's policy papers, where the introduction of new policies is done regularly to keep in pace with the changing environment in the energy market

The Energy Planning & Development Divison (EPDD) under Energy Market Authority is responsible for the planning and development for Singapore's energy market. The EPDD is an expansion of EMA's mandate and serves as the agency for energy development in addition to its regulatory and power system operation functions. The EDPP oversees planning and development aspects of EMA's work in the energy sector.

The Urban Redevelopment Agency (URA) in Singapore releases a revision of the Master Plan (MP) every 5 years with a statutory land use plan which guides the development in the medium term over the next 10-15 years. The 2019 Master Plan (MP19) was released in Nov 2019, and focusing on planning for inclusive, sustainable and green neighbourhoods. The planning for a sustainable Singapore is also outlined by URA.

Key Policies in the Energy Sector

There are several policies and regulations in place together with a variety of authorities regulating and controlling the energy market in Singapore. Policies are set by the Energy Market Authority.

EMA was established by the **Energy Market Authority of Singapore Act.** The Electricity Act allocates responsibility to EMA for regulation of the electricity sector. Authorisation for an entity to conduct most electricity-related functions is via an electricity license issued by the EMA. EMA's three key roles are as power systems operator, industry regulator, and industry developer.

The National Electricity Market of Singapore (NEMS) is established under the authority of the Electricity Act as well and is largely governed by it. Additionally, NEMS is governed by the wholesale market rules and associated manuals as well as the electricity licenses and codes of practice issued by the Energy Market Authority (EMA). NEMS is designed to promote the efficient supply of competitively-priced electricity and open up the retail market to full competition.

SP Group is a government-owned electricity and gas distribution corporation in Singapore, operating the national electricity grid. Prior to 2019, the electricity market was monopolised by SP Group. Multiple electricity retailers and distributors have been introduced since the open market was established earlier this year.

An additional stakeholder of relevance is the **National Environment Agency (NEA)**. NEA is responsible for ensuring a clean and green environment and the sustainable development of Singapore. Through its partnership with the People, Public and Private sectors, NEA develops and spearheads environmental initiatives and programs.

Key Targets in the Energy Sector

The Minister for Trade & Industry introduced the creation of Singapore's "Energy Story", harnessing 4 'switches' to guide and transform the country's energy supply. The four switches describe Singapore's targets in the energy sector.

- **Natural gas** – Will continue to be the dominant fuel before scaling up the other switches. Government will support in making the plants energy efficient.
- **Solar** – Solar target of 350 MW by 2020, 2 GW by 2030 and an energy storage deployment target of 200 MW beyond 2025.
- **Regional power grids** – Singapore will explore ways to tap on regional power grids to access energy that is cost-competitive through bilateral cooperation or regional initiatives.
- **Emerging low-carbon alternatives** – looking into solutions to help reduce Singapore's carbon footprint, including carbon capture, utilisation or storage technologies and hydrogen.

SP Group and EMA have concluded nuclear fusion and hydrogen technologies could be an option in the long-run (~15 years) as a more carbon-free energy alternative for Singapore. With the current technologies, nuclear presence is not a viable option today due to safety concerns and Singapore's limited land area for power plants.

The Efficiency Programme Office drives energy efficiency projects across many different types of activities. Included, but not limited to, constraining number of vehicles in the city and encouraging public transport and introducing a carbon tax from 2019. Singapore has an objective to improve energy efficiency with 35% by 2030.

Energy Prices and Incentives

Electricity tariffs for non-contestable consumers in Singapore are regulated by the EMA. The four components of electricity tariffs in Singapore are energy costs, grid charges, market support services fees, and market administration and power system operation fees. The average electricity tariffs in 2019 is USD 25 per kWh.

A carbon tax, introduced as the Carbon Pricing Act (CPA), came into operation in January 2019 and incentivises emitters to reduce their emissions. According to NEA, the carbon tax gives the industry the flexibility and time to implement energy efficiency projects. The tax rate, currently set at USD 3.7 (SGD 5) per tons of GHG emissions, is planned to gradually increase up to USD 11 (SGD 15) by 2030.

The Energy Efficient Fund (E^2F) supports a wide range of energy efficiency efforts, with an emphasis on the industrial sector. For example, there is a co-funding scheme of up to 50% of consultancy fees for resource efficient designs and energy assessments. In addition to grant funding, there are several tax incentives for companies to apply for early write-off on capital expenditure on energy efficient equipment.

According to EMA, adopting subsidies such as feed-in tariffs (FiT) creates a distortion in the energy market and increases costs for consumer. Subsidies are therefore not provided, and they argue for an enhancement of regulations to facilitate entry of renewable energy. However, the government supports initiatives with funding to catalyse applied research and development (R&D) of innovative technologies and solutions through grant calls by EMA. By rolling out competitive grant calls to catalyse R&D to address industry-relevant challenges and opportunities in the energy sector, Singapore aims to find long-term solutions and has awarded over USD 74 million (SGD 100 million) to over 25 companies and 11 Institutes of Higher Learning/Research Institutes.

The Economic Development Board (EDB) in Singapore have several funding schemes for companies expanding their economic activities on a more general scale: Pioneer Certificate Incentive (PC) and Development and Expansion Incentive (DEI).

Regulations on Renewable Energy

EMA aims to continuously and proactively enhance the market and regulatory framework to facilitate the deployment of renewable energy sources. They have summarised their approach to promoting sustainable energy as:

- **Right Pricing** – aiming to price energy right to incentivise the efficient use of energy in all sectors
- **Regulation Reduction** – continuing to streamline the existing regulations and processes to facilitate solar PV deployment
- **Raising Demand** – aggregating the public sector demand for solar PV by initiating the SolarNova program led by the government
- **Research & Development** – partnering with industry and research community to test-bed solutions to manage the intermittency challenges posed by renewables

Regulations on Energy Efficiency

National Environment Agency (NEA) set up the Energy Efficiency Program Office, a multi-agency committee to adopt and implement measures to improve energy efficiency. There are initiatives and regulatory practices for different sectors to apply.

- **Household sector** – NEA has rolled out a "Save Energy Save Money" initiative to raise public awareness of households to reduce energy at home. There is a Mandatory Energy Labelling (MELS) and Minimum Energy Performance Standards (MEPS) for household appliances to help improve energy efficiency.
- **Industrial sector** – There is mandatory energy management practices under the Energy Conversation Act (ECA) to drive energy efficiency where requirements that have been initiated, or shortly will be, for companies include: Energy Management System must be adopted by 2021; regular energy efficiency opportunities assessments to be conducted regularly with first submission by 2021; and new industrial facilities and major expansion projects will undergo reviews to incorporate energy efficiency measures from 2018.
- **Public sector** – The "Public Sector Taking the Lead in Environmental Sustainability" (PSTLES) initiative was introduced in 2006 and encourages public sector agencies to put measures in place to encompass energy efficiency, water efficiency and recycling

Renewable Energy

Singapore's size and constrained resources leads to limited renewable energy alternatives. The small physical size, high population density and land scarcity limits Singapore's potential to grow domestic biomass sustainably. Additionally, the wind speed in Singapore is below the needed for operating commercial wind turbines, and the narrow tidal range and use of ports for anchorage and shipping lanes limit opportunities for tidal power generation.

Situation Overview

While there are minor initiatives taking place within several areas, solar energy has been deemed most viable and commercially feasible in the nearest future. Solar energy and waste-to-energy are currently the two renewable energy sources that are part of the energy mix in a larger scale.

Main Opportunities in Renewable Energy

Solar Energy

Solar energy has been deemed the most viable energy source for Singapore in terms of renewable energy generation due to the high average annual solar irradiation of about 1,500 kWh/m^2.

There are apparent challenges for deploying solar photovoltaic (PV) systems, such as limited land area to scale installations and the presence of high cloud cover as well as urban shading. However, the limited applicability of other renewable options makes solar a priority for Singapore. According to Singapore Energy Statistics, there was an installed capacity of 115 MWh generated from 2,155 installations in 2018.

Singapore has pledged to reduce its emissions intensity (EI) by 36% from 2005 levels to 2030. To be able to reduce the emissions in power generation, additional solar installations around the country is planned and Singapore is aiming to increase solar installed capacity from the current 260 MW (2019) to provide 350 MW electricity by 2020, representing about 5% of peak electricity demand. A continued market demand is expected to accelerate the adoption of solar energy.

Key Solar Energy Policy and Targets

The SolarNova Program was launched in 2014 and is a governmental effort led by the Economic Development Board (EDB) and Housing Development Board (HDB) to accelerate the deployment of solar PV systems. EDB works with HDB to aggregate demand from government agencies and provides funding for such agencies to conduct feasibility studies and determine solar PV requirements. HDB structures the solar leasing tenders and handles the tendering process.

Several governmental agencies are supporting the development of solar energy and is encouraging deployment of solar PV systems on buildings, R&D investments, policy enhancements and engagement efforts with various sectors and stakeholders. EMA has made several enhancements to the market and the regulatory framework by streamlining the existing processes, including Enhanced Central Intermediary Scheme (ECIS) and the Solar Generation Profile (SGP).

Key targets for solar power in Singapore are:

- Increase solar deployment from the current 260 MW (2019) to provide 350 MW electricity by 2020, representing about 5% of peak electricity demand.
- Have 2 GW of solar power installed by 2030, enough to meet the annual power needs of around 350,000 households. By 2020, one in every two HDB rooftops will have solar panels deployed.
- Develop floating solar and rooftop solar solutions to maximise the deployment of solar panels onto all available surfaces. This also include reservoirs and vertical surfaces, so-called building-integrated PVs.

Investment in Solar Energy

Companies could expect large investments within new technologies and solutions such as floating solar, mobile solar panels, and building-integrated PVs in addition to the traditional deployment on rooftops. With a large focus on energy efficiency for solar PV deployment, investments in technology combining solar and energy storage would be expected to deal with the intermittency issue in the grid.

There are large development projects occurring throughout the country with a focus on Smart Nation. Deploying of solar PVs or alike technology is integrated in the master plan for virtually all such large developments.

Opportunities and Challenges for Swedish Companies

The SolarNova Phase 1 and Phase 2 was launched in 2015 and 2016. SolarNova tenders for the HDB buildings will be launched until 2020 when the 350 MW target is met. According to the Solar Energy Research Institute, main areas of deployment of solar PVs will be rooftop and floating solar PVs and the expected output to be installed will be about 250-300 MW per year starting 2020.

The government will take the lead to maximise solar deployment on the rooftops of both private industrial and commercial buildings.

In addition, they will be developing building-integrated PV to develop and bring down the costs of innovative solar applications. Building-integrated PV refers to replacing the materials of building facades and vertical surfaces, such as noise barriers and fences. JTC, Jurong Town Corporation, are planning on deploying mobile or semi-mobile solar panels and substations on vacant land. SolarNova program is trying to aggregate solar energy demand in order to enhance the economies of scale and make equity investments in distributed solar energy more attractive to equity investor and lenders.

There are feasibility studies for deployment being initiated as well as environmental studies where consultancy companies can seek opportunities for involvement as well. In addition to the deployment of various solar panels, Swedish companies could leverage on innovative technological solutions within transmission and distribution systems, energy storage systems, grid interactions, and solar radiation forecast with advanced forecasting algorithms solutions.

The main challenge for Swedish companies will be within the technical area, due to Singapore's limitations of land area for traditional deployment of solar PVs. The technical challenge for solar energy in Singapore lies in the integration of variable and non-dispatchable solar electricity into the nation's electricity grid. In addition, the Energy Research Institute at National University of Singapore (NUS) discussed how fire safety and building as well as safety codes are current roadblocks for deployment of building-integrated solar PVs. They are currently working closely with consultancy firms, architecture and energy managers to lower barrier of entry for installation of PVs.

Swedish companies can expect competition from both domestic and international companies due to Singapore's ambitious solar power target and hence, the large number of projects sought to be invested in. For example, French multinational electric utility companies ENGIE and Schneider Electric are two players that play a large part in the changing energy landscape in Singapore.

Singapore's pledge to combat climate crisis and reduce their carbon emissions together with its large R&D hub and start-up scene have created a competitive environment for domestic players as well. In accordance to Singapore's International Energy Week 2019, there is still room for new and more technological advanced solutions to emerge to meet the carbon emission targets of 2030, both from international and domestic providers.

Waste-to-Energy

Waste-to-energy is currently part of Singapore's energy mix for renewable energy together with solar PV systems. About 1.9% of the total electricity generation capacity is made up of waste-to-energy with four waste-to-energy plants around Singapore – Tuas, Senoko (SWTE), Tuas South and Keppel Seghers Tuas (KSTP). The incineration reduces the volume of solid waste in Singapore by 90% and generates enough electricity to meet up to 3% of Singapore's total electricity demand today. In the past few years, including current levels of 2019, Singapore's waste-to-energy plants have an electricity generation capacity of 257 MW. A new waste-to-energy plant is under construction in Tuas and is set to be Singapore's largest with the ability to incinerate 3,600 tons of waste per day and an electricity generation capacity of 120 MW.

In addition to solar energy, waste-to-energy is the second renewable energy source in Singapore's current energy mix. There are several policies and targets in place, including opportunities for Swedish companies to take part of the planned waste-to-energy plants.

Key Waste-to-Energy Policy and Targets

Singapore declared 2019 as the Year Towards Zero Waste as the Semakau landfill has been set to run out of space by 2035. According to the Ministry of the Environment and Water Resources (MEWR) there is no area on the mainland for a second landfill. They are currently looking into technological solutions to prolong its lifetime.

Currently, there are two major waste-to-energy projects recently launched: Integrated Waste Management Facility (IWMF) and the Waste-to-Energy Research Facility at Nanyang Technological University (NTU).

IWMF will be co-located with PUB's Tuas Water Reclamation Plant to optimise efficiency and is set to be Singapore's largest. The IWMF plant is to be completed in 2024 and aims to generate electricity for the water reclamation plant. The facility will also be used as a test-bed for different gasification technologies and other innovative technologies to convert waste into energy. Approximately 2,000 GWh will be generated through the processes of the new mega-plan, enough energy to power its facilities and plant as well as supplied back in the grid. In comparison, this is about 80% more electricity per tons of waste than those currently generating in the waste-to-energy plants.

With the new waste-to-energy plant approaching its completion in the upcoming years, two of the existing plants – Tuas Incineration Plant and SWTE plant will be replaced as they are nearing the end of their lifespan.

Investment in Waste-to-Energy Sector

According to National Environment Agency, there are plans for additional waste-to-energy plants in Singapore. Another plant is currently in the consultancy stage, where a feasibility study will be the first step to initiate the project. There will be another 2-3 years before any big tenders will take place. While not as big as IMWF, one can expect large investment opportunities for the project once deemed feasible. For current plants, most of the investments will be made for replacing the equipment in 5-10 years. However, in addition to governmental initiated waste-to-energy plants, companies should also look for private actors in the sector such as Sembcorp. Sembcorp operates a waste-to-energy plant at Jurong Island who do procurements and updates technology regularly.

New initiatives such as the Waste-to-Energy Research Facility in cooperation with NTU will introduce new slagging gasification technology and provide a play-and-plug feature for test-bedding. The test-bedding creates opportunities for future technological investments for Singapore in the area of waste-to-energy.

Opportunities and Challenges for Swedish Companies

The IWMF to be completed in 2024 whereas the Waste-to-Energy Research Facility was initiated in May 2019. The IWMF is currently in the stage of awarding EPC tenders and detailed design construction. Open public tenders are released through Singapore Government's procurement portal GeBiz. Energy Market Authority releases information about upcoming tenders through email and on their website. The lifespan of IWMF is 30 years and have been designed in a way for the facility to incorporate new technology and make upgrades where feasible. Such key design features of the main structure include easy dismantling and removal of equipment.

The IWMF is aiming to achieve a high overall plant efficiency of 38%. Solutions for energy efficiency of waste-to-energy plants could provide additional opportunities for Swedish companies, for example technology for energy efficient separation processes, energy-optimising pneumatic processes, and thermochemical processes. Turnkey electrical and automation solutions for larger Swedish companies.

The USD 40 million Waste-to-Energy Research Facility will be unique in its test-bed feature and the ability to test new technologies in a play-and-plug style. This includes the capability to process diverse feeds like municipal solid waste, incineration bottom ash and sludge, provision for the evaluation of gas separation technologies to supply enriched-oxygen air, syngas upgrading and novel flue gas treatment techniques. NTU is planning on partner more companies to develop and trail new solutions at this open test-bed facility.

Project	Timeline/Phase	Total investment
IWMF (public)	To be completed in 2024 and have a capacity of 200 MW. Currently awarding EPC tenders and detailed design construction. In the next 5-10 years, the government will put out tenders for replacement of large equipment.	Original 11 construction tenders had a value of USD 5 billion, which was awarded in 2019.
Waste-to-Energy Research Facility (public)	Initiated May 2019. Plug & play applications, test-bedding new technologies.	USD 40 million value in original contract.
New plant (public)	Won't be initiated until 2022-2024 Consultancy procurement/tender currently out for feasibility studies	Estimation ¼ of IMWF size: USD 125 million
Sembcorp (private)	Completed in 2016 Doing procurements for new technology when needed	USD 250 million in 2014

Source: *Integrated Waste Management Facility - National Environment Agency*

Due to the size of the contracts for governmental-initiated projects, conditions in the contract can be deemed stringent for foreign companies. The contracts are modelled after the so-called Public Service Standards Condition (PSSC). According to NEA, many foreign companies find the conditions strict where much of the risk is put on the parent company. While there are not many legal issues present, the way the contracts are written create difficulties for companies to become involved in the projects to a full extent.

The requirements are usually set in terms of emissions and quality of residues when it comes to equipment and technology solutions for waste-to-energy plants. Many companies who bring new technology into Singapore for the first time sometimes experience difficulties to comply to the standards and requirements. However, much of the standards are modelled after international standards, but Swedish companies should keep in mind the highly regulatory nature of Singapore.

Other Opportunities in Renewable Energy

Wind Energy

The first long-span wind turbine in Singapore was installed at Semakau Landfill in 2017, with a sensitivity enough to generate power with wind speeds as low as 3 m/s. The low wind speed in Singapore is one of the reasons for the limited usage of wind energy in

the country. Commercial wind turbines usually operate at wind speeds above 4.5 m/s, whereas the average wind speed in Singapore is only about 2 m/s. The wind turbine at Semakau Landfill is part of Nanyang Technological University's Renewable Energy Integration Demonstrator – Singapore (REIDS) and is a partnership with the French multinational electric utility company ENGIE. At peak capacity, the wind turbine together with the solar panels in the same location, has a total output of 1.5 MW.

Singapore's limited land area and ability to place additional wind turbines for commercial usage, currently create difficulties for determining feasibility of future wind energy projects. As Singapore continues to invest in floating solar panels, opportunities for sea-based wind turbines is limited.

Geothermal Energy

Singapore does not have geothermal energy sources. There has been a limited number of studies about geothermal prospects in Singapore. A 2010 report from the Australian Geothermal Conference illustrate three prospective hot springs to deep well in – Sembawang Hot Spring, Pulau Tekong Hot Springs, and Jurong Formation. Geophysical surveys are required to locate 2-3 km deep exploration wells to further test for high heat flow, geothermal gradients and stress orientation. Further reports have determined that a feasibility study is needed to rule out geothermal energy sources. This has not yet been initiated by the Singaporean government. Some believe that passive geothermal cooling systems would be a more realistic option in Singapore.

Biomass Energy

Singapore's small physical size and land scarcity limit the potential for sustainably-grown domestic biomass. In 2012, Chinese-owned CGNPC Solar-Biofuel Power built and currently operates a biomass power station in Singapore that contributes with more than 62.5 GWh of electricity energy to the national grid each year. By combining waste biomass and solar energy, the facility uses a proprietary waste-to-energy process.

In 2019, SP Group and Gardens by the Bay launched a two-year pilot project to turn waste produced within the premises into syngas and carbonised biomass. The carbonized biomass, known as biochar, can be used to help soil retain nutrients better.

Biogas Energy

Throughout the recent years, Singapore's national water agency Public Utilities Board (PUB) and National Environment Agency (NEA) have initiated projects to turn waste water sludge and food waste to generate biogas. The method of combining the two to generate power to the country's water treatment plants was implemented as a trial in 2016. Sludge and food waste were combined through an anaerobic digestion to produce biogas. In 2019, such initiatives are continuing across relevant plants. At the Ulu Pandan facility, biogas from sludge supplies 25% of the plant's electricity needs. By mixing food waste and sludge, the supply could increase to 40%. Moving forward, the trial will be evaluated to determine operational costs and data analytics of additional deployments.

Hydropower

The relatively narrow tidal range and calm seas in Singapore limit the opportunities for commercial tidal power generation. Singapore as an economic hub for trading uses much of its sea space off the coasts for ports, anchorage, and shipping lanes. As a result, the application of ocean energy technologies is limited.

In September 2019, a tidal energy demonstration project began generating electricity in Singapore under the Sentosa Boardwalk. The project group from NYK Group Company had installed MAKO turbines under the bridge between Singapore mainland and the island of Sentosa. The purpose of the demonstration project is to examine the efficiency and cost of power generation over the upcoming year. Aiming to be the first in Singapore

to commercialise on marine renewable energy, the project is also expected to expand into Asian countries in the future.

Due to the importance of Singapore's ports for the its economy, there are limited opportunities for tidal and wave energy to become extensively commercialised in a larger scale in Singapore. In addition, Singapore does not have a river system with fast flowing water throughout the year, meaning hydroelectric power cannot be harnessed either.

Energy Efficiency

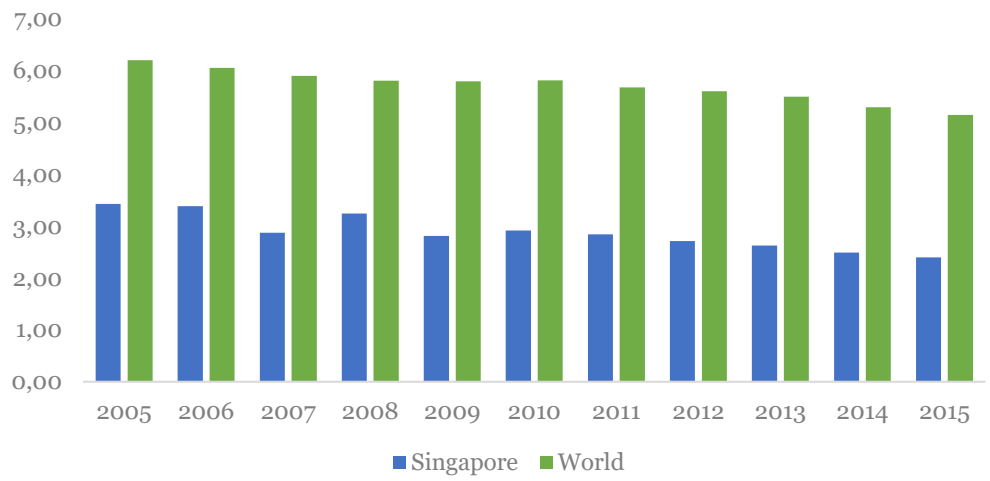
Since Singapore's options for renewable energy is limited, energy efficiency projects have been initiated island-wide to cope with its 2030 target of decreasing its emission level by 36%. To reach such targeted levels, Singapore has pledge to adopt more efficient power generation and increase deployment of solar photovoltaic systems and increase the efficiency of waste-to-energy plants.

