



Scoping study

Industrial development in Thailand: Renewable energy sector

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South Pole

South Pole Carbon Asset Management Ltd. · Technoparkstrasse 1 · 8005 Zurich · Switzerland
+41 43 501 35 50 · info@southpole.com · southpole.com

Details

Prepared for:

**Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek
(Netherlands Organisation for Applied Scientific Research, TNO)**
Motion Building, Radarweg · 601043 NT, Amsterdam · the Netherlands

Prepared by:

South Pole Carbon Asset Management Ltd. (South Pole)
Technoparkstrasse 1 · 8005 Zurich · Switzerland
southpole.com

Project Manager:

Erick Ratajczak, Consultant Climate Change and Sustainability
+(66) 267 8786 ext. 16 · e.ratajczak@southpole.com

Project Team:

Yulia Dobrolyubova, Head of Climate Policy & Finance, Asia
Erick Ratajczak, Consultant Climate Change and Sustainability
Nattaya Lonawan, Senior Consultant
Thanwarat Srichampa, Junior Consultant

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Acronyms and abbreviations

AEDP	Alternative Energy Development Plan
BOI	Board of Investment
BOS	Balance of system
DEDE	Department of Alternative Energy Development and Efficiency
DIP	Department of Industrial Promotion
DIW	Department of Industrial Works
DPIM	Department of Primary Industries and Mines
EFAI	Energy Fund Administration Institute
EGAT	Electricity Generating Authority of Thailand
EPPO	Energy Policy and Planning Office
ERC	Office of Energy Regulatory Commission
ESS	Energy storage systems
GHG	Greenhouse gas
GW	Gigawatt
IRENA	International Renewable Energy Agency
ktoe	Thousand tonnes of oil equivalent
MoEN	Ministry of Energy
Mol	Ministry of Industry
MoST	Ministry of Science and Technology (Ministry of Higher Education, Science, Research and Innovation, MHESI) since May 2019
MtCO ₂	Metric tons of carbon dioxide equivalent
MW	Megawatt
NDC	Nationally Determined Contribution
NESDB	Office of the National Economic and Social Development Board
NEPC	National Energy Policy Council
NSTDA	National Science and Technology Development Agency
O&M	Operation and Maintenance
OCSB	Office of The Cane and Sugar Board
OIE	Office of Industrial Economics
PDP	Power Development Plan
PEA	Provincial Electricity Authority
PMO	Office of the Prime Minister
PV	Photovoltaics
R&D	Research and development
RE	Renewable energy
STI	National Science Technology and Innovation Policy Office
THB	Thai Baht

1 Introduction

The Netherlands Organisation for Applied Scientific Research (TNO), with the assistance of South Pole Carbon Asset Management Ltd. (South Pole), is supporting the government of Thailand by implementing the project 'Advancing from Mitigation Ambition to Action' (A2A) funded by the German government's International Climate Initiative. The project aims to support the continued development and implementation of Thailand's Nationally Determined Contribution (NDC) 'in line with the Paris Agreement – the international agreement signed in 2016 to combat climate change – with a focus on the energy sector and the articulation of the social, economic and environmental benefits of climate change mitigation actions in the sector.

As part of this assignment, TNO has tasked South Pole with providing initial guidance by means of a b on industrial development in Thailand that may impact the renewable energy (RE) sector. This scoping study covers the RE technologies prioritised in Thailand's Alternative Energy Development Plan 2015 (AEDP 2015)¹ and the country's NDC, namely solar PV, wind and biomass. This document does not intend to provide an in-depth analysis, but rather a detailed overview of the RE industry in Thailand and its linkages to industrial development to guide the identification of areas for further research/support.

Section 2 of this briefing note provides the overall context of Thai industrial development in relation to the RE sector. Section 3 focuses on specific RE technologies and their respective supply chains and connections with industrial sectors; an overview of the government strategy for supply chain promotion is also included in this section. Section 3 introduces the key stakeholders (government entities) responsible for industrial promotion in Thailand, while Section 4 focuses on the specific philosophies, strategies and policies which guide industrial development in the country (with a focus on RE promotion).