Situation Overview

Within its energy efficiency strategy, Singapore is prioritising efforts across all sectors of the public, households and the industry. Singapore has identified four main areas to push its agenda further: the promotion of adopting energy efficient solutions and new technologies; building capacity to sustain and drive such efforts to develop a local knowledge base in energy management; raising awareness among all sectors; and supporting R&D to leverage on the technologies present for energy efficiency.

As illustrated in figure 43, the energy intensity level in Singapore is low in comparison to the world, meaning less energy is used to produce one unit of output. While Singapore is evidently an energy efficient country as of today, its limitation of renewable energy sources and the difficulties of integrating them into the national grid, solutions for energy efficiency will continue to be of relevance.

Figure 43. Singapore's Energy Intensity
(2005 - 2015, MJ/$2011 PPP GDP)



Singapore's energy intensity is among with lowest in the world

Source: World Bank

In 2014, Singapore launched its Smart Nation initiative made up of by three pillars – digital economy, digital government and digital society. Strategic national projects, urban living, transport, health, digital government services and start-ups and businesses are main areas of initiatives for Smart Nation. Energy efficiency plays a big part in the initiative, covering a large search for solutions within smart grid, smart lighting, smart metering, smart lighting and alike, with Housing Development Board's framework for smart towns as their main project. As a result, commercial and residential buildings are grouped as one area of interest for Singapore.

The Energy Efficiency Fund (E^2F) supports a wide range of energy efficiency efforts within the industrial sector where there are several tax incentives and schemes to allow such investments. The Energy Conversation Act include new requirements in the upcoming years for projects and facilities to improve energy efficiency in the industry, including design reviews and assessments.

Main Opportunities in Energy Efficiency

Energy Generation and Transmission

Based upon Singapore's land scarcity and its limitation to renewable energy sources, energy generation and transmission is deemed a priority for moving forward with Singapore's green agenda. As Singapore continues to explore more sustainable energy sources, there is a greater need to leverage on new and innovative solutions for energy storage, smart grid, metering and such.

According to S&P Global Ratings, grid transition will be one of the opportunities for growth in the Singaporean energy market. Battery and energy storage solutions is of key to harvest the energy generated from the limited renewable sources. By shifting the grid gradually to a greater share of renewables, independent power producers can see large growth opportunities to tap into as Singapore is progressing towards a utility-scale energy storage system.

Singapore's limitation to scaling renewable energy sources such as solar and waste-to-energy creates a need for managing the output in a more efficient manner. With the intermittency issue of such energy output, integrating into the national grid with

innovative solutions such as smart grids and smart energy storage systems are of relevance for Singapore.

Key Energy Generation and Transmission Policy and Targets

The opening of Singapore's energy market initially took place in April 2018, with the last launch in May 2019, with SP Group long being the only retailer on the market. Throughout the years, the restructuring and privatisation of the energy sector have taken place to turn it into a competitive market instead. While there are additional electricity retailers present, SP Group is still the utility provider and operates the national electricity grid.

Government have expressed priority in technologies and solutions for storing energy as a solution for their limitation of renewable energy resources alternatives. Energy Storage System began test-bedding in the fall of 2019. The nationwide deployment of Energy Storage Systems (ESS) has a target of 200 MW beyond 2025. The government and EMA will work closely with the industry and agencies to build test-beds and standards to support the nationwide and large-scale deployment of ESS in Singapore.

The ambition of turning Singapore into a smart city is further aligned with its policies for energy generation and transmission. Smart grid, smart metering and energy storage systems are areas of solutions required for such development.

Investment in Energy Generation and Transmission Sector

During the Singapore International Energy Week in October 2019, energy storage solutions was named as one of the main areas for further investment to deal with energy efficiency within the area of energy generation and transmission. As a result, a bigger push for such solutions could be expected with a greater sense of certainty. According to EMA, the growth will also be dependent on stakeholders where they will continue working with research partners to deal with the regulations and intermittence challenges. Since the gap between current and future planned level of solar PVs is large, EMA will continue to look for innovative and creative ways of generating solar energy in an efficient manner.

The government has expressed interest to continue seek commercially viable solutions for the Energy Storage System (ESS), an area the government is making further investments in. EMA uses targeted outreach for solutions required and has made grant calls for generation companies within this area.

Opportunities and Challenges for Swedish Companies

EMA and PSA Singapore launched a joint grant call in May 2019 for proposals in smart grid and energy storage to reduce overall energy usage, costs and carbon footprints. The grant call was open to research institutes, public sector agencies, not-for-profit organisations and private sector companies. While EMA does not currently (as of December 2019) have ongoing grant calls, companies should stay updated for future calls as energy efficiency solutions within energy generation and transmission continues to be of priority in Singapore with its target beyond 2025.

Singapore Power Centre of Excellence signed partnerships with private sector companies back in 2016 within the areas of: grid sensing with 3M, analytics with NEC, Space-Time insight, grid solutions for substation digitalisation, and smart energy and analytics platforms. For Swedish companies, main areas of opportunities could include smart energy storage systems, power system applications, smart power transmission and distribution grids, and microgrids for integration of solar panels. Additional technological solutions within energy storage solutions sought after includes flywheel energy storage, compressed air energy storage, chemical batteries, flow batteries, thermal energy storage.

There are two main challenges when it comes to energy generation and transmission for companies looking to provide solutions. Firstly, regulations and policy framework for

the ESS and other storage solutions are not fully determined yet, as Singapore is working on determining the source and ownership of such solutions when integrating the systems into the national grid.

Secondly, integrating the energy storage systems into the grid is another challenge which is currently under review by EMA. Due to the intermittence issue of renewable energy sources, the final determination paper for the intermittency pricing mechanism (IPM) was launched in 2018 and will be adopted to manage the reserves cost for ESS.

Residential and Commercial Buildings

In total, both residential and non-residential buildings consume about half of the country's electricity. For Singapore, finding technologies that improve the energy efficiency of both residential and commercial buildings is vital to reduce energy usage. There are several initiatives in the pipeline, with the Master Plan including digital and innovation districts, integrated business parks, and zero carbon buildings. The projects are tapping smart energy technologies in both public housing and commercial residences. For example, the first smart grid for business parks was initiated for the Punggol Digital District in 2019, including solutions for district cooling and smart lighting for planned buildings in the district.

As previously mentioned, the Housing Development Board (HDB) has initiated a smart town framework, including several sustainability efforts such as smart lighting, deployment of PVs, and pneumatic waste conveyance system. For example, Envac's waste management system has been implemented as a solution for the framework.

Key Residential and Commercial Buildings Policy and Targets

With a large focus on energy efficiency solutions for many types of buildings, residential and commercial buildings including, Smart Nation and the government targets new technology solutions for buildings. The National Energy Agency uses ESCO (Energy Services Company) accreditation for companies providing energy auditing services and implementing energy efficiency and conservation projects for buildings and facilities with the use of energy-efficiency technology. The accreditation scheme is used to support public sector incentive schemes and services procurements to promote energy efficiency in buildings.

At the forefront of Singapore's Smart Nation push, the Punggol Digital District will be Singapore's first truly smart district. The co-location of Singapore Institute of Technology's (SIT) campus and JTC Corp's Business Park aims to create synergies, enable close integration between industry and academia, as well as foster vibrant and strong communities. Commencement of construction has begun where the developments are set to be up and running in 2023.

In July 2018, SP Group and HDB signed a memorandum of understanding for the collaboration of an integrated energy masterplan to develop Singapore's first smart energy town at Tengah. The masterplan integrates a wide range of energy solutions to help Tengah residents save energy and cost, including Singapore's first residential district cooling solution, solar energy, electric vehicle charging points and batteries as a smart energy enabler. SP will develop an integrative software layer that will integrate the various energy solutions to generate efficiencies and energy savings. They build in 3-years block and rollout is expected in 2025.

Singapore has a target to achieve BCA Green Mark standards for 80% of the buildings by 2030, where the focus will be to improve energy efficiency for the tenants. BCA Green Mark standards was introduced by the Building and Construction Authority (BCA) of Singapore in 2005 and is a rating system evaluating a building's environmental impact and recognises its sustainability performance. The BCA Green Mark differs from the Leadership in Energy and Environmental Design (LEED) certification in three ways:

stronger emphasis on energy efficiency; tailored to tropical climates with heat gain and cooling of inner spaces with air-conditioning as key design considerations; and higher standards of measurement and verification instrumentation for air-conditioning chiller plants to ensure continual performance monitoring.

Investment in Residential and Commercial Buildings Sector

Largest investment opportunities for buildings can be found in the innovation districts and smart towns, identified under the Master Plan for Smart Nation. The two overlap in several ways in terms of solutions and investment opportunities. JTC is the main developer for the smart districts, with a focus on Business Parks and large development sites, whereas HDB is the main stakeholder for the residential buildings. Major investments are made both in commercial and residential buildings to make them more sustainable. Business Sweden in Singapore is involved in mapping out opportunities and stakeholders for Swedish companies within the Smart Nation project, including Changi Airport, Tuas Mega Port, Punggol Digital District, and HDB smart towns.

Opportunities and Challenges for Swedish Companies

Many of the smart district and smart towns have commenced construction and is currently in the stage of procuring solutions and services. In particular, the Punggol Digital District has been identified as a potential for Swedish companies to provide energy related solutions within smart energy grid, district cooling, and smart facilities management. The land area of Punggol Digital District is 500 000 m² with a USD 1.5-2 billion estimated investment value.

HDB has through the Smart Towns framework communicated interest of specific solutions they are currently looking for within energy. In addition to their smart town framework for new developments, HDB are initiating projects to make their residential buildings more energy efficient. Example of solutions required for the innovation districts and smart towns can be identified similar as of those mentioned below. HDB's planned smart towns are currently located in Tengah, Yuhua, and Punggol.

Table 14. Singapore's Smart Towns Initiatives

Initiative: Smart Towns (HDB)	Description of solutions required
Solar-ready roofs	Infrastructure and equipment required to prepare roofs to receive solar panels
Vertical Solar PV	Vertically-mounted solar panels
Building Integrated PV	Integration of solar panels and vertical greenery systems
Energy Storage Systems	Looking at energy-storage systems to store solar power and mitigate grid instability
LED + Ducted Lighting	More energy-efficient lighting for common corridors
Smart lighting	Common lighting with adaptive brightness and motion detection
Home Energy Management System	Residential energy monitoring system
Smart Sockets	Integrated energy monitoring within power socket, able to differentiate loads on a device-level

Smart Distribution Board	Energy monitoring on a household level, includes universal gateway for smart sockets and selected 3rd party IoT devices
Regenerative lift system	Energy recovery from lift car braking
Remote water meters	Eliminates current practice of manual meter reading
EV-ready carpark	Infrastructure (substations, charging points) to support Electric Vehicles. Focus on upgrading older carparks with lower capacity grids
Integrated Environmental Modeler	Integrated physics simulation engine for wind, solar, noise, rain, etc.
Complex Systems modelling	Decision-making tool that draws relations between urban solutions to generate optimal approaches. E.g., install more green roofs to reduce ambient temperature or solar panels to generate energy?
Predictive maintenance	Data analytics based on sensor information to perform predictive maintenance on key infrastructure such as pumps and lifts

Source: Housing Development Board

In addition to solutions for smart towns, EMA identifies district cooling as a key solution for making buildings more energy efficient. For example, how to aggregate the cool air in the facilities and generate from a central source. There are also many initiatives in changing customer behaviour, where data analytics and applications for comparing energy efficiency usages in households have become of greater interest.

Three main challenges have been identified for Swedish companies to take part in the projects.

Firstly, navigating authorities and projects have been identified as challenging due to the multi-faceted smart city projects in the various sectors. There is a lack of project management offices for the smart city projects and agendas differ across government agencies. Companies can find it challenging to identify and approach the correct stakeholders.

Secondly, managing expectation and competition of stakeholders in Singapore is another challenge. Government has a focus on efficiency and productivity, rather than sustainability. Tenders focus on price rather than quality and there is rather much competition from local companies.

Thirdly, support for long term commitments. There is a difficulty to commit without viability on long-term contracts. The procurement phase has been identified as challenging for Swedish companies for the ongoing projects. To be able to influence what standards and technical specifications that is required, companies need to be involved from a very early stage.

Other Opportunities in Energy Efficiency

Industrial

The industry sector accounts for more than half of Singapore's GHG emissions, where several areas of improvement for energy efficiency has been deemed necessary. There have been significant energy efficiency opportunities identified in several industries, including petroleum, petrochemical, and semiconductor subsectors. By 2030, industrial energy efficiency in Singapore is estimated to increase by 20% by implementing projects and energy management practices to save energy and reduce costs for companies. In the manufacturing sector, NEA and Economic Development Board (EDB) are cooperating with relevant industries to improve the energy efficiency in their facilities and production to reach targeted improvement rates of 1-2% as of leading countries such as Belgium and the Netherlands.

While Singapore has a limited manufacturing and industrial sector, the country is emerging as Southeast Asia's hub for data centres holding 60% of the regions' facilities. The number of data centres in Singapore is expected to grow which has ignited the need for energy efficiency within the facilities. By 2030, the emissions from data centres are to be reduced by 50% with the help of large schemes and incentives to decrease the environmental impact.

Transportation

Singapore has an ambitious plan to increase energy efficiency within its transportation modes, including target of achieving a 75% use of public transport by 2030, encouraging cycling and walking and improving vehicle fuel efficiency. In addition, the plan is to double its rail network in 15 years, adding 120 trains to its existing lines and increasing the total fleet size by more than 40%. Private transport usage has been limited in Singapore for many years due to the requirement of obtaining a Certificate of Entitlement (COE) and the Electronic Road Pricing (ERP) system. In addition, there are high vehicle taxes, registration fees and fuel duties. A Carbon Emissions-based Vehicle (CEV) scheme was introduced in 2015 to incentivise consumers to purchase vehicles with lower emissions.

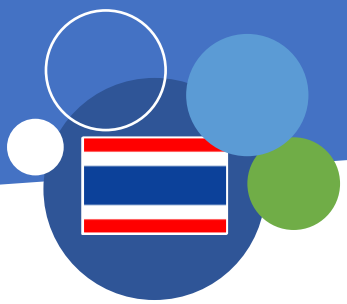
The Electric Vehicle (EV) pilot program, Phase 2, is currently underway with various trials to assess the implementation of electric vehicles in Singapore. During the first phase between 2011-2013 there were 89 vehicles deployed. For the second phase, there will be a trail for fleet-based operations and a car-sharing pilot program to introduce as many as 1000 EVs. An island-wide charging infrastructure will compromise 2,000 charging kiosks to support the eventual proliferation of EVs.

In western Singapore, a test-bed for autonomous vehicles (AV) is to be set covering more than 1,000 km of public roads. This expansion will take place gradually over the upcoming years. Land Transportation Authority (LTA) has signed several agreements with companies to develop solutions for autonomous trucks and utility vehicles in addition to the current trial for cars, buses, and shuttles.

THAILAND

DEVELOPMENT FOR STABILITY AND SUSTAINABILITY

THAILAND – DEVELOPMENT FOR STABILITY AND SUSTAINABILITY



Country Summary

In line with economic growth in the past decades, Thailand's energy demand in all economic sectors has been on the rise and Thai authorities are tasked to ensure the demand is fulfilled. Various energy development plans and schemes, thus, have been implemented, considering the facts that the country needs to ensure its energy security to support economic expansion while having environmental perspectives in focus.

The importance of renewable energy development is currently much more crucial than it was in the past. Thailand has abundance of renewable resources that it can take advantage of and has started the journey toward increasing the share of renewables in its future energy mix, with sets of policy and incentive schemes to attract investments.

This green development leads to emerging opportunities for Swedish companies aspiring to expand into a high potential market. Solutions to increase renewable energy output will be welcomed by Thai energy producers. The priority is the highest for solar energy and Swedish consulting companies will find opportunities by participating in various solar farms projects being planned while manufacturers or distributors of high-performance solar panels, solar collectors, and solar energy storage solutions will also find opportunities in smaller self-consumption projects. The second priority is placed on biomass, which represent chances for Swedish companies to work with Small Power Producers (SPPs) from consulting services, to engineering support for optimisation and efficiency, and even to supply chain management e.g. pelletizing or bracketing for storage and logistics.

The Thai government is also working toward increasing the nation's energy efficiency both in the production and consumption side. Increasing investment budgets are now allocated to the development of smart grid projects taking place nationwide by public and private power companies. Swedish companies can provide engineering and consulting supports to SPP in the areas of substation automation, microgrid development, distributed generation, energy storage and advanced metering infrastructure.

Residential and commercial buildings sector is also incentivised to improve their energy efficiency through the implementation of smart solutions while the industrial and transport sector attempt to lower both energy costs and greenhouse gas emission. Swedish manufacturers and/or distributors of building envelop materials, HVAC, lighting equipment and lighting systems, as well as water heating will find opportunities to increase their sales in Thailand.

Situation Overview

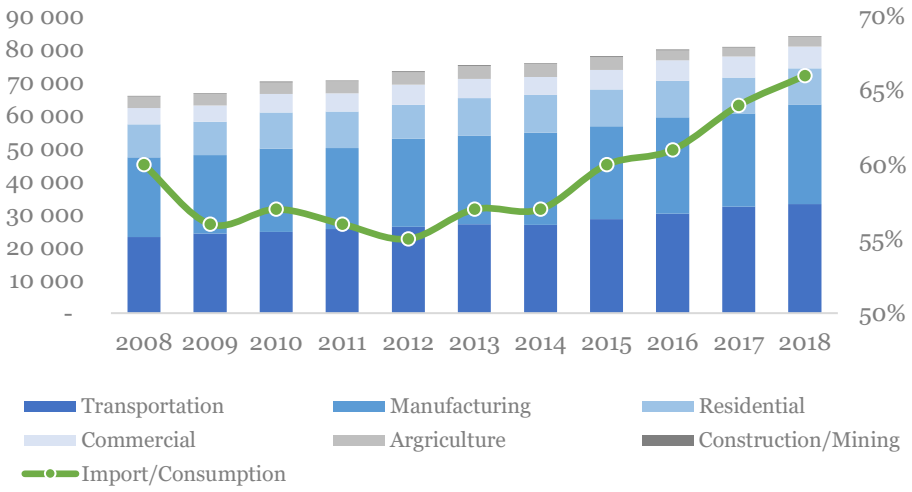
Thailand has made progress toward strong economic growth over the past 50 years. Such development lifted the country up to become an upper-middle income economy, evolved the industrial and commercial sectors rapidly, and brought about significant surge in demand for energy. Energy demand in Thailand is expected to increase by 78% by 2036. This continuous demand increase, coupled with depleting domestic reserves of non-renewable energy resources in Thailand, has prompted the Thai government to explicitly set energy security as the top policy objective. The Thai government has also committed to reduce carbon emissions by 20-25% from the business-as-usual scenario by 2030. Renewables will play an important role in achieving these goals.

Energy Utilisation

The growth of Thailand's total final energy consumption (TFEC) has been 2.5% per year for the past decade as shown in figure 44. Transportation and manufacturing combined account for more than 70% of the total energy consumption and the growth of total consumption is driven primary by higher energy usage in the transportation sector.

With more than half of its energy demand fulfilled by imported energy and the increasing energy price volatility, Thailand may find itself having to cope with energy security challenges in the future. This calls for the Thai government to make efforts to improve energy efficiency and diversify the energy sources. Thailand has its own fossil energy resources including crude oil, natural gas, and coal. However, these energy sources cover only 34% of domestic consumption.

Figure 44. Thailand's Energy Utilisation by Sector
(2008 - 2018, ktoe)



Source: Energy Policy and Planning Office, 2019; Department of Alternative Energy Development and Efficiency, 2019

Energy consumption increased at the rate of 2.5% per year

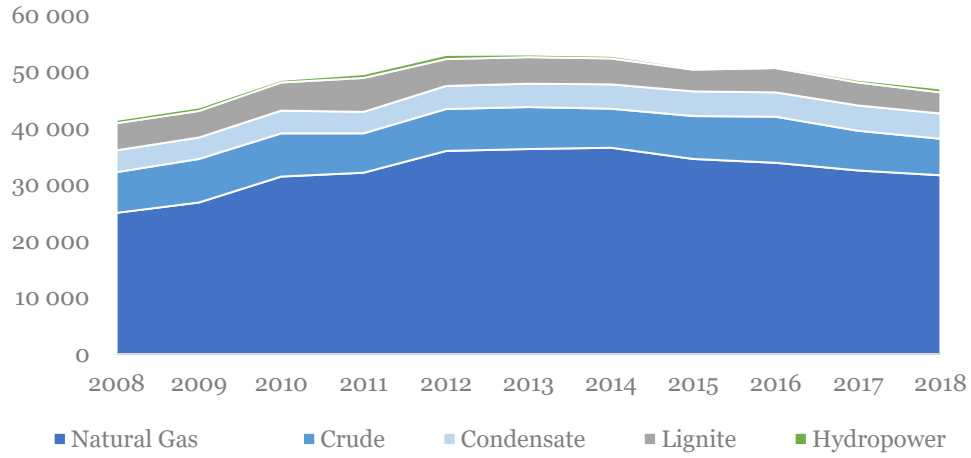
With more than 2/3 of energy consumed imported

The total primary energy production of natural gas, crude, condensate, lignite and hydropower in Thailand in 2018 decreased for the second consecutive year, forcing the country to rely more on imports of energy. The country's production totalled at 942 kilo barrels per day of crude oil equivalent, representing a decline of 3.1% from 2017. Crude oil and lignite declined by 8.5% due to lower oil prices and lower demand for lignite while natural gas production was lowered by 2.6% since almost every main production source reduced its production.

Condensate production remained at the same level as that of 2017. Hydropower generation, on the other hand, significantly increased for the second year in a row. The increment of 62.1% of hydropower production was recorded in 2018, owing to more rainfall that resulted in higher water levels in dam reservoirs as seen in figure 45.