¹ AEDP 2015 can be found [here](#). However, it is important to highlight that with the approval of the new Power Development Plan (PDP 2018), the AEDP will be revised accordingly in the near future. To date, no further details are available regarding these revisions.

2 Context

Thailand has transformed its economy from one based on agriculture to one more focused on export-oriented manufacturing, while integrating key manufacturing production into the regional and national value chain, particularly for automobiles, electronics (e.g. Thailand is a major producer of hard disk drives) and electrical equipment and products.

Growth and structural transformation have largely been concentrated in and around Bangkok. The northern, north-eastern and southern regions continue to lag behind Bangkok and the central region in terms of both economic growth and social development (ADB, 2015). The industrial sector, including energy-intensive sub-sectors such as iron and steel, mining, petrochemicals and construction, provides jobs for about 20% of the labour force, constituting about 40% of GDP (IRENA, 2017). Under the Thailand 4.0 strategy, the country's Eastern Economic Corridor has also become a manufacturing hub, drawing high-tech companies from around the region with various tax incentives offered by the Board of Investment (BOI). More details can be found in Section 4 of this report.

The deployment of RE in Thailand can provide opportunities for socioeconomic development and local value creation. These opportunities may vary along different segments of the value chain (and among technologies), including project planning and assessment, financing, the sourcing of raw materials, manufacturing and assembly of components, construction and installation, Operation and Maintenance (O&M) and decommissioning. To harness this potential through the design of policies or strategies to support value creation from the development of a domestic RE industry, policymakers (a review of the key stakeholders can be found in Section 4) require a deeper understanding of the requirements for labour, skills, materials and equipment as well as the specific local market conditions that could support or hinder the desired transformation.

For instance, an IRENA (2017) assessment suggests that Thailand can minimise overdependence on imported technologies and maximise the benefits of domestic production for local communities by developing the local bio-economy to enable it to utilise the entire value chain of locally produced bioenergy; local expertise in solar thermal technologies, solar PV and wind power generation technologies; and manufacturing capacity for electric vehicles, including two- and three-wheelers.

2.1 Policy outlook

Uncertainties about the pipeline of new RE projects and the security of potential investments represent a significant barrier for investors and are unlikely to encourage the development of local RE companies.

Local entrepreneurs and companies need a predictable and stable pipeline of new RE projects in which to invest, as this will give them an indication that the RE business might be sustainable over the long term.

To balance the high up-front investment costs and secure investments in new production facilities over the payback period, it is crucial for investors to have a clear vision of the long-term policy framework. Therefore, the regulatory and policy framework (e.g. RE laws, funding programmes, feed-in tariffs, loans, R&D-programmes, local content requirements, subsidies) must be formulated and secured over a long-time horizon. While it may appear that the national market may be too limited to develop localised production for several components along the RE value chain, given the increasing trend of regional integration in the ASEAN region, the potential for local production in Thailand to supply neighbouring markets (and beyond) should also be taken into consideration.

In Thailand, the AEDP 2015 includes specific strategies for RE promotion in Thailand. Among these, Strategy 1 focuses on the preparation of raw materials (and components) for RE technologies and includes 'tactics' such as promoting the development of appropriate technology for the generation and utilisation of energy. Other tactics include:

- promoting the use of domestically-produced parts or technology;
- developing spare parts, equipment and new RE technologies that are suitable for use in each area and can be reproduced for commercial purposes; and
- standardising materials, equipment and the installation and system performance testing of RE technologies.

Although these aspirations related to industrial development have been included in the strategic documents, the status of implementation and impact is currently unclear and requires a more in-depth study for better understanding.

Moreover, it is important to note that a revised Power Development Plan (PDP 2018) was introduced in early 2019. The revised PDP has updated targets for RE technologies, specifically for solar PV and biomass. The AEDP 2015 is currently being revised as well. Therefore, an in-depth study of industrial development potential through the deployment of RE would be timely and would enable the AEDP to build on an assessment of the existing progress and better target future industry potential.

The Thailand Industrial Development Strategy 4.0 (2017-2036) has replaced the National Industrial Development Master Plan (2012-2031), which emphasised RE, particularly the development of industrial solar and wind technology. The Thailand Industrial Development Strategy 4.0 (2017-2036) emphasises the use of bioenergy, including biomass, but has not explicitly targeted industrial development for solar and wind technologies, probably following the existing merit order for RE technologies in the country² (to be confirmed through additional research). Policy coherence is needed to support consistent development in this regard.