Figure 45. Thailand's Primary Energy Production by Fuel Type

(2008 - 2018, ktoe)



Primary production is dominated by natural gas

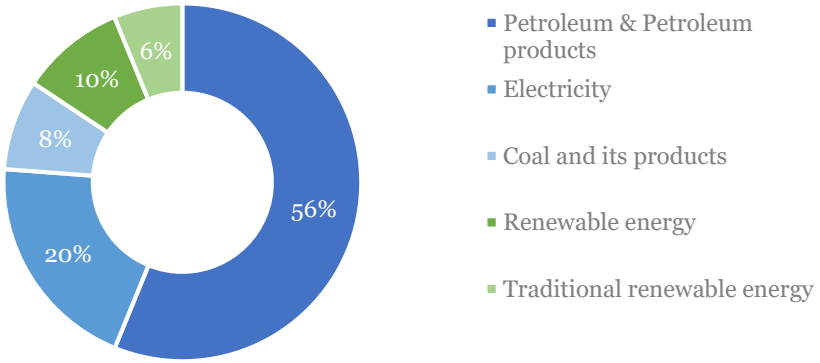
However, the output has been decreasing for the past 3 years

Source: Energy Policy and Planning Office, 2019

Current Energy Mix

Thailand's energy mix, similar to that of most Southeast Asia countries, is currently dominated by fossil fuels. The consumption of petroleum and petroleum products accounted for 64% of Thailand's TFEC in 2018 while the consumption of electricity and renewable energy only contributed 20% and 16% respectively (figure 46). With the depletion of indigenous oil and gas resources, Thailand is forced to explore means to scale up the other forms of energy in order to meet the growing demand. The country may have to turn to domestic lignite coal or imported energy if renewable energy cannot fill in the void.

Figure 46. Thailand's Final Energy Consumption
(2018, percentage)



Thailand's reliance on petroleum is expected to lessen over the next decade

Note: Traditional Renewable Energy includes fuel wood, charcoal, paddy husk and agricultural waste

Source: Energy Policy and Planning Office, 2019; Department of Alternative Energy Development and Efficiency, 2019

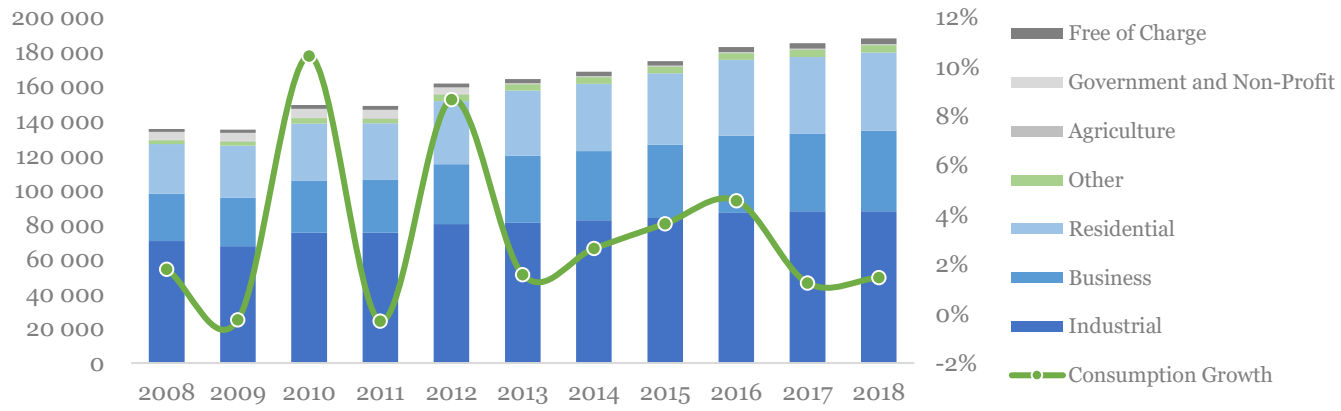
Thailand has long been promoting and supporting renewable energy development, with the aim to steadily increase the use of renewable energy and improve energy efficiency so that the country does not have to rely heavily on imports of fossil fuels and foster economic growth with lower environmental impacts, the Thai government has established ambitious targets and policies, together with incentive schemes, to support the development of renewable energy sources including solar, wind, biomass and biogas, waste-to-energy and hydropower.

Electric Power System

Thailand has a well-established electric power grid infrastructure enabling the country to be 99% electrified and providing universal access to electricity with an installed generating capacity of 44.5 GW. Electricity generation has gradually increased to cater increasing demand, but the primary source of energy is still domestic and imported natural gas.

Electricity consumption has been on the rise. In 2018, the total electricity consumption reached almost 188 TWh, representing the growth of 1.5% over the previous year. This was primarily due to economic expansion, most notably in exports and tourism. As seen in figure 47 the industrial sector remained the highest consumer of electricity, accounted for 47% of total consumption, followed by commercial and residential sector.

Figure 47. Thailand's Electricity Consumption by Sector
(2008 - 2018, GWh)



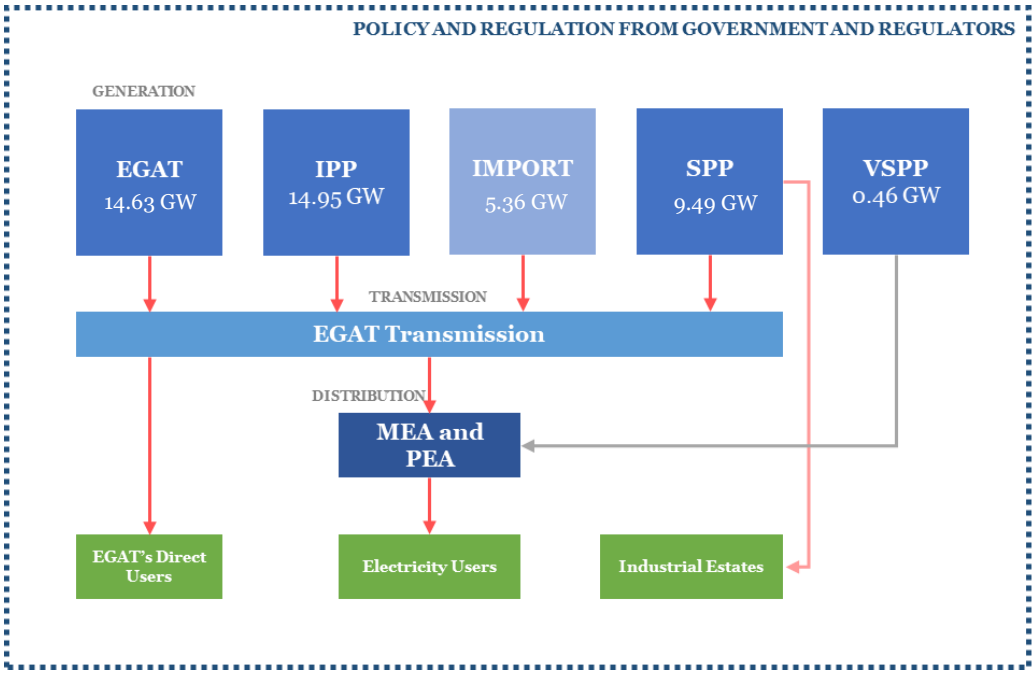
Note: Since 2012, government and non-profit organisations have been classified as business. Thailand has implemented the subsidisation or free-of-charge power consumption policy for lower-income citizens.

Source: Energy Policy and Planning Office, 2019

The electric power sector in Thailand is largely a state-controlled sector as the entire value chain from generation to transmission and distribution is dominated by state-owned enterprises. Thailand has adopted the Enhanced Single Buyer (ESB) Structure for the power industry, with Electricity Generation Authority of Thailand (EGAT) being the key buyer of electricity from other private generating entities, including foreign ones, under long-term Power Purchase Agreements (PPA).

As illustrated in figure 48 there is only a handful of small power producers (SPPs) and very small power producers (VSPP) operating in Thailand, EGAT is also the key power generator and the only operator of the whole national transmission network while Metropolitan Electricity Authority (MEA) and Provincial Electricity Authority (PEA) are responsible for the distribution in Bangkok and vicinity areas and provincial areas respectively. EGAT itself has a total installed capacity of under 15 GW.

Figure 48. Thailand's Electric Power Sector Structure

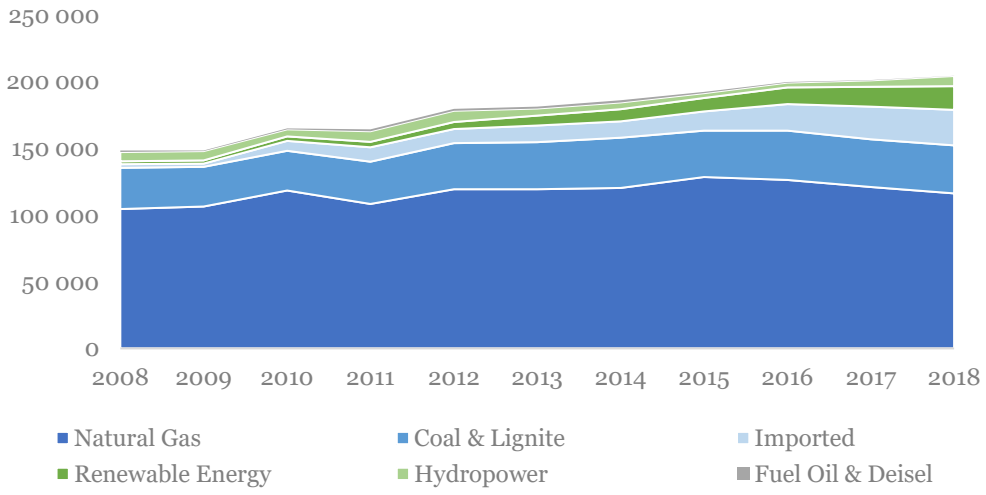


Source: Ministry of Energy, 2019, EGAT, 2019

In 2019, generating capacity under EGAT's system totalled 44.5 GW, of which EGAT's generation accounted for 33%, IPPs contributed 34%, SPPs contributed 21%, and the rest 12% was imports from Lao People's Democratic Republic and barters with Malaysia. The generating capacity of VSPPs, not under EGAT's system added another 0.5 GW to the country's capacity, see figure 49.

The total electricity generated on EGAT's system totalled 204,306 GWh, a growth of 1.6% over the previous year. On top of domestic generation, Thailand signed a memorandum of understanding (MoU) on the purchase of electricity from Lao PDR in 2016.

Figure 49. Electricity Generation by Energy Source (on EGAT's System)
(2008 - 2018, GWh)



Source: Energy Policy and Planning Office, 2019; Department of Alternative Energy Development and Efficiency, 2019

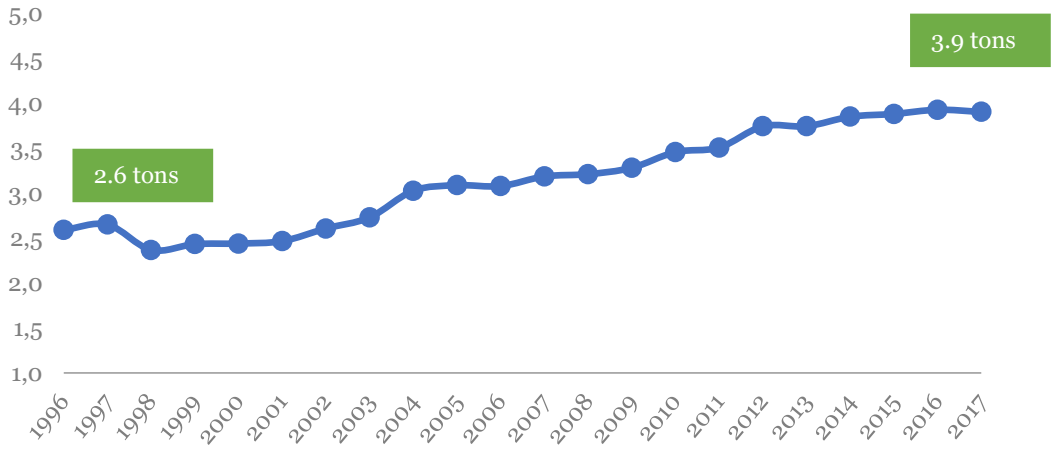
Fossil fuels remain the dominant fuel for power generation

while biomass has the major share with the renewable energy generation portfolio

CO_2 Emissions

Thailand's carbon dioxide emissions per capita over the past two decades has experienced a significant drop only once in 1998 as Asian financial crisis negatively impacted energy consumption. Since then the trend has been upward with the average growth of 2.7% per year until reaching 3.9 tons per capita in 2017 (figure 50).

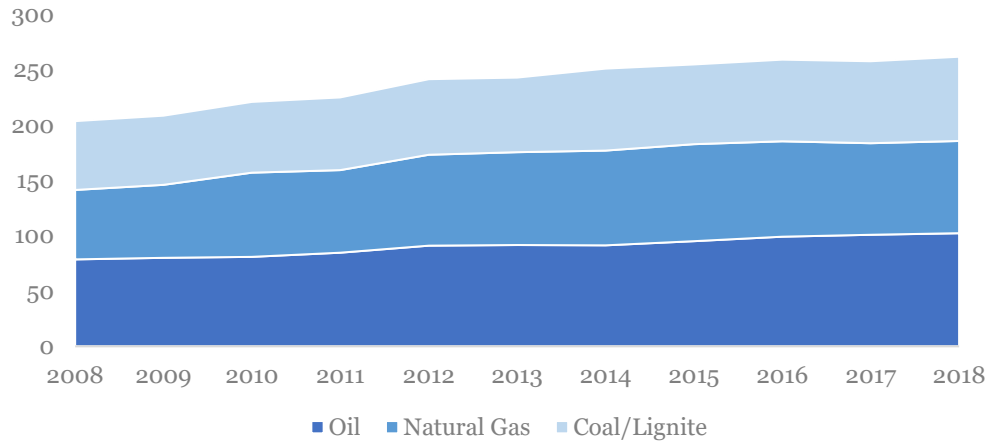
Figure 50. Thailand's CO_2 Emissions Per Capita
(1996 - 2017, tons)



Source: Energy Policy and Planning Office, 2018; Department of Provincial Administration, 2018

The level of CO_2 emissions in the energy sector in Thailand increased in 2018. This is in line with the increasing energy consumption. Figure 51 shows the primary CO_2-emitting fuel type which was petroleum and petroleum products, accounting for 39% of total emissions, followed by natural gas and coal/lignite at 32% and 29% respectively.

Figure 51. Thailand's CO_2 Emissions by Energy Type
(2008 - 2018, million tons)

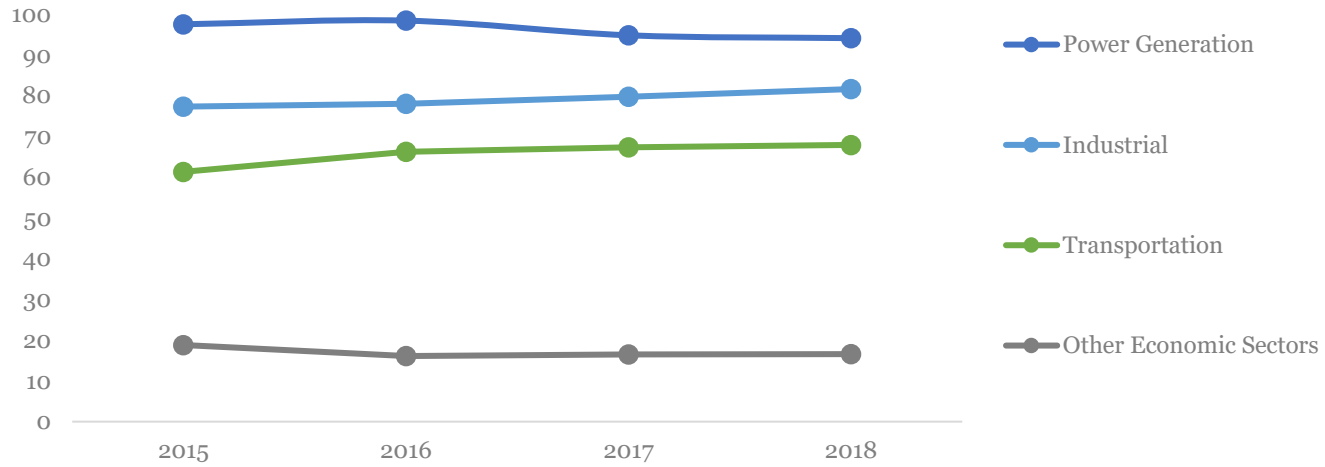


Thailand's primary CO_2-emitting fuel type has been petroleum over the past decade

Source: Energy Policy and Planning Office, 2019

The expansion of the Thai economy especially in the retail/wholesale, hospitality, transportation, and agricultural sector in 2018 resulted in the increase of 0.8% in CO_2 emissions. The highest increment was seen in the industrial sector at 2.4% while the increment in other sectors was kept at the average of 1%. The emission in the power generation dropped for two consecutive years due to the lower dependency on natural gas.

Figure 52. Thailand's CO_2 Emissions by Economic Sector
(2015 - 2018, million tons)



Source: Energy Policy and Planning Office, 2019

Key National Energy Policies and Targets

Thailand's national energy policies have been consistently focused on enhancing the country's energy security through diversifying the energy mix, increasing efficiency for depleting fossil fuel supply, keeping energy prices affordable, and minimising impacts on the environment and society.

Key Public Institutions in the Energy Sector

The Ministry of Energy (MoE) is the authority given mandate to be responsible for the overall operation of the energy sector and to manage the Thailand Oil Fund. It is also tasked to formulate and supervise the execution of national energy policies and regulations, energy plans, and energy-related strategies.

The National Energy Policy Council (NEPC) is the authority for the approval of national energy policies and regulations, energy plans, and energy-related strategies proposed, with the ultimate objectives of enhancing energy security. The NECP is chaired by the Prime Minister.

The Energy Policy and Planning Office (EPPO) is the operational body of the NEPC. It is responsible for formulating national energy policy and strategy proposals and overseeing the implementation of such policies and plans.

The Department of Alternative Energy Development and Efficiency (DEDE) covers the domain of all alternatives to conventional energy sources to ensure the development of renewable energy sources and to promote energy efficiency measures to minimise the growth of energy demand.

The Energy Regulatory Commission (ERC) is an independent regulatory agency overseeing energy sector operations in both the power and natural gas sectors. Its primary tasks are to ensure the fair and transparent calculation of tariffs and to ensure fair competition in the energy marketplaces.

Key Policies in the Energy Sector

The MoE, in order to address the changing and challenging contexts the country will encounter in the future while keeping the balance between costs, benefits, and environmental impacts, has been tasked to create various energy plans throughout the past decades. In 2015, the agency realised the need to harmonise such plans to ensure alignments and effective inter-agency executions.

As a result, the **Thailand Integrated Energy Blueprint (TIEB) 2015-36** was created by harmonising five primary energy plans in an integrated blueprint serving as the national energy policy and energy sector development plan combined. The TIEB consists of the Power Development Plan (PDP), the Energy Efficiency Plan (EEP), the Alternative Energy Development Plan (AEDP), the Gas Plan (GP), and the Oil Plan (OP). The authority driving the implementation of the policies and plans included in the blueprint is NEPC.

The TIEB's overall policy framework is to ensure the stability, prosperity, and sustainability in Thailand's energy sector with the following objectives:

- Renewable energies shall become a major part of the national energy supply in order to replace fossil fuels and oil imports
- Strengthening of the national energy security
- Establishing facilities for alternate energy production on the communal level
- Nationwide support for production of renewable energy
- Promotion of competitiveness through research and development

Power Development Plan (PDP) formulates the national power system development framework. The plan consists of key actions to reduce reliance on natural gas and increase the share of renewable energy, clean coal technology and power purchasing from neighbouring countries and to promote research of power efficiency technologies including smart grid, electric vehicles and energy storage.

Energy Efficiency Plan (EEP) aims to improve electricity security, addressing projected demand growth, and reducing the need for additional power generation and related state-backed investment. The EEP outlines five strategic approaches to improving energy efficiency, including strengthening and expanding the following:

- Mandatory requirements with rules, regulations and standards
- Energy conservation promotion and support
- Public awareness of energy efficiency and behaviour change
- Promotion of technology development and innovation
- Development of human resources and institutional capacity

Alternative Energy Development Plan (AEDP) has primary objectives to promote alternative energy usage by replacing fossil fuels and at the same time reducing dependency on energy import. The principle activities under the plan includes:

- Power
  - Solving the bottleneck problem of the national grid
  - Supporting power generation from currently unutilised or low-utilised fuel (e.g. agricultural and industrial waste, and fast-growing crops)
  - Promoting local renewable energy resources for power generation
  - Enhancing the competitive bidding for power purchasing
- Heating
  - Enhancing heat production from transformed renewable energy fuel
  - Promoting local contents in renewable energy machinery
  - Researching appropriate Renewable Heat Incentive (RHI)
  - Promoting heat utilisation in building by establishing building codes

    - Promoting renewable energy heat utilisation in household
- Transport
    - Promoting utilisation of biodiesel in transportation/industrial sector
    - Promoting gasohol utilisation
    - Promoting compressed biogas utilisation for vehicle and industry
    - Promoting biofuel production efficiency improvements

Gas Plan (GP) outlines transitioning Thailand from its reliance on natural gas to alternative/renewable and imported energy, while conserving domestic energy, increasing current efficiency and reducing overall power consumption by 2036. The plan consists of key actions to reduce natural gas demand in accordance with PDP, EEP, and AEDP, to extend domestic natural gas supply and LNG management, and to develop and improve infrastructure for LNG imports.

Oil Plan (GP) is a long-term plan to support fossil fuel management in line with the goals of AEDP, while considering the environment and potential risks to the country's energy security by 2036. The Plan, which also covers natural gas management, sets five key management principles and details each with proposed measures:

- Supporting measures to save fuel in the transportation sector
- Promoting optimal type of fuel according to uses
- Restructuring prices of fuel to reflect cost of pollution and other externalities
- Enhancing ethanol and biodiesel consumption
- Encouraging investment in the fuel infrastructure

Key Targets in the Energy Sector

Key policy targets are established by TIEB. They are 2036 targets using 2015 as the base line. Table 15 below summarises the key targets set forth under each plan, with a breakdown for the power sector, heating, and transport where applicable.

Table 15. Thailand's Key Target in Energy Plans
(2015 – 2036)

Energy Plans	Key Targets
Power Development Plan (PDP)* *revised in 2018 with targets set for 2037	2037: fuel/generation capacity mix: Gas: 57% Renewable Energy: 19% Coal: 13% Imported Hydropower: 9% Hydropower: 2% 2037: renewable energy installed capacity at 29.4 GW Solar PV: 15.6 GW Wind: 3.0 GW Large Hydropower: 2.9 GW Small Hydropower: 0.4 GW

	Biogas: 0.9 GW Biomass: 5.8 GW Waste-to-energy: 1.0 GW Energy Crops: 0.7 GW To be determined: 9.0 GW 2037: CO_2 emissions from power generation at 0.3 $kgCO_2/kWh$
Energy Efficiency Plan (EEP)	2036: energy intensity reduction of 30% from level in the 2010 2036: total expected savings of 50,699 ktoe in power sector, heating sector, and transport sector
Alternative Energy Development Plan (AEDP)	2036: renewable energy final consumption accounts for 30% of TFEC (39,389 ktoe)
Gas Plan (GP)	2036: total expected savings of 89,672 GWh in the industrial sector 2036: decreased LNG dependency by 29%
Oil Plan (OP)	2036: total expected savings in transport sector of 30,213 ktoe 2026: increment in sugarcane plantations area for ethanol production from 10 million hectares to 16 million hectares, with yield increasing to 7 tons per hectare 2036: extension of palm plantation area from 4.5 million hectares to be 7.5 million hectares, with increased productivity from 3.2 tons per hectare to 3.5 tons per hectare.