2.2 Introduction to local content potential in Thailand

This section provides an introductory assessment of the domestic localisation potential among RE technologies in Thailand, solar PV, biomass and wind (to a lesser extent) which, according to PDP 2018 and the draft NDC Action Plan for RE (issued in January 2019), are to constitute the major share of newly added RE capacity. The assessment is based on a combination of various factors, including (1) a review of industry status quo; (2) a desk review of publication and reports presenting other country case-studies which may be applicable to Thailand; (3) the prioritisation of technologies in government policy (targets); and (4) the resource potential of the technology.

It should be noted that this section and the scoping study overall present only an initial overview of the domestic industrial development potential for RE technologies in Thailand. An in-depth assessment of domestic localisation potential requires more granular study, stakeholder engagement and validation.

Solar PV: the domestic localisation potential is high.

Early in Thailand's solar boom, most modules were imported because local production could not compete with global prices. In 2014, Thailand only had 235 MW/year of module production capacity – this jumped to 3.6 GW/year by 2015 (DEDE, 2015).³

Using imported silicon wafers, large producers of PV cells have made investments for factories to manufacture cells in Thailand for both the domestic and export market. Early-comers (2015-2016) to the Thai market include Chinese Yingli Solar and Trina Solar. The latter has established a manufacturing facility in the Thai-Chinese Rayong Industrial Zone that has an annual module assembly capacity of 500 MW and solar cell capacity of 700 MW.⁴

² For more information, refer to AEDP 2015.

³ It was reported that 1.2 GW of modules were produced in Thailand in 2016. Updated figures from 2018 have not yet been found.

⁴ Trina Solar, for example, has also established manufacturing facilities in Malaysia (700 MW module plant) and Viet Nam (1 GW cell plant). More information can be found here and here.

To date, solar modules manufactured in Thailand use imported solar cells. However, in late 2016 the Ministry of Industry (Mol; Department of Primary Industries and Mines) announced that the country has 25 million tonnes of domestically-mined, high-quality quartz in reserve which could be used to manufacture approximately 6 million tonnes of solar-cell-grade silicon. It was announced that the Department was considering a development programme to maximise benefits of rapid growth in the solar PV manufacturing industry and to nurture its potential as a large revenue source for the country.⁵ A desk review of Mol documents found no further mention of this plan, and thus, the status of promulgation or implementation needs to be established through direct interaction with ministry representatives.

In addition to the solar panels, further study is required to better understand how, and if, the country could leverage its pre-existing semiconductor industries (wiring and electronic components) and production capacities to localise other components and equipment, such as the balance of system (BOS). It would also be worth exploring the potential of leveraging this pre-existing industry in the creation of new capabilities in parallel industries, such as energy storage systems (ESS; batteries).

Moreover, localisation potential exists in the construction and O&M phases. In these phases, nearly all kind of workers (low to highly skilled workers, engineering and management staff) are required, creating local job opportunities given the right training and education programmes.

Wind: the domestic localisation potential is low to medium.

Taking into consideration the current limited domestic market in for wind power in Thailand, the main higher technology components (for example turbine and blades) for wind projects are manufactured by the original equipment manufacturer companies outside of Thailand. While the localisation potential is likely low under the status quo, a medium assessment is included as new technological advancements make power generation at low and medium wind speeds more economically feasible.⁶ Higher towers and larger blades are more suitable for low to medium wind speed locations. Examples from other countries have shown that the large size of the blades and towers favours manufacturing close to the market to reduce transportation costs.⁷

For towers, the existing manufacturing knowledge of local steel companies would potentially allow for more local production. For onshore wind in Thailand, a potential incentive for local manufacturing of bulky components, such as blades and towers, is their high cost of transport. For example, German developer Max Bogl set up a mobile factory in Thailand to build hybrid towers for the 207 MW Korat 1 and 2 wind farms and confirmed that local resources and labour would be used (200 local employees), with 25 staff members from its German headquarters to oversee operations.⁸

As mentioned above, there is additional potential for local manufacturing companies which already produce more low-tech electrical components and would require only adaptations of their existing production processes to become suppliers of BOS components.