Source: Energy Policy and Planning Office, 2019; Department of Alternative Energy Development and Efficiency, 2019; Electricity Generation Authority of Thailand, 2019

Energy Prices and Incentives

The domestic trading of oil and gas is governed by the Fuel Oils Trading Act, BE 2543 (2000) and Fuel Oils Control Act, BE 2542 (1999). These two laws are administered by the Department of Energy Business (DOEB). Both the DMF and DOEB are in the MOE and play a role in implementing the policy.

The natural gas sector is also regulated by the Energy Industry Act, BE 2550 (2007) (EIA), supervised by the Energy Regulatory Commission (ERC).

The domestic retail sales prices of petroleum products are controlled by EPPO through subsidy plans with the budget from the Oil Fund and retail petroleum companies are required to make contributions to the fund.

On the electricity front, the primary legislation governing the electricity sector is the Energy Industry Act B.E. 2550 (2007). The Energy Industry Act established the Energy Regulatory Commission (ERC), which is the primary regulatory in the electricity industry. The ERC also controls electricity price through fuel tariff.

Thailand offers various incentive schemes to drive investments in renewable energy, which play an important role in driving renewable energy development in the country. Renewable energy production business may qualify for incentives according to Thailand's Board of Investment (BOI) announcement no. 2/2557. There is a slight difference in incentives, depending on the renewable fuel types, where waste such as municipal solid waste (MSW), industrial waste, or refuse derived fuel (RDF) get slightly better incentives than other renewable sources (solar, wind, biomass, biogas).

Adder and feed-in-tariff schemes have also been implemented, which will be detailed in the following section.

Renewable Energy

Renewable energy and energy conservation have been on the main agenda for Thailand for decades as the country aims to improve its energy security while minimising environmental impacts. With the improved technology and better accessibility of renewable energy resources, Thailand has assigned priority to the development of solar, wind, biomass and hydropower, with the support of clear and ambitious policies and targets.

Situation Overview

Renewable energy is currently recognised in Thai politics thanks to its contribution to global climate change mitigation. It is also seen as the main instrument to reduce dependencies on fossil fuels, especially imported fossil fuels.

Since the development of the first AEDP in 2015, various targets have been set, supported by extensive promotion and incentive schemes for investments in renewable energies as well as the expansion of the power grid capacity.

In the power sector, Thailand has seen the rapid rise of installed renewable energy generating capacity since 2012, with the average growth of 12.6% per year during 2012 - 2018. The major contribution to such steep increment started with hydropower and bioenergy before solar PV and wind power, boosted by favourable policy and incentive schemes, quickly caught up.

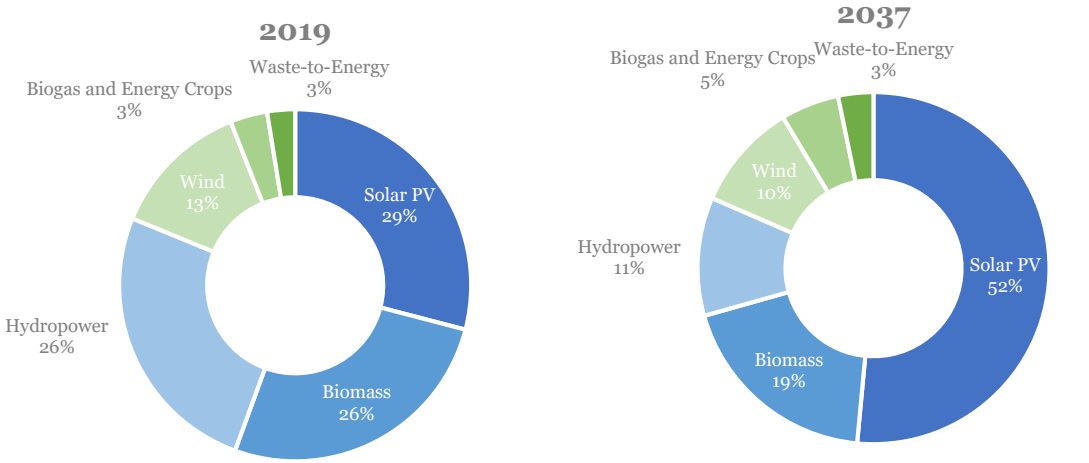
Renewable energy is also utilised heavily in heating and in the transport sector. The use of renewable energy for heating in the residential sector is primarily the use of biomass energy for cooking, while the industrial sector uses biomass energy as one of the main energy sources for heat.

In the transport sector, as Thailand's fuel consumption is high and the country has high dependency on the imports of fuel for transport, biofuel blending (gasohol and biodiesel) has become common in Thailand.

To fulfil its commitment to drive the development of renewable energy, the Thai government currently put two promotion schemes in place. The first scheme is feed-in-tariff (FiT) which fixes the prices of energy that energy producers sell to MEA and PEA.

The second scheme is offered by the Board of Investment (BOI) in the forms of multiple investment promotions, which provides benefits to investors including tax holidays of up to 8 years and exemption from import duty for certain machinery or raw materials. The BOI has also made it possible for investors to bring in foreign experts and to buy/own lands. In general, incentives can be grouped into two types: tax incentives, and non-tax incentives. The former, tax incentives, can also be categorised into basic incentives (also called "activity-based incentives") and additional incentives (also called "merit-based incentives").

Figure 53. Thailand's Current and Target Renewable Energy Installed Capacity
(2019 and 2037, percentage)



Thailand places an ambitious target on solar energy

As hydropower has almost reached its full potential

Source: Energy Policy and Planning Office, 2019; Department of Alternative Energy Development and Efficiency, 2019; Electricity Generation Authority of Thailand, 2019

By the end of 2019, the installed capacity of Thailand's existing renewable power generation is expected to reach 11.7 GW. The highest contributions were from solar, biomass and hydropower. The target for 2037 is 29.4 GW.

Main Opportunities in Renewable Energy

Solar Energy

Solar energy is among the abundant resources available in Thailand. The installed capacity of solar PV has significantly increased over the last decade, owing to consistent policy support and the lower cost of the technology, but its potential is so far mostly untapped. Thailand's north-eastern and central parts possess high irradiance with the peak density of solar radiation in the range of 1,200-1,400 kWh per square meter per annum.

Over the last five years, EGAT has been working on the development and enhancement of transmission networks and grid flexibility while the MoE has worked on drafting a suitable regulatory framework to ensure that Thailand can reach its solar PV potential.

The growth for solar energy investment is expected to be at a fast pace. Apart from investments in solar farms, new investment will also be in production for private rooftop solar cells. The major drag is currently costs. Although the costs of installation are falling, the cost of equipment required to connect to the grid remains relatively high.

From 2010 when the first significant installations of solar panels were completed to the end of 2019, the total solar power capacity of almost 3.5 GW has been installed in Thailand with more than 560 solar power plants in the EGAT system, which is still only less than one-fourth of the 2037 target of 15.5 GW. The majority of solar installations has been utility-scale; however, rooftop solar PV installations are on the course of scaling up due to the constraints on land availability for utility-scale installations.

Over the past 5 years, sales of solar power into the grid have substantially increased, particularly from state-owned solar farms and solar farms operated by agricultural cooperatives. The sales from rooftop installations have also followed suit. Among the drivers for growth are the lower costs for solar cell purchase and installation, especially after 2016.

The outlook for Thailand's solar energy is bright. Apart from the increased target, the county also plans to build the world's largest floating solar farms to boost the share of clean energy. To this end, EGAT plans for tenders to float 16 solar farms with a combined capacity of more than 2.7 GW in nine of its hydroelectric dam reservoirs by 2037. Nevertheless, the challenge will be grid integration and incorporation of new forms of battery storage into the grid. Should these challenges be resolved, it would drastically increase the utilisation of solar energy in Thailand.

Key Solar Energy Policy and Targets

Solar energy is the key focus of both PDP and AEDP, with the updated 2037 target set at 15.5 GW. The plans specify the desired total generating capacity for each type of power plant and also set with regard to the price paid for purchases of solar energy and this is now used in determining the FiT, whereas the adder system was used to calculate payments prior to 2011. The timeline of solar energy related policy can be summarised as the following:

2006: Policy initiation which detailed solar farm setup directive (ground-mounted solar installations), with the 2021 solar target of 200 MW

2007: Introduction of the first adder scheme

2009: 15-year Renewable Energy Development Plan (REDP 2008 – 2022) promoting energy efficiency and renewable energy, with the target of 500 MW by 2022

2011: 10-year Alternative Energy Development Plan (AEDP) with the target of 2 GW by 2021 and the introduction of FiT scheme to replace adder scheme

2015: 20-year AEDP with the target of 6 GW by 2036

2019: Power Development Plan 2018 with the target of 15.6 GW by 2037

Regulations for project developers: in order to maintain grid stability, the MoE demands that new project developers provide semi-firm or firm capacity. In the current power purchasing agreements for SPPs and VSPPs, two types of contract are applicable for power plants with firm and non-firm capacity, respectively. Solar energy source fits into the latter, as the electricity production varies with the availability of the resources.

Firm capacity refers to those who can provide power for a whole year, while semi-firm capacity is defined as 100% availability of dispatchable power generation capacity during 08:00-22:00, with 65% of the total capacity during 23:00-07:00 for every day over the four peak months (March-June) in a year. Non-firm capacity refers to those who can provide power for the rest of the year.

Incentives for project developers – Feed-in tariff for solar energy: as of 2019, the FiT rate for renewable energy purchase is set at USD 0.08 per kWh, and solar energy is included.

Board of Investment (BOI) promotion: solar cells or solar-related raw material manufacturers are entitled to receive 8 years of corporate income tax exemption, capped at the investment amount. They are also entitled to import duty exemption for machine and raw materials. The same promotion scheme is applied to solar energy producers as well while manufacturers of parts and equipment of solar-powered products receive 5 years of corporate income exemption and import duty exemption for machine and raw materials.

Public Private Partnership: large-scale solar PV facilities, or solar farms, receive special provision. Government and Agricultural Cooperatives regulations were announced in 2016. The regulation scheme, often referred to as "Agro-Solar", mandates that solar farms with a capacity of up to 5 MW each and a total capacity of 800 MW shall be built. These projects shall be carried out in cooperation between the private and public sector. A PPA shall be agreed with MEA or PEA which guarantees the power purchase and the FiT of USD 0.18 per kWh for 25 years.

Net-metering: MEA and ERC have launched a net metering scheme for residential PV installations with a generation capacity of up to 10 kW. Under the scheme, the two authorities are the buyer of surplus power produced by rooftop systems. The net metering tariff, set for 10 years, is USD 0.05 per kWh, substantially lower than the current residential power price of USD 0.12 per kWh. Solar system owners also have to pay a grid connection fee of around USD 280.

Investment in Solar Energy Sector

There will be opportunities for companies in the solar energy sector as high investment in building not only new land-based solar farms but also off-grid solar farms as soon as 2020, thanks to policies to promote very small power producers and distributed energy resources. The availability of policy schemes makes electricity generating sector one of the most secure businesses in Thailand for private operators given the long-term power purchase agreement with state-owned EGAT, MEA, and PEA. Floating solar farms are also in the centre of attention as nine new projects are currently planned.

Another area that can potentially attract investment is self-consumption schemes for commercial and industrial property owners that allows them to install solar panels onto their own roofs and to produce electricity "behind-the-meter" for self-consumption. Finally, solar rooftop investment is expected to only moderately increase due to an unclear regulatory framework, complex licensing procedures, and difficulty in obtaining bank financing of smaller rooftop systems.

Opportunities and Challenges for Swedish Companies

Despite promising opportunity in land-based solar farms, off-grid solar farms, and floating solar farms, typical project size tends to be relatively large and often requires a close connection and cooperation with a Thai partner. This may limit opportunities for Swedish companies at least in the short term, as Chinese players have already had a strong foothold in the market. The opportunity for Swedish companies may be in the consulting service components of the projects.

On the other hand, self-consumption schemes represent a good opportunity for Swedish companies, for example suppliers of high-performance solar panels, solar collectors, and solar energy storage solutions. With the number of competitors emphasising the lower cost of equipment and installation, Swedish companies can differentiate themselves and play in the blue ocean market by promoting the superior return on investment rather than lower upfront project cost. Establishing a local support infrastructure (or partnering with local partners) will also be key to a successful market expansion. Swedish companies could take advantage of BOI promotion scheme to lower cost of operation and production.

Another area that Swedish companies can provide solutions for is grid integration and incorporating new forms of battery storage into the grid. The elimination of these problems will drastically increase the utilisation of not just solar but also other renewables in Thailand.

Chinese government-owned solar energy industry players are now entering the Thai market on a massive basis. They still have to adapt to the Thai market and conditions, but there is no doubt that they will manage to navigate through the challenges. The focus of these Chinese actors is not so much on profitability as it is on market entry and gaining a market share. The competition among rooftop providers is also becoming fiercer, making a price war likely as roughly 400 solar trading firms are in the battlefield. Many distributors are expected to cut their price tags by 30% in the near future in order to attract property owners. This may result in a red ocean market with high price competition among market players and will act as a market barrier for new Swedish entrants.

As Thailand has a unique set of regulations and market conditions, Swedish companies entering the country will inevitably face the challenge of having to adapt themselves. This is the challenge that derailed several first-movers in the past. As Swedish solutions' value proposition and branding are not yet well-known in Thailand, collectively collaborating with Swedish support functions currently established in the country to educate the market will help address part of this challenge.

Establishing a foreign-owned company in Thailand is relatively easy when compared to other countries in the region but the process tends to consume up to 6 months. As the market dynamics evolve at a quick pace, it has become important for foreign entrants aiming to harness the opportunities in Thailand to strategize and execute their market entry plan sooner rather than later.

Biomass Energy

Biomass is an important source of renewable energy in Thailand and is currently among the major sources of energy for heating, especially for households and small industries in rural areas. Being an agricultural country, Thailand has significant amount of agricultural waste that is left after harvesting and can be used for energy generation. Biomass power stations – or the co-generation of heat and power – have been built across the nation, with combined capacity of 3.1 GW as of 2019. The country targets that, by 2037, electricity generated from biomass energy sources will feed 5.79 GW into the national power grid.

The growth of the biomass sector is projected to be at middling levels. SPP hybrid firms will tend to increase their investments as they are competitive on price. However, there is a moderately high risk of a shortage of raw materials, and thus of rising production costs.

Bioenergy-based generation will remain the largest domestic source of renewable electricity generation and will have the highest share of renewable energy in the industrial sector due to the significant use of biomass residues, mostly driven by the growing output of biomass processing industries, such as sugarcane, cassava and palm oil. Biomass has been a traditional energy source in rural Thailand for decades and the utilisation of biomass' potential in power generation has continuously increased.

One advantage of biomass compared to other types of renewable energy such as wind and solar is control. With stability and controllability regarding production, biomass is one of the most viable renewable energy alternatives to replace natural gas. The major biomass resources in Thailand comes from:

- Woody biomass residues (from forest plantations, wood and furniture industries)
- Agricultural residues (rice husk, bagasse, corn cobs, etc.)
- Biomass for ethanol production (cassava, sugar cane, etc.)
- Biomass for biodiesel production (palm oil, jatropha oil, etc.)
- Industrial wastewater from agro-industry
- Livestock manure
- Municipal solid waste and sewage

In 2014 and 2015, a large number of biomass producers encountered problems with sourcing raw materials, especially rice husk, wood, and waste from processing palm oil, which resulted in rising prices. At the same time, many communities were objected to the siting of power plants and the outcome of this was then that over 300 projects with a potential capacity of 2.8 GW was cancelled.

Since then the biomass-based energy producers have placed emphasis on access to reliable sources of residual biomass produced, with the ultimate objective to establish biomass supply chains that ensure the delivery of reliable, high-quality and affordable biomass energy. In most cases, these plants operate in co-generation mode for the production of both electricity and heat. They are also associated with some other industrial operation that produces the biomass residues or has direct access to harvesting residues.

At present, the total cumulative installed capacity for biomass power plants as of 2019 stands at 3.1 GW, including both off-grid and on-grid installations. Most of the power plants are located in the north-western and central provinces as they are agricultural dominated and due to the existing grid connection opportunities. The community objections to biomass power plants remain an important hindrance until present days.

The robust growth of Thailand's renewables will be significantly driven by biomass sector. This is due to the strong government support, as witnessed by the amendments in regulatory norms and attractive financial incentives surrounding the biomass sector, and large amounts of agricultural and bio waste that the country produces. It is forecasted that biomass capacity will grow at an annual average of 4.14% until 2028.

Key Biomass Energy Policy and Targets

The Thailand government has enacted various policy schemes revolving promotion of plantation of fast growing trees that can be used as feedstock for power/heat generation, establishment of standards of biomass pellets for future biomass energy, development of advanced gasifier and gas engine technology as well as biomass-to-liquid (BTL) technology, support of Distributed Green Generation (DGG), as well as development of necessary transmission and distribution infrastructure with EGAT.

Top priority has been assigned to the biomass sector, with an investment quota of over 2.7 GW remaining to reach the 2037 target of 5.79 GW.

Regulations for project developers: the same regulations for solar power project developers also applies to biomass project developers, in order to maintain grid stability. New project developers are required to provide semi-firm or firm capacity (the same requirement for solar project developers). Hybridising biomass with either solar PV or wind power is likely to push up overall project development costs.

Incentives for project developers – Feed-in tariff for biomass energy: the current FiT for small-scale producers of energy from biomass (capacity of up to 200 kW) consists of the following:

- A fixed amount ranging from USD 0.08 to USD 0.10 per kWh depending on capacity, guaranteed for up to 20 years
- A variable part that is fixed between USD 0.06 and 0.07 per kWh, depending on capacity, until 2019 and shall be adjusted in accordance with inflation
- An additional bonus of USD 0.01 per kWh for facilities in the southern border provinces

BOI Promotion: the production of electricity or fuel from biomass receives eight years of corporate income tax exemption, capped at the amount of the total investment, as well as exemption from import duties on machines and raw materials. The production of biomass briquettes and pellets receives 5 years of corporate income tax exemption, capped at the amount of the total investment, as well as exemption from import duties on machines and raw materials.

Investment in Biomass Energy Sector

The switch in financial support schemes from the original Adder system to the FiT systems shields biomass power plants from the volatility of oil and natural gas prices and as a result stimulates higher investment in the biomass sector. With 2.7 GW of investment quota remaining, it is expected that the investment in biogas development will continue its impressive growth in the future. In fact, given such high potential, the biomass energy industry is expected to even continue to invest more than USD 4 billion in additional investment after the quota has been used up.

Not only biogas power plant related investments will increase, the investments in supporting transmission infrastructure is also expected to be on the rise. The current transmission infrastructure has not been able to keep pace with new additional capacity of power plants. As a result, some new plants were unable to sell the electricity they generate. The government has opted for a short-term solution of limiting power plant sites based on the availability of transmission and substations. However, sooner rather than later, the Thai authorities will be under stronger pressure to improve transmission infrastructure.

Opportunities and Challenges for Swedish Companies

Swedish companies bring expertise in developing biomass projects, particularly in using forest residues as feedstock. The aspects that represent opportunities for Swedish companies can range from consulting services, to engineering support for optimisation and efficiency, and even to supply chain management e.g. pelletizing or bracketing for storage and logistics.

Small power producers (SPPs) are expected to increase their installed generating capacity and their investments in new power plants, especially for natural gas-fuelled cogenerating power plants whose contracts are due to expire. These SPPs will have to increase investments in construction of new power plants with the focus on renewables in the form of mixed-fuel power generation. In order to become competitive in terms of pricing and to reduce the risk from fluctuations in feedstock prices, biomass SPPs will be looking to increase their efficiency and will seek external help to achieve such goal.

Apart from the challenges around adapting to Thailand's unique regulations and market conditions, Swedish companies entering the country will have to adapt to working with local feedstock which is dominated by agricultural residues (rice husk, bagasse, corn cobs, etc.).

Furthermore, in order to increase SPP and VSPP customer base, relationship will need to be built with local partners, if not with the end customers themselves in some projects. It is also important to note that, based on feedback from potential and current biomass electricity producers, the expected break-even period is within 7-10 years. This is likely to be achieve only if feedstock is efficiently managed.

Other Opportunities in Renewable Energy

Wind Energy

According to the wind potential study conducted by DEDE, the technical potential of wind power can reach 13 - 17 GW in many areas across the nation, with highest potential in the western, north-eastern, and southern parts. However, in order to realise such potential, modern low-speed wind turbines will have to be used rather than conventional land-based wind turbines. This is one of the reasons why the 2037 target is only set at 2.99 GW. As of the end of 2019, Thailand's installed capacity of wind energy totalled 1.5 GW, accounting for half of the target. The future of wind energy in Thailand will largely depend on technology and installation location selection.

The wind energy sector will only pose limited growth. Investment opportunities will favour large-scale investors who have the necessary funds, understanding of the technology, and access to areas that are served by suitable transmission lines. Furthermore, the majority of high-potential sites are in national parks which are difficult to access and to connect to transmission lines.

Geothermal Energy

There is very little geothermal potential Thailand. The resource is available in the northern part of the country and a geothermal power plant was first built in 1989 with a capacity of 300 kW. Since then, the development of geothermal energy in Thailand has been minimal. Geothermal energy is not a focus area by the Thai government and thus there is no national target established.

Biogas Energy

Thai policymakers have promoted biogas generation for three decades through continuous support measures for industrial scale biogas plants including adder schemes, tax incentives, and investment grants.

The focus has been on bio waste from pig farms and agricultural production (starch, palm oil and sugar industries). As a result, many projects are currently connected to the state grid. Thailand currently has a installed biogas capacity of 300 MW from 36 power plants, which is one-third of the target of 930 MW. Since the potential for biogas from agricultural residues and waste is highly utilised already, newer political support programs focus on the support of alternative raw materials e.g. energy crops, household and community waste, municipal waste-to-energy, and the utilisation of compressed biogas (CBG) in the transport sector.

Only limited growth is anticipated for the biogas sector. New investment will likely come from producers who have access to inputs and who are generating power for their own use, with any surplus sold to the grid.

Hydropower

Hydropower is among the top-3 renewable energy sources in Thailand. Large-scale hydropower was the focus in the renewable energy field for decades and consequently attracted significant investment. However, it reached nearly 3 GW in 2000, which made further development much more difficult if potential environmental impacts are taken into account. Since then, the hydropower development in Thailand has been mainly for small hydropower. The target capacity for hydropower is set at 3.29 GW by 2037.

The limited growth of hydropower sector will mainly be driven by projects carried out by the public sector. Moreover, the majority of sites with potential are in national parks which makes them unfeasible for hydropower projects.

Waste-to-Energy

The updated PDP for 2018 - 2037 was designed to eliminate most of complicated conditions and regulations that had been a barrier to developing a waste-to-energy sector in the country during 2012 – 2015. The plan opens for investor participation in waste-to-energy power projects, setting a goal of 980 MW from such fuel, representing 3% of total renewable resources by 2037. Up until the end of 2019 there were 36 operational waste-to-energy plants in Thailand, bringing the total installed capacity from waste-to-energy plants to 283 MW.

The regulator ERC currently provides two types of licenses: small power producer at a capacity between 10-99 MW and very small power producer for less than 10 MW. The government also offers more subsidies to further boost investments in waste-to-energy power plants at the local level by allocating an additional budget of USD 80 million to fund its waste management strategy.

Waste-to-energy will only receive moderate investment, despite the drive from policy and regulation standpoint. Concentrated sources of waste are still lacking (1 MW of generating capacity consumes 100 tons of waste per day) and the quality of waste separation remains poor, which results in pollution problems from facilities. Businesses focusing on collecting and separating waste will see opportunities for growth.

Energy Efficiency

Thailand has been promoting the development and use of renewable energy for decades. The result is seen in a form of fossil-fuel combustion displacement, but it has not reduced the build-out of large-scale fossil-fuel based generation capacity. This is because Thailand's power sector planning still focuses mainly on the supply side, especially on increasing capacity rather than generation and transmission efficiency and has not adequately incorporated demand-side options such as end-use efficiency. The Thai government started to realise this challenge and is now working toward improving the nation's energy efficiency.

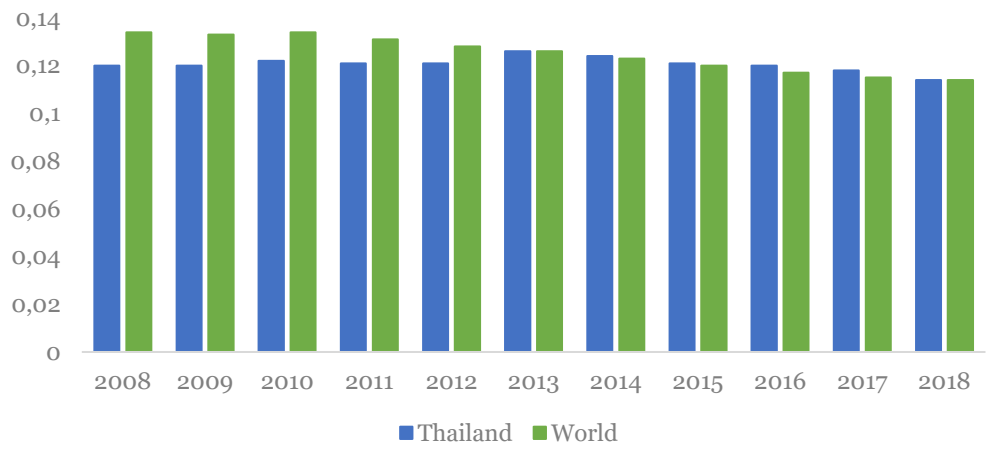
Situation Overview

The growth of Thailand's total TFEC has been 2.5% per year for the past decade and, under Thailand's new power demand forecast, electricity consumption is expected to grow an average of 2.5% annually from 2017 to 2036 with energy demand expected to reach about 326,000 GWh.

Apart from the obvious transportation sector, the growth has been primarily driven by industrial and commercial sector. If there are no significant energy efficiency improvement measures or no reform of the industrial structure and transportation system, demand in the industrial and commercial sectors will still increase at a higher rate than other sectors. Hence, greenhouse gas emission from the energy sector will tend to increase accordingly. Despite the fact that Thailand's energy demand growth is projected to continue to be slower than the growth of the economy, energy efficiency both in the demand and supply side is still an area that needs improvement.

Thailand's energy elasticity during 2008 - 2017 was at 0.81, which is considered quite high when compared with developed countries where energy consumption efficiency is higher. In addition to energy elasticity, another index that indicates the efficiency of overall energy use of the country is the energy intensity, which has only gradually decreased at a slow speed over the past 10 years as seen in figure 54.

Figure 54. Thailand's Energy Intensity
(2008 - 2018, koe/$2015p)



Energy intensity is on the downward trends, albeit at the lower rate compared to the world average

Source: Global Energy Statistical Yearbook, 2019

To address this concern, various Energy Conservation Programs, both mandatory and supportive strategic approaches and measures have been introduced, with further implementation and expansion of measures incorporated in the latest 20-Year Energy Efficiency Plan (2015 – 2036). The plan's strategic approaches compulsory, voluntary and complementary programs in four economic sectors – industry, commercial and government buildings, residential buildings and transport. The goals of the plan are to reduce energy intensity by 30% in 2036 comparing to the level in 2010, to contribute to APEC's target to reduce energy intensity by 45% in 2035 comparing to the level in 2005, and to contribute to UNFCCC intention from COP20 target to reduce Greenhouse Gas from transportation and energy sectors by 7% - 20% in 2020 comparing to the year of 2005 under ambient situation. Examples of the main measures applied in the plan are:

- Standards for energy conservation and energy management in factories and buildings
- Building standards for new construction for energy conservation
- Standards and labelling of machinery and materials equipment used for energy conservation
- Mandatory standards of energy conservation for manufacturers and distributors
- Assistance and subsidies for operations relating to energy conservation
- Using energy saving lighting system and energy conservation in transportation

It is estimated that the effective implementation of EEP will result in energy savings in 2036 of 51.7 mtoe (in comparison with the BAU scenario) and total estimated savings within 22 years of 558 mtoe valued at USD 280 billion. The measures in the voluntary category contribute to a majority of the energy saving (79% of total) while the measures in the compulsory contribute to the rest (21%).

The investment in energy efficiency in both private and public sector is projected to reach USD 80 billion by 2036.

Table 16: EEP's Sectoral Energy Efficiency 2036 Targets
(ktoe)

Sector	Reduction	Share
Industrial	14,515	28.1%
Commercial (+ Government)	4,819	9.3%
Residential	2,153	4.2%
Transport	30,213	58.4%
Total	51,700	100%

Source: Energy Policy and Planning Office, 2018

Main Opportunities in Energy Efficiency

Energy Generation and Transmission

Although the industry is still largely regulated, private sector participation has increased the competition as well as power-generating efficiency in the industry, especially during the bidding for investment in new projects, both conventional and renewable ones. The primary investment among power producers is expected to be in increasing power generation efficiency to lower cost of production, sourcing improved battery and energy storage solutions to harvest the energy generated from the limited renewable sources, and in developing grid system to be smarter and more flexible to support the increasing portion of renewable energy fed to the grid. Furthermore, there will also be investments to address the ongoing issue of transmission and distribution losses from PEA and MEA as well.

Over the next 3-5 years, smart grid is anticipated to be the centre of attention. As finding funding sources for renewable energy projects has become easier in Thailand, the next top priority for the government's renewable energy policy is to revamp regulatory support for a smart grid. While building a smart grid system for the whole country is currently far from reality, there will be plans to develop smart grid in designated areas as Thailand grows the number of its smart cities and industrial areas.

Thailand is currently facing the oversupply situation; however, the price of electricity is still relatively high. The average monthly power rate in Thailand is expected to climb 50% in the next 10 years, from USD 0.12 to USD 0.18, which may negatively impact the economic expansion in the future. This is due to several factors including the efficiency factor both related to power generation and power transmission and distribution.

Key Energy Generation and Transmission Policy and Targets

The MoE has been aware that if prices keep rising, Thailand may lose its competitive edge in infrastructure to other players in the region -- and there would be little time to mitigate the effects of such a loss. The first step the Thai authorities are taking is to deregulate power generation to open up the market for renewable energy. The next step will be to support the development of smart grid with the goals of generation, transmission, and distribution loss reduction, as well as effective DSM/demand response.

Through the integration of PEA, MEA, EGAT Smart Grid Roadmaps, and strategic plans of related stakeholders, the master plan of Thailand Smart Grid development (2015 -

2036) has been drafted. The master plan will be used for Implementation Guidelines and Regulatory Framework development. It also identifies objectives, Key Achievement Indicators, initiatives/activities that can be revised in the future with response to technology leap, energy and climate change situations. The master plan covers development of green grid to support higher portion of renewable energy, smart micro grid, and smart metering.

Investment in Energy Generation and Transmission Sector

On the power generation front, the thermal efficiency of coal and natural gas is already on acceptable level, but investment is being made to push the boundary further. One example is the development of Gulf SRC's natural-gas power plant that uses a new high-efficiency technology to reduce pollutants and emissions resulting in a lower carbon footprint and better air quality. The gas power plant, expected to be fully operational by 2022, will utilise the combined-cycle gas turbine technology to reach a maximum rated thermal efficiency greater than 63%.

The efficiency of renewable energy production, on the other hand, still has room for improvement. For example, investment in solar energy sector will concentrate on sourcing higher efficiency solar panels or solar collectors, as well as battery solutions to drive the cost of production to be below USD 0.05 per kWh, while bioenergy sector will focus on increasing yield from feedstock, and waste-to-energy sector will look for solutions to improve the quality of waste separation and sorting to increase output.

On the power transmission front, the development of smart grid in various areas will be the centre of investment on top of the regular transmission improvement, maintenance, and expansion. Both PEA and MEA are exploring solutions to reduce their transmission and distribution losses, which stood at 5.36% and 3.50% respectively in 2018.

Opportunities and challenges for Swedish Companies

Swedish companies offering products and services related to power generation from renewable energy sources will find opportunities to capture the rising demand in Thailand. When it comes to harnessing opportunity from smart grid development, however, the opportunities are abundant not only for energy-technology companies but also for ICT solution providers specialising in Internet of Things (IoT) data analytics and management.

Opportunities in the early stage will be around substation automation, microgrid development, distributed generation, energy storage, advanced metering infrastructure, optimised asset management, optimised mobile workforce, intelligent street lights, and cyber security.

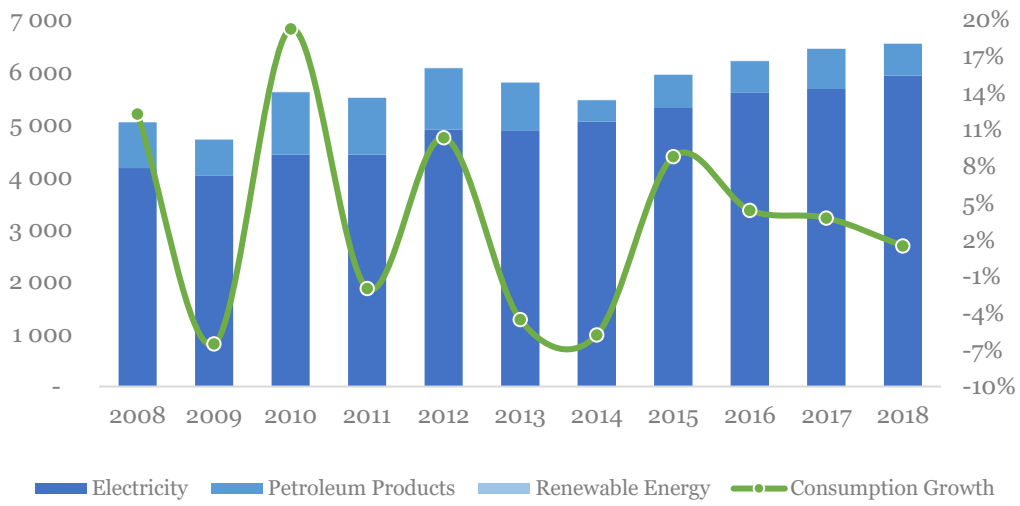
As the accumulated investment budget in this area is expected to be high, competition is also getting fiercer. There have already been solution providers entering the market by partnering with local companies to start initial dialogues with power producers and public and private organisations planning to develop smart grids. Pricing is another challenge that Swedish companies have to overcome as the local market still perceive that European solutions are not so economical.

Other caveats that companies aspiring to take part in the smart grid development have to consider are the uncertainties around development plans. Although the master plan has been in place, key sub-initiatives and activities are not comprehensively defined. This may thus be subject to significant changes in the future.

Commercial Buildings

Commercial buildings sector's final energy demand in Thailand consists of electricity to power appliances and for cooling, thermal needs for water heating, and the use of oil products (mostly LPG) for cooking, similar to that of residentials sector. In recent years, around 90% of energy demand in the commercial buildings sector has been met with electricity. Energy demand in this sector only expanded at the rate of 2.6% per year during 2008 - 2018. The fluctuation of demand is in line with the economic situation in each year, see figure 55.

Figure 55. Final Energy Utilisation for Commercial Buildings Sector
(2008 - 2018, ktoe)



Source: Department of Alternative Energy Development and Efficiency, 2019

Economic expansion brings about higher demand for energy from commercial buildings

Green buildings are promoted to address efficiency issues

The majority of energy usage in buildings is for air-conditioning (cooling), followed by lighting and office appliances. In Thailand, the major challenges in buildings are the cold supply and dehumidification. The most common cooling technologies are single-split and multi-split air conditioning systems, but commercial building developers have explored advanced cooling concepts including PV-driven compression cooling systems, thermal-driven cooling (ad-/ absorption cooling) and district cooling for quite sometimes now. They have also started to incorporate shading devices at windows and partly also at the façade, insulation of the building envelope, and better insulating windows (double-glazing), free night ventilation, and ventilation with heat recovery, with the ultimate objective to reduce demand for energy.

While realising (nearly) zero-energy buildings is still far from reality, major steps have been taken by the Thai government and the building developers to reduce energy demand of a building, increase the share of renewable energy especially solar thermal and bioenergy, and at the same time improve buildings' energy efficiency.

Key Commercial Buildings Policy and Targets

The EEP established a target of electricity savings at 3,800 ktoe (44 TWh) and another 1,053 ktoe (12 TWh) of heat/fuel savings in the commercial buildings sector in 2036. Several strategic measures have been included in the plan as follows:

- Enforcement of energy conservation standards in designated buildings through intensive supervision of the implementation of the ministerial regulations and the legal punishment enforcement

- Establishment of Building Energy Code (BEC) for new buildings – hotels, offices, hospitals, department stores, theatres, gas stations, meeting convention halls, campus buildings and condominiums – with an area greater than 10,000 square meters
- Provision of financial support tools to hasten equipment changing, which includes subsidies, soft loans, and incentives
- Promotion of the greater use of LED light bulbs through pricing mechanism

The measures are mostly welcomed among property developers as building operators can enjoy reduced power bills when the buildings are completed and the operators themselves can create more value-added buildings using green or eco-friendly designs to attract buyers and tenants.

Investment in Commercial Buildings Sector

The investment in "green building" has been on the rise. The number of Leadership in Energy and Environmental Design ("LEED") certified and Thailand Rating Energy & Environment System ("TREES") certified buildings has grown from merely 55 buildings in 2012 to over 250 buildings in 2018. This trend is driven by the new BEC and the higher return on investment when compared to traditional building. In general, the net present value (NPV) of a green office is higher than a traditional office by approx. 50% and the discount payback Period (DPP) is higher by approx. 10%.

Apart from redesigning and using materials and equipment with properties that reduce energy usages, building developers emphasise investment in the use of heat sources and sinks in combination with efficient cooling technologies such as PV driven compression cooling systems and Thermal-driven cooling, and district cooling. At the same time, the remaining energy demand of the building is supplied by on-site renewable energy sources including solar thermal, solar PV, and bioenergy.

Opportunities and challenges for Swedish Companies

Swedish's expertise and technologies in developing green buildings can be applied to Thailand, which represents opportunities for manufacturers and/or distributors of building envelop materials, Heating, ventilation, and air conditioning (HVAC), lighting equipment and lighting systems, as well as water heating. Around 40% of green buildings in Thailand are LEED certified while the majority 60% are TREES certified, and this trend is expected to continue. Swedish companies aspiring to expand into Thailand will thus have to familiarise themselves will TREES certification system, which was developed on the basis of LEED and modified to fit Thailand's particular needs.

In addition to establishing business relationship with commercial building developers and contractors, it is advised that Swedish companies seek partnership with green building consultants as well. As the number of consultants specialising in the green building development is scant in Thailand, high competition can be expected.

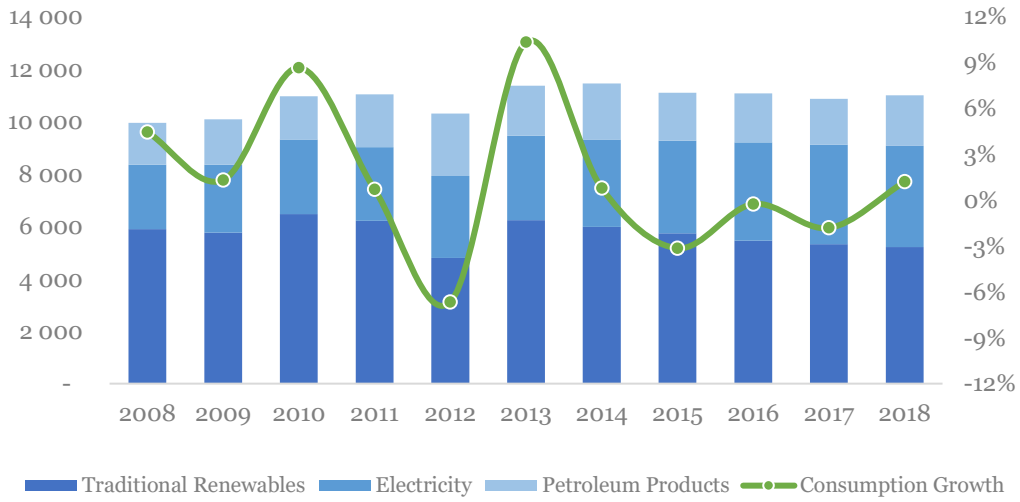
Other Opportunities in Energy Efficiency

Residential Buildings

Residential buildings sector's final energy demand in Thailand consists of electricity to power appliances and for cooling, thermal needs for water heating, and the use of oil products (mostly LPG) for cooking. Over the past decade, energy demand in this sector only expanded at the rate of 1% per year. As seen in figure 56 the majority of this growth came from electricity used in appliances and cooling, which grew at a faster pace of 4.7% per year.

Figure 56. Final Energy Utilisation for Residential Buildings Sector

(2008 - 2018, ktoe)



Higher demand for cooling in residential buildings spurs the growth of electricity consumption

Source: Department of Alternative Energy Development and Efficiency, 2019

A large portion of electricity demand in the residential buildings sector is for cooling. While traditional air conditioners can cater almost the entirety of the increasing cooling demand, they still require significant amounts of electricity. New developments are thus now leveraging new solutions through the use of new technologies such as district cooling. Smart home solutions are also being explored and property developers have increasingly incorporated smart lighting and appliances control, smart energy monitoring, and various smart sensors into their new projects.

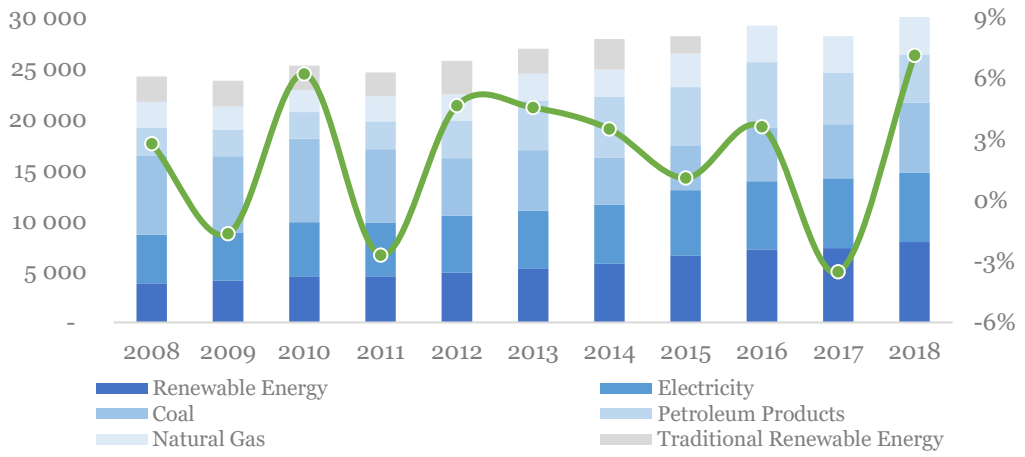
In order to increase energy efficiency in the residential buildings sector, the Thai authorities have implemented various programs including Energy Efficiency Label No.5 Ranking Project for appliances and clothes, Energy Efficiency Label No.5 House and Building Project, Thailand Refrigeration and Air Conditioning Nationally Appropriate Mitigation Action (RAC NAMA) Project, and MEA Cleans Air-Conditioners to Reduce Global Warming Project.

Industrial

Industrial sector's final energy demand in Thailand is fulfilled by mixture of energy sources including coal, petroleum products, natural gas, electricity, and renewable energy. Energy demand in this sector increased at the rate of 2.2% per year during 2008 - 2018. Coal used to be the primary source of energy in the industrial sector but the use of renewable energy, petroleum products, and natural gas has grown by more than 7% per year as illustrated in figure 57. The electricity usage has increased by 3.6% per year.

Throughout the years, the Thai industry has allocated investment in energy efficiency through several major initiatives such as the energy conservation fund, energy efficiency revolving fund, utility-based DSM, Total Energy Management program, and active Energy Service Company (ESCO) industry. Despite this, realisation of energy efficiency initiatives by the industries to reduce energy consumption has been low. Part of the reasons is that the focus tends to be on individual systems such as pumps, motors, or boilers, rather than on the entire systems.