Localisation potential also exists for the construction and O&M phases. In these phases, nearly all kinds of workers (low to highly skilled workers, engineering and management staff) are required, creating local job opportunities given the right training and education programmes.

Bioenergy: the domestic localisation of feedstock supply is high, as is the potential for equipment and technology localisation.

Thailand is an agricultural country and the agriculture sector still employs around 31% of workers.⁹ A significant amount of agricultural waste is left after harvesting (or burned in an unsustainable manner) that could instead be used to produce biomass energy that would generate multiple

⁵ Insight found through desk review of news sources such as the one [here](#).

⁶ The potential for a high share (target) of wind in Thailand's power mix was noted during a presentation by the International Energy Agency (IEA) during the Thailand 4.0 Energy Conference held on 24-25 January 2019.

⁷ This assessment draws from analysis conducted by EIM and IRENA for Egypt. The full report can be found [here](#).

⁸ More information on the Max Bogl mobile factory can be found [here](#).

⁹ Estimate based on International Labour Organisation (ILO) data can be found [here](#).

benefits for the environment, society and economy. According to national policies, Thailand emphasises the need to utilise its abundant biomass resources. Typical Thai biomass includes rice husk/rice-chaff, bagasse fibre, cassava, lees of sugarcane, empty fruit bunches of palm and scrapped rubber trees.

Given the abundance of biomass resources in Thailand, the domestic localisation of the feedstock supply is currently high. No reference to the importation of feedstock was found in a desk review of relevant material; in this context, strategies are needed to strengthen the supply to meet increased demand and maintain the domestic market without impacting the food supply/security.

The technology necessary for the production of bioenergy, namely for combustion and generation (conversion), is mainly imported from abroad and resold by local suppliers/distributors in Thailand.

Most of the industrial facilities that could potentially use biomass for process heat are large-scale, centralised plants operating at economies of scale. The development of such supply chains would benefit not only heat applications but also electricity production and, more importantly, the co-generation of heat and power.

Renewable thermal energy utilisation will account for nearly two-thirds of the renewables in the final energy mix by 2036 if the AEDP 2015 projected target is met. The majority of this is expected to come from biomass.¹⁰ Over the past decade, renewable power capacity in Thailand has expanded from 100 MW to almost 10,000 MW currently. The government has announced that it will continue to promote biomass power plants in the country's southern most provinces (Yala, Pattani, Narathiwat) with a total capacity of 300 MW as it aims to resolve power shortages.¹¹

Currently, rice husks are burned to produce steam for turbine operation in rice mills; bagasse and palm residues are used to produce steam and electricity for on-site manufacturing processes; and rubber wood chips are burned to produce hot air for rubber wood seasoning.

Lastly, the use of new technologies for managing feedstocks and derived products should be encouraged, for instance, solid biomass pellets, provided they can meet the expected or desired quality assurance.

¹⁰ More information can be found in the AEDP 2015.

¹¹ Information on the current biomass situation in Thailand can be found [here](#).

3 RE technology supply chains in Thailand

This section focuses on the RE supply chain in Thailand for technologies prioritised for electricity and heat production in the AEDP 2015 and Thailand's NDC for RE, namely, solar PV, wind and biomass. For each technology, a brief introduction on the current status is provided along with the government's current strategy to promote and strengthen the supply chain.