Figure 57. Final Energy Consumption for Industrial Sector
(2008 - 2018, ktoe)



The search for energy efficiency is on in the industrial sector

In anticipation of increasing economic activities

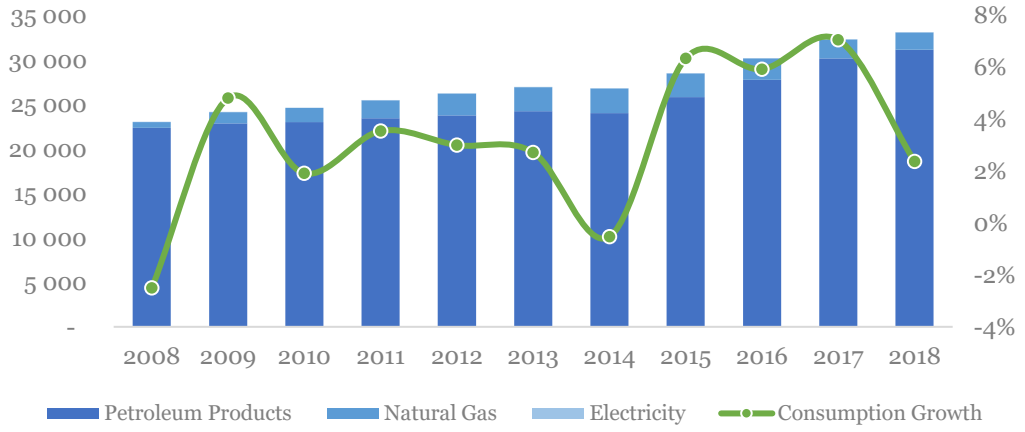
Source: Department of Alternative Energy Development and Efficiency, 2019

For cross-cutting technologies in the industrial production process, the induction motor is one of the most commonly used equipment today but there is a need for motors with increased efficiency and reliability such as superconductor motors, copper-rotor motors, and switched reluctance motors. Boilers and chillers are also among of the most important equipment across the industries and thus the search is on for so-called "super boilers" and "super chillers" that provide superior energy efficiency.

Transportation

Alternatives to petroleum-derived fuels for vehicles has been under the spotlights in Thailand as the automotive industry is one of the country's main GDP contributors and the energy consumption in this sector accounts for around 40% of the total energy usage. Biofuels used to be regarded as the solution, but they can only meet the demand from transport sector partially, due to supply constraints on feedstock.

Figure 58. Final Energy Consumption for Transport Sector
(2008 - 2018, ktoe)



Roadmap for EVs has been developed to reduce reliance on petroleum-derived fuels in the transport sector

Source: Department of Alternative Energy Development and Efficiency, 2019

In this context, Thailand released the Roadmap for Electric Vehicle (EV) development, which includes 3 strategic development stages – developing infrastructure particularly for public transport, deploying EVs for public transport while developing infrastructure for personal vehicles, and scaling up the use of the EVs for personal use.

Thailand targets to increase the number of EVs to 1.2 million by 2036 supported by more than 690 charging station. This is part of the plan to reduce 30,000 ktoe or 349 TWh of energy consumption in the transport sector by 2036. A majority of the vehicles will be personal vehicles as there is no clear roadmap for public transport yet. The Thai government plans to launch a performance testing program of 35 electric buses in 2020 and, depending on the success of the performance test, the pilot program consisting of 200 buses will follow.

VIETNAM

THE TIPPING POINT FOR SUSTAINABLE DEVELOPMENT

VIETNAM – THE TIPPING POINT FOR SUSTAINABLE DEVELOPMENT

Country Summary

Being one of the fastest-growing economies in the region, Vietnam offers opportunities to pursue a sustainable development roadmap considering the potential of domestic renewable energy resources and efficient use of energy. On the other hand, Vietnam also faces challenges in ensuring future energy demand while at the same time complying with the government's objectives of reducing greenhouse gas emissions by promoting renewable energy and energy efficiency technologies.

Renewable energy is emerging as the tipping point for inclusive and sustainable development in Vietnam. Realising this movement, the government has planned to transform the power system of Vietnam towards a more sustainable and decentralised system that builds on abundant but variable domestic renewable energy sources, such as wind, solar and biomass energy, and less on coal and other fossil fuels. This transition will prompt several opportunities, as well as potential challenges, for Swedish companies to expand into this market by the form of supply chain, consultancy, investment or partnership.

For wind power there are currently no offshore projects which should show potential for Swedish companies to step in, either in terms of equipment supply or consulting services areas. In the biomass sector there are opportunities to provide solutions to generate energy out of materials at their rawest forms, there is also potential within the area of residential biomass. The waste-to-energy sector demands the technology of low-calorific incineration which is the most suitable one for current waste situation.

In parallel with the development of energy sources, energy conservation is considered as one of the effective solutions contributing to the nation's energy security. Energy efficiency has been promoted in several sectors through programs and regulations. As a result, increasing attention is paid to improve energy conservation, most notably in industrial and building sectors. Vietnam is seeking experiences and know-how from international pioneers in the energy efficiency area, in which Swedish enterprises are among the world leaders. Seizing these opportunities will help position Swedish solutions in the market and possibly create good models for other countries to follow.

Situation Overview

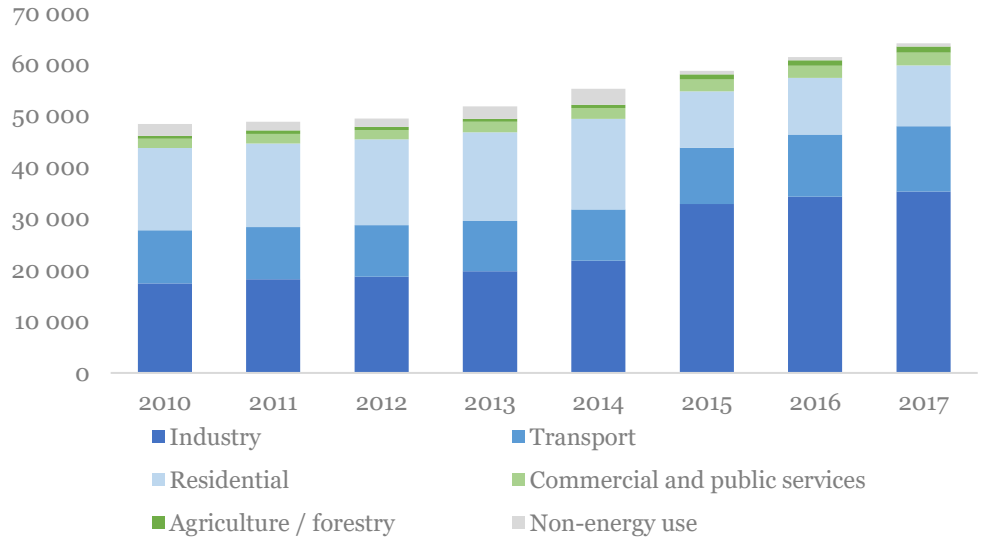
Vietnam is a lower-middle-income country paving the way to become an industrial economy. This transition has far-reaching effects on energy security. On the one hand, energy consumption is expected to increase steadily in the future thanks to the nationwide urbanisation and industrialisation. On the other hand, depleting natural fuel resources poses big challenges for Vietnam – where coal will continue to account for the biggest share in the energy mix. On top of that, the Vietnamese government has set forth long-term development plans on sustainable energy, which emphasises the utmost importance of energy efficiency and renewable energy sources.

Energy Utilisation

Vietnam's economy has changed rapidly in the past few decades, with the transition from an agricultural economy, using traditional biomass-based energy, to an economy of modern and fossil fuel-based energy. Vietnam features a wide range of domestic primary energy sources, such as crude oil, coal, natural gas, hydroelectricity and non-commercial energy, which in the past two decades have played a major role in guaranteeing energy security for economic development.

During the period 2010-2017, the total final energy consumption (TFEC) increased from 48,375 ktoe (563 TWh) in 2010 to 64,053 ktoe (745 TWh) in 2017, with a growth rate of 4% per annum (figure 59).

Figure 59. Vietnam's Energy Utilisation by Sector
(2010 - 2017, ktoe)



With a rapidly growing economy, Vietnam is facing an increase in energy demand

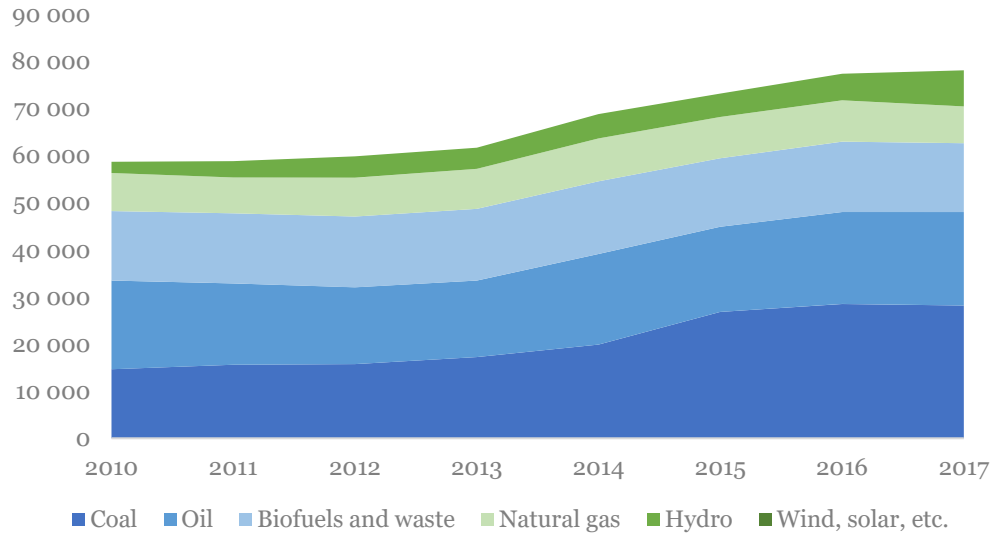
Source: IEA, 2019
Non-energy use: use of other petroleum products (such as white spirit, paraffin waxes, lubricants, bitumen) and non-energy use of coal (peat excluded)

Vietnam's total primary energy production (TPES) increased gradually between 2010 and 2017. Production totalled 58,694 ktoe (683 TWh) in 2010 and only slightly increased by around 1-2% per annum until 2013. The period of 2014-2017 witnessed a sharper rise as production grew by 4-5% per annum, reaching a total of 78,130 ktoe (909 TWh) in 2017. This is mostly due to the increase of production of coal-based power, as 2017 figure almost doubled that of 2010, equivalent to a growth rate of 10% per annum.

Hydropower also had an impressive leap at 18% per annum, however it did not significantly affect the total production due to its limited share in the energy mix.

Although not depicted in the figure 60, Vietnam has become a net energy importer since 2015 with increasing demand and recent fluctuations in power imports and exports. The net import amount increased quickly due to growing domestic demand for coal import and a policy limiting coal export.

Figure 60. Vietnam's Primary Energy Production by Fuel Type
(2010 – 2017, ktoe)



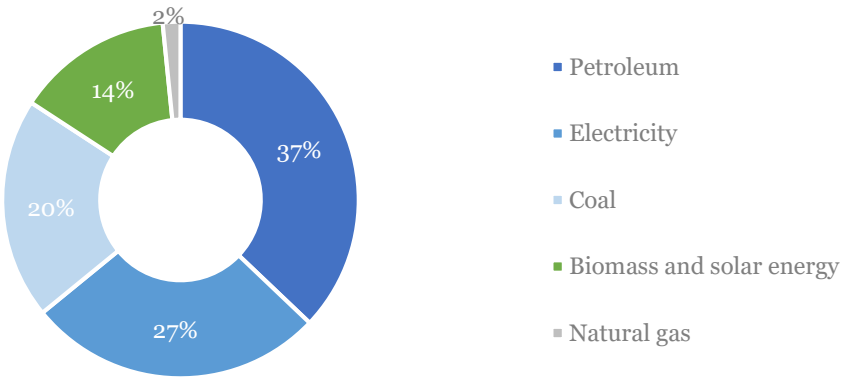
Growing energy demand forces Vietnam to expand its coal sector due to its affordability

Source: IEA, 2019

Current Energy Mix

The estimated total final energy consumption (TFEC) 2017 was 64,053 ktoe (745 TWh). In the consumption structure, petroleum products with 37%, followed by electricity at 27% and coal with 20%. Biomass and solar energy accounts for 14%. Natural gas is mainly used for the production of nitrogenous fertiliser and some thermal applications in the production of steel and porcelain. Due to its niche industrial application, natural gas only accounts for 2% of TFEC (figure 61).

Figure 61. Vietnam's Share of Final Energy Consumption by Fuel Type
(2017, percentage)



In the consumption structure, **petroleum products and electricity make up for more than half of the energy mix**

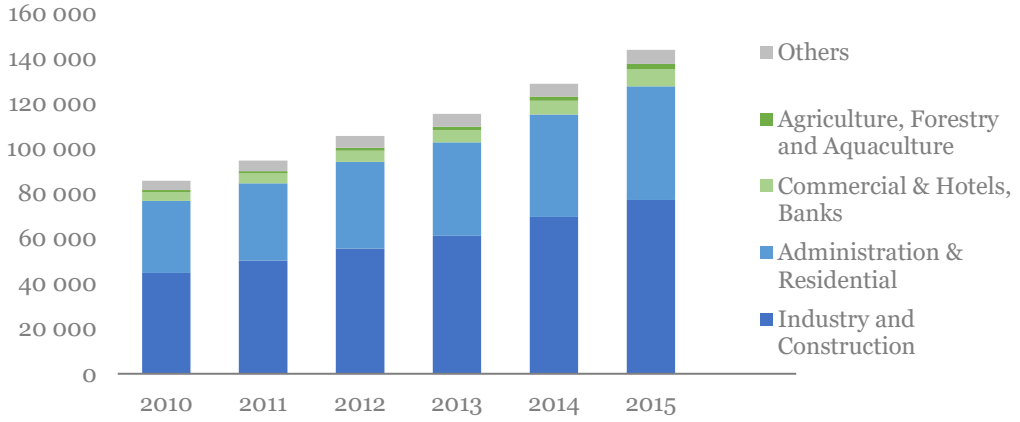
Source: Electricity and Renewable Energy Authority, Ministry of Industry and Trade, 2017

With regard to the sectoral structure of final energy consumption (TFEC) in 2017, the industrial sector remains the largest user with 55%, followed by the transport sector with 20% and the residential sector with 18%.

Electric Power System

Electricity is crucial in the energy sector, accounting for 27% of final energy consumption in 2017. Vietnam's electricity demand is fuelled by two factors: industrial growth and the expansion of the middle class. Industry/Construction and Administration/Residential categories together account for almost 90% during the period of 2010-2015 (figure 62). Households' access to electricity is now at 98% – showing good progress if compared to the 1995 figure when only 50% of households could connect to the power grid. Due to the growing electricity demand, Vietnam has also been importing electricity from China and Laos, but electricity is mostly generated domestically.

Figure 62. Vietnam's Electricity Consumption by Sector
(2010 – 2015, GWh)



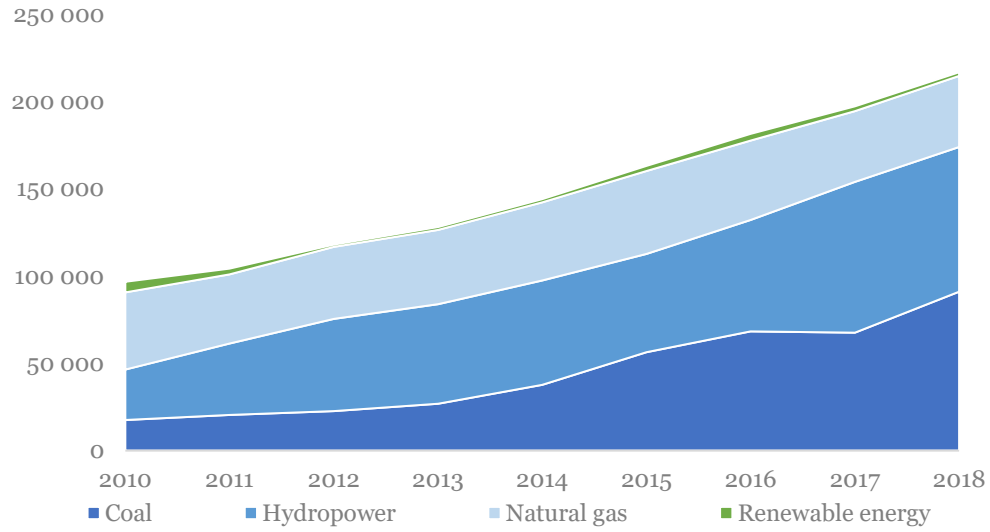
Source: EVN Annual Report, 2016

Electricity demand is fuelled by two factors: industrial growth and the expansion of the middle class

The operation and sales of power are mainly in the hands of state-owned companies. There are only a few Build-Operate-Transfer (BOT) and Independent Power Producer (IPP) companies participating in the value chain as power generators, representing about 24% of total national power generation capacity. The other 75% of power generation, as well as transmission, sales, distribution, and retail are all dominated by state-owned companies, mostly Vietnam Electricity Company (EVN).

Vietnam's electricity generation is dominated by coal 42%, followed by hydropower 38% and natural gas 19% as shown in figure 63. Despite the government efforts for accelerating renewable resources for generating electricity, coal is set to dominate over the coming decade to meet the increasing demand. Continued focus is however to embrace and develop low cost renewables to gradually decrease the dependence on traditional electricity generating sources. Favourable feed-in-tariffs for renewables in general and wind and solar in particular are resulting in a strong interest for developers to establish in the country which potentially could lead to cheaper and better renewable options outpacing coal as main electricity source.

Figure 63. Electricity Generation by Energy Source
(2010 - 2018, GWh)



Coal, hydropower and natural gas are the dominating fuel types for electricity generation

while focus is on the untapped potential within solar and wind

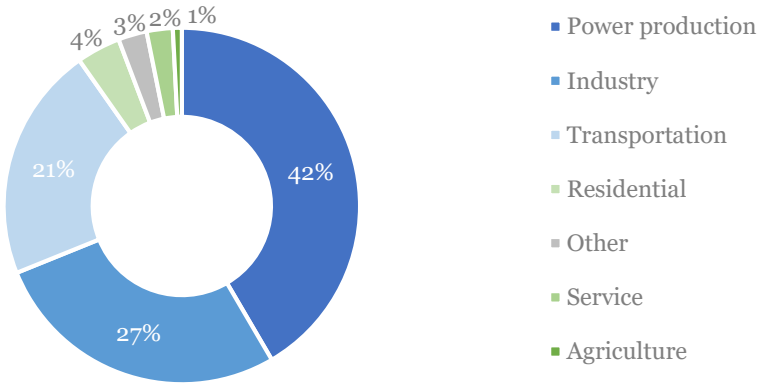
Source: Climatescope, 2018

CO_2 Emissions

Vietnam emitted 173.2 million tons of CO_2 in 2015. The main polluters – power production, industry, and transportation – constituted up to 90% of total carbon emission. This is a direct consequence of the economy's quick heat-up, whereas the development of alternative, low-carbon sources of energy is still at a very early stage.

Vietnam was home to 96 million people in 2019 with an urbanisation rate of nearly 37%. The reliance on coal and oil in power production, coupled with the expansion in the industry sector, has contributed greatly to the greenhouse gas emissions and further strained the environment. The increase in income has prompted citizens to spend more, travel more, and enjoy a "fast" lifestyle. With a large number of private vehicles and an under-developed public transportation system, transport contribute to the country's pollution and climate change.

Figure 64. Vietnam's CO_2 Emissions by Economic Sector
(2015, %)



The reliance on coal and oil in power production and the expansion in the industry sector contribute greatly to CO_2 emissions

Source: Vietnam Energy Outlook Report, 2017

Key National Energy Policies and Targets

Key Public Institutions in the Energy Sector

The Ministry of Industry and Trade (MOIT) is an agency of the Government, performing the function of state management of industry and commerce and it covers the following sectors: domestic industries, energy, import and export, international economic integration and promotion. The MOIT bears the main responsibility for the management of the energy sector, including e.g. developing policies and mechanisms on energy use and electricity price, preparing technical standards, and identifying schemes to mobilise funds.

Under the MOIT, there are four departments/authorities and one institute whose responsibilities are closely related to the energy sector. The departments serve as advisors and assistants to the MOIT, drafting policies and formulating strategies for promulgation, in their respective fields:

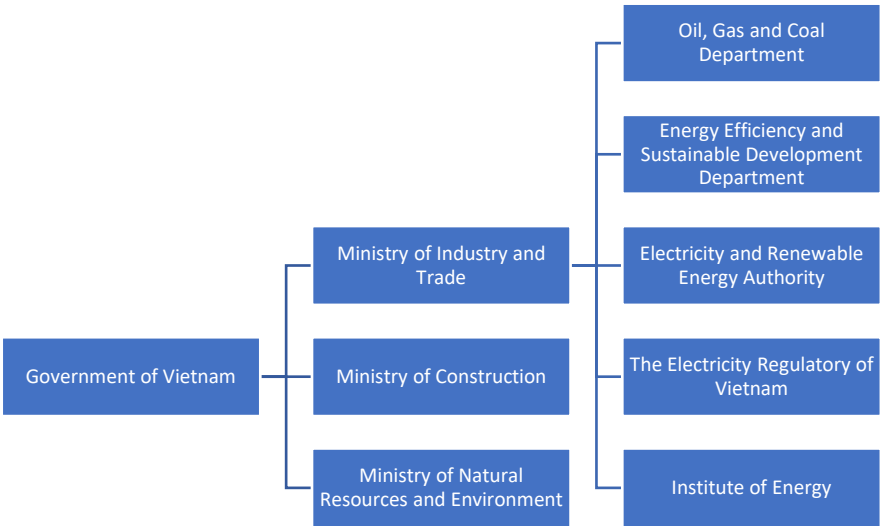
- Oil, Gas and Coal Department,
- Energy Efficiency and Sustainable Development Department,
- Electricity and Renewable Energy Authority, and
- Electricity Regulatory of Vietnam

The Ministry of Construction (MOC) is responsible for developing general construction plans for inter-provincial new urban areas, high-tech areas, and specialised economic zones; MOC and MOIT share a number of energy efficiency activities in the building sector.

The Ministry of Natural Resources and Environment (MONRE) plays an important role in energy and environmental research and development besides other related projects. Waste-to-energy projects are often shared responsibilities of both MOIT and MONRE.

The Institute of Energy conducts research on national energy strategies, policies, and development plans; forecasts future energy demand; prepares project feasibility studies; and identifies new energy production and supply technologies.

Figure 65. Vietnam's Public Institutions Related to Energy



The energy sector is heavily influenced and dominated by the state monopolies, Vietnam Electricity (EVN), the Vietnam Oil and Gas Group (PetroVietnam), and the Vietnam National Coal and Mineral Industries Group (Vinacomin).

Vinacomin is a state-owned limited liability holding corporation with main functions as exploring, surveying, exploiting, selling coal products and other minerals in the domestic and international markets and constructing power plants (mainly coal fuelled).

PetroVietnam (or PVN), is a state-owned corporation engaged in the energy sector, including oil and gas and renewable energy. Their business areas are fully integrated, ranging from exploration – production, refinery – petrochemical, gas industry, gas to power/fertiliser and petroleum technical services.

EVN is a state-owned actor, dominating the entire electricity transmission, distribution and retail chain in Vietnam. It is also the owner of National Load Dispatch Center, a system and market operator, and multiple hydropower plants.

Key Policies in the Energy sector

The Petroleum Law 1993, 2000, 2008 and Decree: This set of law regulates the petroleum exploration and exploitation activities in the territory, exclusive economic zones and continent shelf of the Socialist Republic of Vietnam.

The Electricity Law 2004 and the Law amending and supplementing articles of The Electricity Law 2004: This set of law governs the rights and obligations of organisations and individuals operating in the electricity industry, investment in electricity planning and development, electricity market and pricing, electricity conservation, etc.

Revisions to the National Power Development Plan from 2011-2020 with vision to 2030 (revised PDP VII) (Decision 428/QD-TTg on 18 March 2016): This revision of Power Development Plan VII (PDP VII) aims to mobilise domestic and external sources of power to ensure sufficient power supply and energy security targets, by the diversified use of primary energy sources and the development and implementation of renewable energy. In 2030 the share of coal in the energy mix will be 42.6%. Renewable energy targets are detailed in the following section.

Key Targets in the Energy Sector

A summary of key targets in the Renewable Energy and Energy Efficiency sub-sectors across several guidance is shown in table 17 below.

Table 17. Vietnam's key targets for renewable energy and energy efficiency

Target		Plan
Renewable Energy		
Renewable energy in primary energy supply	**2020**: 31% **2030**: 32% **2050**: 44%	Decision 2068/QD-TTg on 25 November 2015
Renewable energy in total electricity generation	**2020**: 38% (4% excluding hydropower) **2030**: 32% (15% excluding hydropower) **2050**: 43% (33% excluding hydropower)	Decision 2068/QD-TTg on 25 November 2015
Energy Efficiency		
Final energy demand saving	**2019-2025**: 5-7% **2026-2030**: 8-10%	Decision 280/QD-TTg on 13 March 2019

Source: Vietnam Energy Outlook Report, 2019

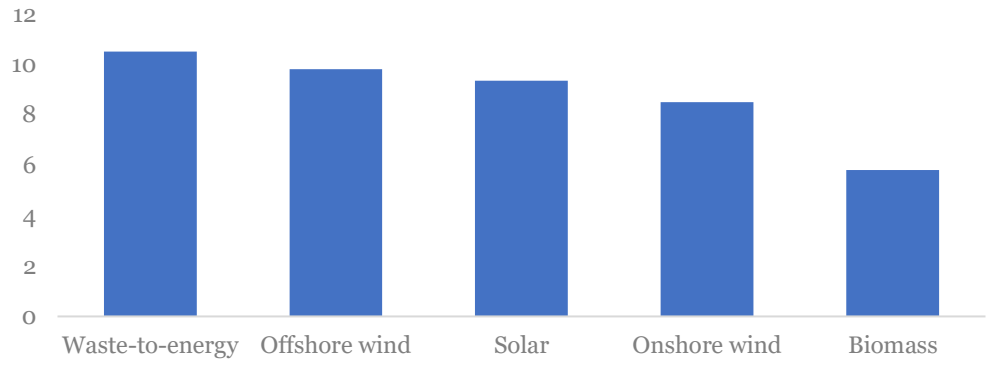
Energy Prices and Incentives

Electricity sale prices in 2009 and for the period 2010-2012 under the market mechanism (Decision 21/2009/QD-TTg on 12 February 2009): Regarding retail electricity price, the government embarked on tariff reforms in 2009 to introduce market-based retail tariff mechanisms with separate performance-based tariffs. The tariffs, however, have not yet reached a cost-recovery level, and revenue is not sufficient for financial autonomy of the power subsector entities. Consequently, several adjustments have been proposed and implemented, resulting in the gradual increase in the retail price. Related regulations include:

- Decision 24/2017/QD-TTg, dated 30 June 2017 regulates mechanisms for adjustment of average retail electricity price. This guidance details principles for adjustment, calculation formula, time frame, and threshold of adjustment. It also stipulates that cost increases from 3-5% can be recovered by EVN in the next tariff adjustment; cost increases from 5% to 10% can be approved by the Ministry of Industry and Trade and Ministry of Finance; and cost increases over 10% require the prime minister's approval.
- Decision 34/2017/QD-TTg, dated 25 July 2017 sets the minimum and maximum retail electricity price at VND 1,606 per kWh or USD 6.9 cents per kWh and VND 1,906 per kWh or USD 8.2 cents per kWh, respectively.
- Decision 648/2017/QD-TTg, dated 20 March 2019 sets the average retail electricity price to be VND 1,864 per kWh or USD 8.0 cents per kWh. The retail price varies based on sectors, timeframe, amount of electricity generation, etc.

Feed-in tariffs for renewable energy (Decision 37/2011/QD-TTg, Decision 39/2018/QD-TTg, Decision 11/2017/QD-TTg): The government has issued feed-in tariffs (FiT) for different renewable energy sources, see figure 66. Waste-to-energy enjoys the highest incentives with FiT at USD 10.5 cents per kWh, whereas electricity sellers can only receive USD 5.8 cents per kWh power generated by biomass energy. Currently, MOIT is submitting a proposal for a new biomass FiT to the Prime Minister, however, the new FiT has yet to be disclosed.

Figure 66. Vietnam's Feed-In Tariff across Different Renewable Energy Sources
(US cents/kWh)



Source: Thu Vien Phap Luat, 2019

Regulations on Renewable Energy

Revisions to the National Power Development Plan from 2011-2020 with vision to 2030 (revised PDP VII): The revised Power Development Plan VII plans to increase the share of renewables in the energy mix to 6.6% by 2020 and 10.2% by 2030. Small hydropower and wind power generation will occupy the largest share in the

renewable capacity. Specifically, wind turbine in all wind farms will be increased to approximately 1 GW by 2020 and 6.2 GW by 2030; biomass power generation in sugar mills is estimated at around 500 MW by 2020 and 2 GW by 230.

Development Strategy of Renewable Energy of Vietnam by 2030 with vision to 2050 (Decision no. 2068/QD-TTg on 25 November 2015): This guidance is intended to promote mobilisation of all resources from the society and citizens for renewable energy development, gradually increasing the proportion of renewable energy sources in the national energy production- and consumption in order to reduce fossil dependencies, contributing to energy security, climate change mitigation, environmental protection and sustainable socioeconomic development.

Table 18. Comparison between PDP VII Revised and Development Strategy of Renewable Energy of Vietnam

Regulations / Types of energy	Revisions to the National Power Development Plan from 2011-2020 with vision to 2030 (PDP VII revised)	Development Strategy of Renewable Energy of Vietnam by 2030 with vision to 2050
	Decision no. 428/QD-TTg on 18 March 2016	Decision no. 2068/QD-TTg on 25 November 2015
Renewable Energy	Covered	Covered
Solar Power	Covered	Covered
Wind Power	Covered	Covered
Geothermal	X	X
Biomass	Covered	Covered
Biogas	X	Covered
Hydropower	Covered	X
Waste-to-Energy	X	Covered

Regulations on Energy Efficiency

National Target Program on energy efficiency and conservation from 2019-2030 (Decision no. 280/QD-TTg on 13 March 2019): The program targets 5-7% and 8-10% energy savings over the total energy consumption during the period 2019-2025 and 2026-2030, respectively. It also aims at 6.5% and 6% reductions on electricity losses during the same time span.

Vietnam National Green Growth Strategy 2012: this strategy establishes a Green Growth Fund, greenhouse gas emission reductions targets and a roadmap for development from 2012 to 2050.

National Energy Efficiency Building Code 2017 (VEEBC): this rule sets mandatory technical standards to achieve energy efficiency during the design, construction or retrofit of civil buildings (office buildings, hotels, hospitals, schools, commercial buildings, services buildings, apartments, buildings, among others) with a gross floor area of 2,500 m^2 or larger.

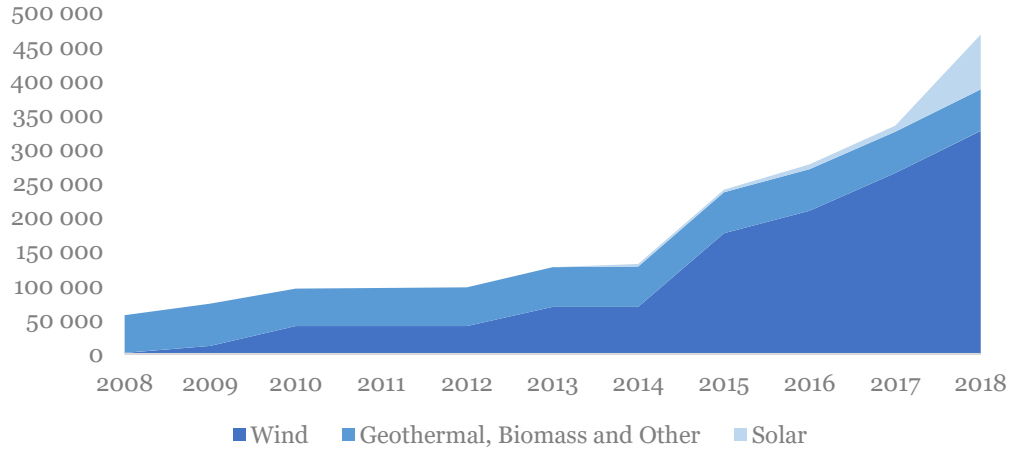
Renewable Energy

Even though future reliance on coal is inevitable to ensure energy security, Vietnam has, at the same time, been focusing on alternative energy sources to mitigate climate change impacts and protect the environment. Over the past few years, steps have been taken to implement a system primarily run on renewables, with top prioritised sources such as solar power, wind power, and biomass power. Despite the imperfect incentives and regulations, the rich potential for renewables still translates to a promising clean energy market for investors and other relevant actors to pay close attention to.

Situation Overview

Renewable energy output has seen a 10-fold increase during the period 2008-2018, not taking large hydropower plants into account. Despite its strong growth, renewable energy accounts for less than 10% of total installed capacity for electricity generation. From 2008 to 2017, wind and biomass power dominated the renewable energy sector (figure 67). Only in 2018 were the first solar plants put into operation, and they became the biggest electricity generators, accounting for around 75% of total electricity output among all renewables sector, only a year after (figure 68). This increase is attributable to the favourable FiT for solar energy which was only applied for plants going into commercial operation before 30 June 2019.

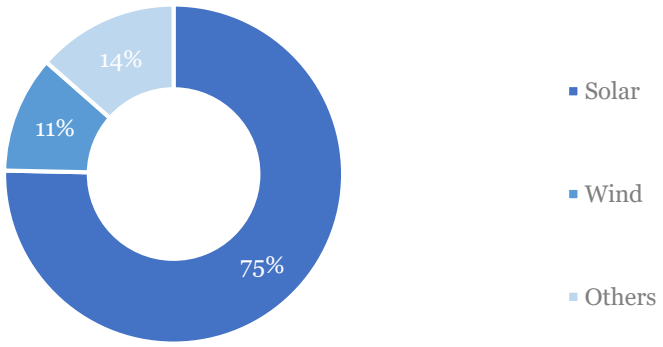
Figure 67. Vietnam's Renewable Energy Generation
(2008 - 2018, MWh)



Despite its strong growth, renewable energy accounts for <10% of total installed capacity for electricity generation

Source: BP Statistical Review of World Energy June 2019

Figure 68. Vietnam's Renewable Energy Generation
(January 2019 - October 2019, percentage)



In 2018 the first solar plants were put into operation, and they became the biggest electricity generators since then

Source: EVN

In the revised PDP VII, renewable energy is expected to generate 6.5% of the country's total electricity in 2020, 7% in 2035, and 10.7% in 2030. To attain these targets, Vietnam requires USD 23.7 billion by 2030; its domestic financial resources are however not strong enough to achieve this. Therefore, the government is unlocking private investment opportunities and attracting global technical expertise and foreign investment to fully exploit its power sector's potential. Foreign ownership is allowed in the energy sector by the government, under several investment models such as 100% foreign-invested company, joint venture, and public-private partnership (PPP) in the form of Build-Operate-Transfer (BOT).

Main Opportunities in Renewable Energy

Wind Energy

With a coastline of more than 3,000 km, along with many islands with an average wind speed of 5 m/s or more throughout the year, Vietnam shows potential in the widespread utilisation of wind power. The current situation, however, is nowhere near the promise it represents. Vietnam has a total of nine wind power plants in operation with a total installed capacity of 275 MW. This is a limited figure if compared with the potential capacity: 93 GW theoretically, 49 GW technically, and 7.4 GW economically.

In 2018, wind power production output accounts for 70% of total renewable energy generation, generating 320 GWh. Wind power gains special attention from the government, as its feed-in tariff was recently amended to USD 8.5 cents per kWh for onshore wind energy, and USD 9,8 cents per kWh for offshore wind energy. However, this FiT is only valid for wind power plants with Commercial Operation Date by 1 November 2021, and the future mechanism is yet to be determined.

Key Wind Energy Policy and Targets

Regarding the Development Strategy of Renewable Energy of Vietnam, the total capacity of wind power is targeted to reach 800 MW by 2020, about 2 GW by 2025 and about 6 GW by 2030. The ratio of wind-based electricity shall be about 0.8% by 2020, about 1% by 2025 and about 2.1% by 2030.

In terms of production output, the revised PDP VII has set wind power plants to produce 2.5 TWh in 2020, 16 TWh in 2030 and 53 TWh in 2050, equivalent to 1.0%, 2.7% and 5% of energy production by 2020, 2030 and 2050, respectively.

Renewable energy developers in Vietnam enjoys several incentives. First, they enjoy exemption from import tax of fixed assets and raw materials, supplies, and semi-finished products not yet domestically produced. Secondly, Corporate Income Tax (CIT) is also exempted for the first 4 years into operation. CIT reduction of 50% will be applied in the next 9 years, and a reduction rate of 10% is applied in the next 15 years. Moreover, renewable energy developers can also enjoy reduction in land use tariff compared to other corporations – which is significant for onshore wind power developers. Power Purchasing Agreement (PPA) with EVN has a clause of 20 years, meaning that output is guaranteed by EVN for 20 years.

Investment in Wind Energy Sector

Both domestic and international investors show their interest towards the huge wind energy potential in Vietnam. International corporations enter Vietnam's renewable energy market in various business models; in which, two main forms of investment are purchasing entire on-going projects or contributing capital and technology know-how. Several projects have been implemented with the former model, as international investors often lack the local business tactics needed to get approval on the projects, whereas local companies often lack finance to maintain the projects in the long run. It should be noted that local knowledge and networking is vital while doing business in Vietnam; hence, international corporations often tend to hire experienced legal consultants or form partnership with local companies.

Opportunities and Challenges for Swedish Companies

Offshore wind power is also a promising aspect to dive into. Technical potential is identified for fixed foundation at 261 GW and 214 GW for floating technology. The most promising region is the coastal area from Binh Thuan province to Ca Mau province with a wind power density of nearly 1 kW per square meter. Currently, out of the nine operating wind powers, there are no offshore projects. Therefore, it is a potential for Swedish companies to step in, either in terms of equipment supply or consulting services.

Unlike solar power sector, distributed renewable energy resources (such as individual and household solar panels) are rarely found in wind power sector; therefore, purchasing criteria do not rely heavily on the affordability to investors. According to MOIT, equipment from G7 countries are quite favoured in big wind farms in Vietnam. Therefore, it is expected that Swedish offerings owning similar quality and price as G7 products would also be highly appreciated in the market.

However, Swedish companies might face several challenges while investing in the energy sector. Technology-wise, the transmission line network and its weak grid capacity has been hindering the development of wind energy. Due to their geographic advantages, the Central and South Central of Vietnam attract the most renewable energy projects, especially solar and wind farms, whereas development of transmission line in these regions are not up to par. Consequently, some projects resorted to restricting their own production to not overload the grid or had to make additional investment into power storage themselves.

Unstable regulations also pose a great challenge for investors of renewable energy in general, and wind power in particular. Vietnam's PDP VIII is expected to be released at the end of 2020, featuring detailed action plans on energy security and more focus on renewable energy. However, what is more worrying is the future of FiT, as the expiration of the current FiT is November 2020, whereas at the moment there is no final decision for FiT in the next period.

In terms of investments, foreign investors are wary of the bankability of the current Power Purchase Agreement (PPA). EVN is the sole purchaser of the non-negotiable PPA, and although required to purchase all electricity generated by the project, EVN is not required to pay the tariff in the event of overhaul or maintenance of the grid. This poses a big question mark and uncertainty from international financing institutions and investors. Meanwhile, local financing is not sufficiently in place to provide financing solutions to the required volume, whereas the government does not offer any financial guarantee. To resolve this issue, specialist and experts are proposing the implementation of Direct PPA (DPPA), which is formulated by energy generators and users of electricity themselves.

Biomass Energy

The theoretical potential of biomass energy in Vietnam from the combustion of rice husk, rice straw, corn cob, cassava stalk, and bagasse are estimated at over 2.5 GW.

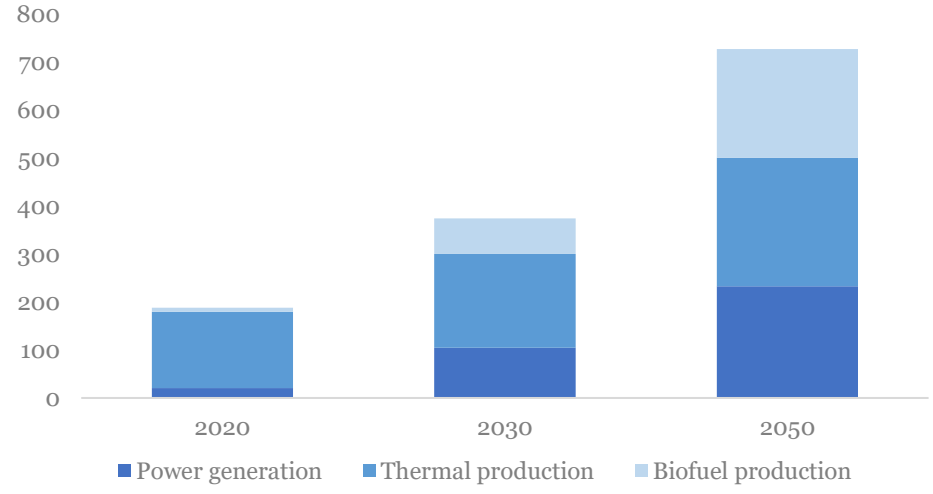
Most biomass energy resources in Vietnam are coming from the non-commercial sectors. They are often the biological waste used as fuels in residential use, neither traded commercially nor having an official market. In 2010, the use of biomass for combined electricity and heat production in Vietnam was only 6.4 GWh – a tiny figure if compared to 104 GWh used as non-commercial fuel, 13.6 GWh for furnace and 25.2 GWh for incinerators. As for 2019, this figure might be higher in due to the operation of 11 biomass energy plants in sugar factories with total installed capacity of 343 MW. However, the huge potential of rice husk, corn cob, cassava is still not entirely exploited.

Key Biomass Energy Policy and Targets

Due to the huge potential of biomass energy and its declining non-commercial use, it is crucial for Vietnam to give priority to the use of biomass energy for power and fuel production.

The total biomass energy used is targeted to increase from around 168 TWh (14.4 mtoe) in 2015 to around 188 TWh (16.2 mtoe) by 2020, around 375 TWh (32.2 mtoe) by 2030 and 727 TWh (62.5 mtoe) by 2050 – in which, the biomass usage for thermal production accounts for the most significant share in 2020 until almost being caught up by power generation and biofuel production in 2050.

Figure 69. Vietnam's Targeted Share of Biomass Usage
(2020 - 2050, TWh)



In the short term, Vietnam assigns priority to the use of biomass energy for power and thermal production

Source: Thu Vien Phap Luat, 2019

To promote usage of biomass in power generation, the government plans to provide for the minimum rate of biomass energy for each power plant. This prompts coal-based power plants to study the power generation combining the use of biomass energy with coal fuel.

Regarding residential use of biomass, the use of traditional biomass energy in cooking in households and local handicraft is encouraged to convert from traditional stoves with low performance equipment with high performance stoves.

Investment in Biomass Energy Sector

Biomass energy investment is concentrated to the Central, South Central and Mekong River region. These areas are home of several sugar mills and are considered the main granary of Vietnam. There are only sugar cane factories which connect to the national power grid. Rice husks and straw power plants are usually small scale and mainly used to serve the needs of local people, not connected to national power grids.

Investment into the biomass energy sector is mobilised from both domestic and international organisations and private sectors. However, the government prioritises the arrangement of preferential credit capital sources from development assistance funds, ODA and other foreign bilateral loan sources for biomass power projects.

Opportunities and Challenges for Swedish Companies

With the strong development of agriculture in Vietnam, opportunities for biomass energy can come from different sources of raw materials such as bagasse, wood chips, rice husks and straw. However, processing all of these biomass potentials prior to energy-making process requires time and further investment in equipment. If compared to wind energy, biomass power production bears an additional cost of compressing materials into pellets. Therefore, Swedish companies can look at the opportunities to provide solutions to generate energy out of materials at their rawest forms, such as wood and rice waste. Not only does this contribute to the reduction of carbon emissions and environmental pollution, but also brings direct economic benefits for farmers to participate in the bioenergy value chain.

Swedish companies can also consider the residential biomass potentials. Electricity from renewable energy can hardly be fed into the power grid due to the risk of overload, small-scaled bioenergy solutions could be an interesting alternative for farmers collectives. This is also in line with government's plan to convert low-performed traditional stoves to advanced biomass-powered equipment.

However, the greatest challenge for developing biomass energy is the FiT. Biomass produced from Combined Heat and Power technology (CHP) suffers the lowest FiT compared to other renewable energy sources. Recently, the government released the avoidable cost for the biomass technology other than CHP. The FiT for all biomass technology is detailed in the below table

Table 19. Vietnam's Feed-In Tariff by Biomass Technology

Biomass technology	Incentives	
Biomass power produced by CHP	FiT	5.8 USD cents/kWh
Biomass power not produced by CHP		
Northen Vietnam	Avoidable cost	7.5 USD cents/kWh

Central Vietnam	Avoidable cost	7.3 USD cents/kWh
Southern Vietnam	Avoidable cost	7.4 USD cents/kWh

As calculated by GGGI, the current FiT at USD 5.8 cents per kWh is not enough to reach the potential capacity of 737 MW of biomass energy in the sugar industry. At this price, no additional capacity is estimated to be economically viable to complement 352 MW of current installed capacity. Realising the inadequacies, the MOIT is submitting to the Prime Minister a revised FiT for biomass energy; however, no rate was disclosed at this point of time.

The second difficulty that biomass power producers face in Vietnam is that biomass residues are normally scattered and subject to seasonal variations, making collection and transportation challenging, as well as costly and labour-intensive. Currently, bagasse – the most used biomass input – is only available during 3 months for power production. Biomass power production can be extended to 9 months if the material is a mix of bagasse and other materials such as rice husk and straw. In addition, biomass residues have several applications, such as composting or producing printing ink.

Apart from the discouraging FiT, biomass power plants also face difficulties in receiving for loans with the current PPA's weak bankability, similar to wind power or other renewable energy projects.