3.1 Solar PV

3.1.1 Status quo of technology

- Under the new PDP (PDP 2018), it has been announced that the solar PV target will be increased to 10,000 MW by 2037, largely driven by solar rooftop, from the approximately 3,245 MW installed as of February 2018.¹²
- From 2021-2030, solar technology (electricity and heat) is estimated to cumulatively reduce greenhouse gas (GHG) emissions by 4.93 MtCO₂ according to the NDC Action Plan for the energy sector (draft version of January 2019), which is largely based on the AEDP 2015 targets.
- Floating solar, including the Hydro-Floating Solar Hybrid System, is prioritised in the new PDP 2018. If deemed successful, the government will aim for the installation of 1,000 MW of the technology. The Electricity Generating Authority of Thailand (EGAT) has already been developing a pilot project with a capacity of 45 MW in north-eastern Thailand and is actively promoting this technology.
- The potential economic benefits of strengthening the solar related business market in Thailand includes a large reduction in the cost of solar PV and ESS technology year by year and the availability of consumers (including in the industrial sector) to use the power generated on-site. Thus, solar PV solutions are becoming increasingly attractive for industrial facilities.
 - According to the Energy Regulatory Commission (ERC), there are no financial subsidies for solar PV right now because the regulator believes that the solar industry can be financially sustainable without subsidies such as the adder or feed-in tariffs provided in the past.
 - Power trading and private power purchase agreements (PPAs) will now be permitted according to the National Energy Policy Council; however, connection to either the Metropolitan Electricity Authority or Provincial Electricity Authority (PEA) grid is not permitted.
 - The 'prosumer' concept is being discussed and promoted; however, there are a number of existing challenges such as the inability of individual producers to connect to the national grid and an unclear policy regarding backup fees and wheeling charges for private PPAs if they need to connect to the national grid or use third-party facilities, such as grid and transmission lines, to send to other consumers. Policy clarity is needed, especially for the backup fees and wheeling charges, which are currently being discussed by EGAT and ERC.
- The smart grid pilot project is being implemented in the city district of Mae Hong Song and the Pattaya area and a microgrid pilot project is being developed in the Maesarieng district of Mae Hong Song. The three projects are being studied by EGAT. Smart and microgrids will be able to support the upcoming expansion of variable RE.
- According to the strategy outlined by the AEDP 2015 Action Plan, the government aims to study and promote local content, the design of new equipment, innovation prototyping, solar dryers for the industrial sector, heat storage for the industrial sector and 'Building Energy Code' regulation. However, there is only a proposed budget allocated and responsible agency under the Action Plan. In this regard, further discussions with DEDE

¹² Updated figures provided at the Thailand 4.0 Conference.

are necessary to understand the current status of the plan's implementation and how the new AEDP revisions scheduled for 2019 will build on progress made to date.

- In the past, most modules and grid-connected inverters were imported due to the inability of local manufacturing to compete with global prices.¹³ However, a key feature of the solar industry in Thailand is the current, and growing, trend of assembling modules with imported solar cells. Moreover, the country is also witnessing an increase in the production of solar cells for both the domestic and export markets.¹⁴ BOI's eight-year income tax holiday and import duty exemption include the manufacturing of solar cells and/or raw materials for solar cells.

Strategy under the AEDP (2015) Action Plan for reference

The AEDP Action Plan includes the following activities for solar PV supply chain promotion in Thailand, as described in Table 1. Activities are described with the level of detail provided in the Action Plan for guidance on the government's line of thinking regarding technology and industry. It is, however, unlikely that all of the activities in the Action Plan will be implemented given the release of a new AEDP in 2019, which will also come with its own Action Plan.

The status and implementation progress of the AEDP 2015 Action Plan implementation needs to be further confirmed in consultation with local stakeholders.

Table 1: AEDP Action Plan activities for the solar industry

Activity	Proposed timeframe	Budget (THB)	Responsible agency
Study of local content	Completed by 2018	10 million	DEDE
Promotion for using more local content	2015-2021	20 million	DEDE, Energy Fund Administration Institute (EFAI)
	2022-2036	60 million	
Design of new equipment	2019	10 million	Siam Cement Group, National Science and Technology Development Agency, the EFAI, the EFAI and DEDE
Innovation prototypes	2015-2021	10 million	DEDE and the EFAI
	2022-2036	75 million	
Study of solar dryers for the industrial sector	2015-2021	5 million	DEDE and the EFAI
	2022-2036	25 million	
Study of heat storage for solar dryers	2022-2031	20 million	DEDE and the EFAI
'Building Energy Code' regulation	2021	20 million	DEDE and the EFAI

(Source: AEDP Action Plan, 2015)

¹³ The Thailand PV Status Report (2014-2015) can be found [here](#).