Waste-to-Energy

Vietnam is among the fastest growing economies in Asia with a total population of 96 million people. This has driven consumerism and waste generation, which is both an opportunity and a challenge for the waste-to-energy sector.

Vietnam has good potential to develop waste-to-energy power. It is projected that installed capacity will reach 860 MW in 2035, whereas operating plants only has a total of 5 MW.

However, Vietnam has been facing huge challenges in waste management, from waste generation, storage to collection, to waste treatment and disposal. The average annual amount of solid waste is 25 million tons; of which 30% is incinerated or added to organic fertiliser, and the rest is buried in landfills. Vietnam's waste segregation is not entirely regulated, nor is it strictly enforced – leading to the situation that some waste-to-energy plants do not have sufficient resources to run the plant to its full capacity.

Nevertheless, Hanoi, Ho Chi Minh City and Danang – the most populated cities in Vietnam – are pushing forward to improve waste segregation and invest in waste treatment and waste-to-energy plants.

Key Waste-to-Energy Policy and Targets

In the decision to approve the adjustment of the national strategy on integrated management of daily-life solid waste to 2025, vision to 2050, the Government has set a goal that by 2025, the waste burial rate will be reduced to 30%.

Incentives are set up for waste-to-energy to fulfil its potential. Regarding investment incentives, investors can borrow up to 70% of the total investment costs from the Vietnam Development Bank (VDB) with a low interest rate (equal to 5-year state bonds plus 1% per annum). Also, subsidies per unit of electricity produced are available for projects established under the Clean Development Mechanism of the Kyoto Protocol.

Investors can also enjoy tax exemptions, including: exemption from fee on land rent or land use, exemption from corporate income tax for the first 4 years (and 50% reduction for the next 9 years), exemption from import duties on imported equipment and raw materials.

The FiT for renewable power generated from solid waste incineration is set at USD 10 cents per kWh. This is the highest rate among all types of renewable energy projects. Meanwhile, combustion of gas collected from solid waste landfills is only charged at USD 7.3 cents per kWh.

Investment in Waste-to-Energy Sector

Large cities actively call for investment in the form of privatising power projects to effectively handle the volume of waste incurred. Unlike solar or wind power projects, waste-to-energy projects are not troubled by overloaded power grids and electricity load centres, since these projects should reside in big cities to guarantee waste supply. Moreover, electricity generated from waste incineration is stable and not dependent on weather. The investment in waste-to-energy power plants is hence expected to be on the rise.

Opportunities and Challenges for Swedish Companies

Due to the lack of waste segregation, it is best to apply the technology of low-calorific incineration generated from general waste sources (waste only removed of porcelain, glass, and metal). This technology yields lower energy recovery, higher ash ratio, but is suitable for current waste segregation situation in Vietnam. Two factories in Bac Ninh and Can Tho are already applying this particular technology.

Swedish enterprises might find difficulties in understanding Vietnam's regulations. Vietnam does not yet have technical regulations for evaluating the process of collecting, transporting and treating waste (including waste-to-fuel). The legal documents do not specify in detail the form of government support and how to apply, although the government encourages investment.

In terms of technology, several waste-to-energy projects remain on paper because the investors failed to reach a compromise on the expenditure for separating and dealing with waste and the selling price of power. Moreover, unsorted waste, if containing a large amount of organic waste – low calorific value, might require additional fuel expenses during incineration.

Last but not least, another barrier is the complexity in implementing projects under the private-public partnership (PPP) model. Unlike solar or wind projects which are wholly commercialised by the government, waste-to-energy power plants require the cooperation between the state and investors to implement projects, as waste collection and treatment is mostly managed by local authorities.

Other Opportunities in Renewable Energy

Solar Energy

Like other Southeast Asian countries, Vietnam enjoys abundant resources of sunlight, especially in the Central and Southern part of the country. Solar energy has the technical potential of around 1,680 GW. However, the solar power capacity is minimal compared to the huge potential of the country. The first solar power plant in Vietnam started its operation in 2018 and until the beginning of 2019, there were only 4 solar plants and several smaller solar rooftop projects in operation with a total installed capacity of 182 MW.

Only by June 2019 the total capacity for solar energy reached 4.5 GW due to several solar plants going into operation, as the consequence of new FiT applicable only for plants operating before June 2019, resulting in Vietnam being the region's fastest growing country within solar to secure its energy needs.

Realising the untapped potential, along with the state's priority for solar power, many investors have focused on solar power projects. This translates to the number of projects waiting in line: 332 proposed projects, 121 projects approved in Master plan, 86 projects with appraised basic design, 63 projects with signed Power Purchasing Agreement, and 10 projects under construction – a big contrast to the number of actual operational solar plants.

The market for solar rooftop is also heating up. Total installed capacity was only 18 MW in 2018 but blew up to roughly 300 MW in November 2019. Total power generation is reported to be 58 GWh. Most solar rooftop projects have registered Power Purchasing Agreement with EVN. However, similar to solar plants and other renewable energy projects, their operators are wary of the potential changes in the feed-in tariff.

Geothermal Energy

Vietnam is considered to have a geothermal potential capacity of 340 MW. Since most hot springs are at an average temperature (70-100 degrees Celsius), geothermal sources are most promising for direct use, such as dried products, convalescence and tourism. Only in the Central region from Quang Binh to Khanh Hoa, where geothermal sources with temperatures from 70-150 degrees Celsius, is considered to have good potential to exploit and build geothermal power plants with a total capacity of about 200 MW.

The first geothermal energy source was approved for construction in 2013. It is located in Quang Tri province, with capacity of 25-30 MW. However, the project is temporarily suspended due to unknown reasons.

Biogas Energy

Despite its large potential as Vietnam has seen strong developments in agriculture, biogas energy is usually generated and utilised at the residential level only. Raw materials for biogas production are biodegradable organic substances such as animal manure, duckweed, grass and straw. The energy generated comes full circle, as it provides power for cooking, lighting, drying commercial agricultural products, heating poultry and animals, poultry incubation, etc.

While non-commercial biomass energy is gradually replaced by other types of fuels, biogas, is an alternative that could effectively make full use of existing fuel sources while requiring low investment and mitigating CO_2 emissions.

Recently, five provinces in Vietnam (Lao Cai, Binh Dinh, Ha Tinh, Soc Son and Tien Giang) are selected as the pilot models of biogas electricity generators. The model using a biogas generator is a component of a low-carbon agricultural support project implemented by loans from the Asian Development Bank (ADB) and the Government of Vietnam.

Hydropower

Thanks to the tropical monsoon climate with an extraordinary rainy season, Vietnam has relatively large hydroelectric resources. The topographic distribution stretching from the North to the South with a coast of more than 3,000 km along with the elevation change of more than 3,100 m to the sea level has created a tremendous source of potential hydropower and tidal energy.

In 2012, total installed capacity of hydropower plants is 13.5 GW, accounting for 50% of total electricity mix; this figure rose at 15.9 GW in 2016, accounting for 40% of total electricity mix.

However, difficulties arise as it is forecasted that all potential reserves of large and medium hydropower plants will be fully exploited by 2020, as their capacity potentially reaches 21.6 GW. Moreover, the overexploitation of hydropower also received several backlashes such as causing land erosion, changes in water flows, frequent flooding, and water shortages at the end of the stream. As a result, the focus has gradually shifted to small hydropower projects with a capacity of less than 100 MW. Meanwhile, tidal/wave energy attracts less attention from both institutions and private sectors despite its potential.

Energy Efficiency

Vietnam faces significant challenges for the energy industry in ensuring the arrangement and mobilisation of investment to upgrade the transmission, develop new electricity resources, as well as provide adequate supply of primary energy resources for power plants. Moreover, the speed of renewables development in Vietnam does not measure up with the rapid increase in energy demand, posing another challenge to the nation's energy development. Therefore, the promotion of activities and solutions for economical and efficient use of energy is one of the most effective and quickest ways to solve the obstacles that Vietnam is confronting.

Situation Overview

The Vietnamese government has acknowledged that fast economic growth has to be accompanied with accelerated progress on sustainable development and social inclusion, and that energy efficiency contributes significantly to many aspects of this agenda. In line with this agenda, the "National target program on economical and efficient use of energy" (VNEEP) has been approved and implemented by the Government of Vietnam since 2006. Ending in 2015, the program has saved the equivalent of energy of more than 186 million MWh (16 mtoe).

Main Opportunities in Energy Efficiency

Residential and Commercial Buildings

Residential buildings account for the largest share of energy consumption in the building industry, with lighting (19%) and air conditioning (17%) accounting for the highest consumption. The average energy consumption is estimated at around 60 kWh/m²/year for residential buildings in cities

Average energy intensities in the commercial sector vary greatly depending on the type of building, with administrative and hospital buildings consuming energy at about 50 kWh/m²/year, whereas hotels and retail buildings surpass 20 kWh/m²/year. Air conditioning accounts for over half of the energy consumption of the sub-sector.

Efficient cooking, room cooling, and lighting are the three main areas of energy efficiency improvements in the residential and commercial sector.

The use of reliable cooking stoves and the conversion of biomass to LPG and electric cooking stoves in rural households is important in order to redeploy biomass energy from domestic use to more efficient industrial CHPs or other central power plants. In addition, with the projected increase in the cooling demand, the introduction of efficient air conditioners plays a central role in reducing energy use in the residential sector.

Key Residential and Commercial Buildings Policy and Targets

The National Target Programs on Energy Efficiency and Conservation were implemented by Ministry of Industry and Trade in the period of 2006-2015 (VNEEP1 and VNEEP2), and comprised of many activities ranging from legal framework, capacity building, obligations for designated energy users, support for energy audits, soft loans, standard setting, energy labelling, non-financial and financial incentives. VNEEP1 and VNEEP2 achieved the energy saving ratios of 3.4% and 5.7% respectively. Compulsory labelling and minimum energy performance standard (MEPS) programs under VNEEPs have been implemented for several domestic appliances, including:

- Household: CFLs, fluorescent lamps, electronic and magnetic ballasts, air conditioners, refrigerators, washing machines, rice cookers, electric fans, televisions, LEDs and storage water heaters;
- Service: photocopy machines, monitors, printers, fridges and laptops

Until the introduction of VNEEP3, there are still no specific targets on the energy saving rates for residential and commercial buildings.

Investment in Residential and Commercial Buildings Sector

As of October 2019, Vietnam has 116 green-certified buildings, in which 52% are residential buildings and complexes. Green buildings are developed in a fragmented and spontaneous manner and often led by a handful of pioneers. However, in recent years, the market has witnessed more Vietnamese real estate investors joining this pioneer group, notably Capital House, Novaland, Nam Cuong, etc.

Investment does not come only from real estate developers but from international development programs as well. 90% of residential green buildings are certified by EDGE – certification system developed by International Finance Corporation (IFC), a member of World Bank Group. IFC has been cooperating with local banks to release preferential credit packages for green construction through EDGE.

Since December 2016, EVN and EESL – an Indian corporation specialised in Energy Efficiency – have signed a memorandum of understanding on cooperation in the field of energy saving. Up to now, EESL has completed the feasibility study for the project of

adjusting the market of daily-life lighting in Vietnam, potentially financed by World Bank, Asian Development Bank, or United Nations Development Program.

Opportunities and Challenges for Swedish Companies

Large cities in Vietnam have witnessed a rapid growth of apartment buildings and complexes, with the booming development of the VinGroup conglomerate and its real estate brands VinHomes and Vincom. Smart house with energy saving solutions is becoming popular. The "Hanoi Smart City" project with capital of USD 4.2 billion started construction in October 2019 could potentially open great opportunities for Swedish companies to invest in energy efficiency, especially in HVAC area.

Energy efficiency is generally an open market that international enterprises can enter easily without significant government-imposed constraints, hence the tough competition in the market. Product-wise, Swedish presence is almost non-existent in the energy efficiency market. Many world-famous brands and affordable local brands are dominating the smart home market, including Siemens from Germany, Schneider from France, Smart 4G and TIS Smart Home from the US, BKAV Smarthome, Lumi and Acis from Vietnam. In the market for HVAC, Daikin and Panasonic each control about 25% of Vietnam's air conditioner market, followed by LG, Samsung Electronics of South Korea and Sweden's Electrolux. The popularity of Japanese brands is rising in Vietnam as consumers increasingly value energy efficiency and performance over low prices. This aligns with Swedish commodities' value; their presence, however, cannot be compared to that of Japanese and Korean brands in Vietnam.

Another challenge is the loose enforcement of energy efficiency laws in households and buildings. Regulations and programs are inked by multiple levels; however, there appears to be a lack of management system to efficiently and precisely measure energy saving rates, as well as the lack of sanctions and disincentives, especially in the household and commercial sectors. Most individuals looking for energy-efficient products are out of their own concerns over electricity bill or climate change.

Industrial

Energy is used in the industry mostly for direct heating in furnaces, producing a secondary energy such as steam, compressed air, thermal oil, run electric motor, pump and fan, and HVAC (Heating, Ventilation, Air Conditioning) system or producing refrigeration. The energy-saving potential lies mainly in auxiliary areas serving the production of main products such as lighting, steam, refrigeration, compressed air, pump and fans. As for sub-sectors, cement, steel, textiles and food are the main targets for improving energy efficiency in the industrial sector.

In the period of 2011-2015, Vietnam saved 5-8% of the total energy consumption, equivalent to 11-17 million tons of oil equivalent; in particular the energy intensity of industrial production, high energy consumption gradually decreased in the period of 2011-2015 in multiple sectors.

Key Industrial Policy and Targets

National program on economical and efficient use of energy in the period 2019-2030, until 2030 (VNEEP3) will strive to reduce the average energy consumption in industries compared to the period 2015-2018. The following table showcases the targets for the next 10 years.

Table 20. Vietnam's 2030 Energy Consumption Targets by Sector

	Period 2019-2025 (reduction as compared to 2015-2018)	Period 2026-2030 (reduction as compared to 2015-2018)
% of energy consumption reduction by industries		
Steel	3 - 10%	5 – 16.5%
Chemical	Minimum 7%	Minimum 10%
Plastics	18 - 22.5%	21.6 – 24.8%
Cement	Minimum 7.5%	Minimum 10.9%
Textile and garment	Minimum 5%	Minimum 6.8%
Beverage	3 - 6.9%	4.6 – 8.4%
Paper	8 - 15.8%	9.9 – 18.5%
% of industrial zones and clusters having access to energy efficiency solutions		
Industrial zone	70%	50%
Industrial cluster	90%	70%

Disincentives have also been introduced to put energy consumption under control. The government has implemented time-of-use electricity tariffs for medium and large enterprises and established an energy efficiency policy and a roadmap for energy labelling to promote economic use of electricity and reduce consumption.

Investment in Industrial Sector

Since regulations on energy saving are not strictly enforced, most corporations are not keen on energy efficiency solutions. However, several collaborative programs have been introduced to raise the energy efficiency rate and build incentives for the industrial sectors.

The Vietnam Energy Efficiency for Industrial Enterprises Project (VEEIE) is a project implemented by the MOIT in coordination with the World Bank with a total value of 158 million USD. This program is implemented for 10 years. Participating banks will lend to industrial enterprises/energy service companies (ESCOs) to implement energy saving projects.

Vietnam Scaling up Energy Efficiency for Industrial Enterprises Project (VSUEE) is funded by the Green Climate Fund (GCF) and World Bank with a total budget of USD 11.5 million. MOIT – the project managing agency – is the host agency in charge of overall project implementation. This project provides partial credit guarantees to participating financial institutions as well as provisions of technical assistance to MOIT, relevant government agencies, participating financial institutions, industrial enterprises and ESCOs.

Opportunities and Challenges for Swedish Companies

Improving energy efficiency in cement, steel, paper and pulp, food and textile industries are among the most important sectors to exploit for energy efficiency. In industrial drive systems, energy-efficient motors and inverters (VSDs) are also important applications, especially iron and steel and textile manufacturing. Efficient industrial lighting is also a necessary measure for all sub-industries and should be the priority for industrial plants.

Key programs such as VEEIE and VSUEE bring great opportunities for Swedish companies to participate into the energy efficiency market. Opportunities for lending are open for Swedish ESCOs doing business in Vietnam. Moreover, they are also open for industrial enterprises – which Energy Efficiency solutions providers see as target customers. The programs last until 2022-2024, prompting several enterprises to obtain energy efficient equipment during this period.

Barriers mostly depend on the awareness of individuals and corporations. In Vietnam, leaders of enterprises often focus on improving operations and revenue growth without significantly paying attention to energy efficiency. This is also because the investment into equipment is difficult to acquire, especially for small and medium sized companies. Another reason is the lack of knowledge on energy conservation and lack of energy saving options. Moreover, the loose enforcement of the regulators also contributes to the negligence of enterprises towards energy efficiency.

Regarding finance and banking, access to finance is considered one of the foremost boundaries to the call for energy efficiency. Only a few local financial institutions have dedicated energy efficiency loans as part of their green finance business line, which only accounts for a small fraction of the loan portfolio. Most of the current lending to energy efficiency is focused on a small number of highly credit-worthy large industrial corporations. On the other hand, most industrial enterprises and energy service companies (ESCOs) do not have the same creditworthiness or equity assets as larger firms, consequently leading to restricted access to local capital.

Other Opportunities in Energy Efficiency

Energy Generation and Transmission

The transformation in the power generation structure as well as the increasing energy output are major challenges for the operation of grid management in ensuring reliable, stable, and sustainable electricity supply together with an appropriate electricity price. Realising the demand, on November 8, 2012, the Government has issued Decision 1670/QD-TTg on Developing Smart Grid in Vietnam. The Government also targeted to implement technical solutions and management measures to reduce power loss (both in terms of technical and commercial losses) in the power transmission and distribution system from 9.23% in 2011 to 8% in 2015.

EVN has experienced a continuous decrease in power loss rate in recent 10 years. The target was met in 2015, and by 2018 this figure dropped to 6.9%, making Vietnam one of the top countries with a relatively low power loss rate. Electricity losses on the current power grid of EVN are mainly categorised as technical power losses, which is the loss of electricity on the power grid during transmission and distribution. This loss depends heavily on the characteristics of the electricity system and the investment costs for the system. Hence, it is possible that power loss will increase in some period due to unsecured grid investment plans.

Transportation

In the transport sector, road transport is one of the main areas for energy efficiency improvements with significant contributions from car, motorbike and other commercial vehicles (bus and truck) mainly due to the introduction of higher fuel economy standards. An increasing large share of oil products for transport is imported, thus making energy efficiency in transport a very important focus area. Several regulations on clean energy has been executed, in which a typical example would be the implementation of EURO 3 emission standards, however these regulations are not strictly enforced.

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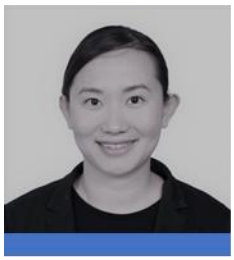

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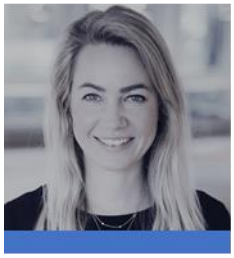

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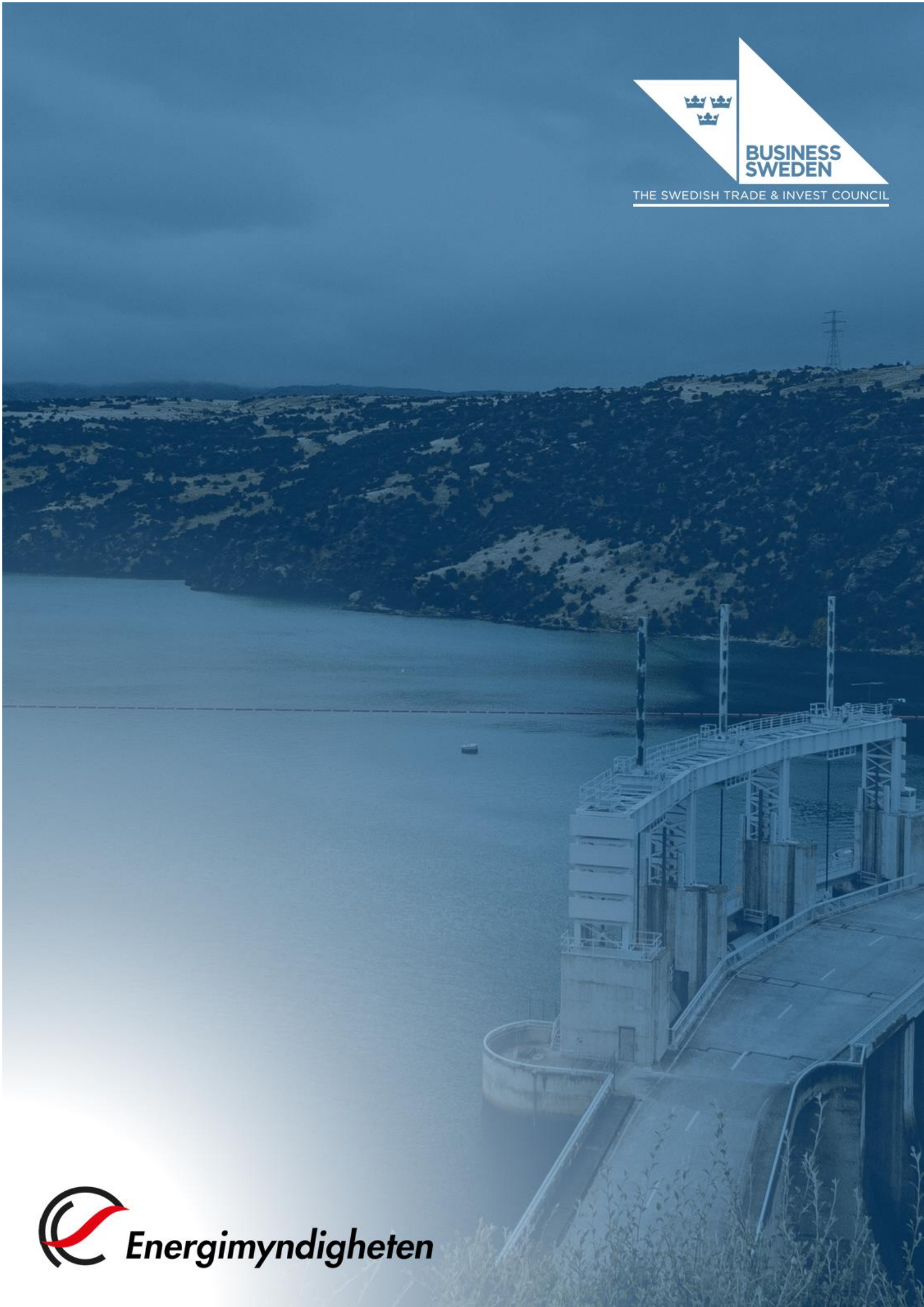
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