¹⁴ For example, Trina Solar, one of the first Chinese companies to set up operations in Thailand, now has an annual 500 MW module assembly capacity and 700 MW solar cell manufacturing capacity at its Rayong plant. More information can be found [here](#). Numerous other Chinese companies have set up operations in the Thai-Chinese Industrial Zone in Rayong.

3.1.2 Supply chain for solar PV in Thailand

The key players in the value chain of the solar industry are equipment manufacturers and project developers, as shown in Table 2 below.

Table 2: Solar PV supply chain in Thailand

	Raw materials, manufacturing and transportation		Project planning and development	Implementation (construction)	Use and service (operation)	End of service
	PV module	BOS and components				
Industries typically involved	Related materials (silicon wafers, transparent conductive oxide glass, Encapsulant sheet, and Terminal box)	Inverter, solar charging controller, cables, structure, box, and medium voltage transformer)	Technology supplier, contractor, project appraisal and financing services	Contractor	Power plant owner (factory and power plant)	Disposal factory (ongoing study)
Scope in Thailand (i.e. what is being done locally and what is outsourced)	<p>Import: producing, sourcing and processing solar cells</p> <p>Local: assembling solar cells into a module, delivering to the users</p> <p>Large local reserve of high-quality quartz (a key component in solar-grade silicone)</p>	Local: electronic manufacturing services; integrated circuit assembly, packaging and testing; and parts and components for electrical products	Import or local (the trend to shift to a higher local share): designing and engineering procurement and construction (EPC)	Local: consultant, construction and installation	Local: system monitoring, O&M	Local: disposal of solar PV through disposal factories (ongoing study)

	Raw materials, manufacturing and transportation		Project planning and development	Implementation (construction)	Use and service (operation)	End of service
	PV module	BOS and components				
Main players	<p>Solar cell and module assembly: Bangkok Solar, Ekkarat, Solar Power Technology, Solartron (local)</p> <p>International: Trina Solar, Yingli, Jinko Solar</p>	<p>Terminal box: Bangkok Solar (local)</p> <p>Inverter: Leonics (local), SMA (foreign), Schneider (foreign)</p> <p>Solar charging controller: Leonics (local)</p> <p>Cable: Bangkok Cable (local), Jaroong Thai (local), Multi-Contact (foreign)</p> <p>Structure: Kemrex (local), Leonics Esco (local), Versolsolar Hangzhou (foreign)</p> <p>Combiner box: Leonics, EIC (local)</p> <p>MV Transformer: Ekarat Engineering, Charoeanchai TF (local)</p>	<p>Local: ItalThai, Toyothai, Leonics ESCO, SPCG, Gunkul, Impact solar, Thai Solar Energy, Glow, BLCP, Symbiosolar, Solaris, EGCO, BGrimm, Solarton, Bangkok Solar</p>	<p>Local: Ekarat Solar, Bangkok Solar Power, Leonics ESCO, Thai Solar Future, CH. Karnchang, Power Solution Technologies, Pro Solar Group, Energy & Environmental Management, SPCG, Local: Gunkul, Impact solar, Thai Solar Energy, Glow, BLCP, Symbiosolar, Solaris, EGCO, BGrimm, Solarton</p> <p>International: Annex Power, Conergy, Jardine Engineering, Sun Edison Energy Engineering, REC Systems, Mctric, 19 Service Local company Foreign company (EPC)</p>	<p>Local system monitoring: Leonics-MoC, SPCG, Gunkul, Impact solar, Thai Solar Energy, Glow, BLCP, Symbiosolar, Solaris, EGCO, BGrimm (local) and Conergy (foreign)</p> <p>Local O&M: Leonics ESCO, Power Solution Technologies, Energy & Environmental Management, SPCG (local)</p>	<p>To be disposed at a disposal factory (ongoing study)</p>

(Source: South Pole, 2019)

3.2 Wind

3.2.1 Status quo of technology

- Ministry of Energy researchers developed a wind resources map (created in 2001 and updated in 2009) of Thailand and found that most areas in the country experience relatively low wind speeds except for the mountain ranges in the southern and north-eastern regions and western parts of the central region, which have higher wind speeds of 6-7 m/s on average at a height of 100 m. However, experts at the IEA have noted that Thailand's wind potential is greater than the estimates from DEDE, largely due to advancements in moderate wind-speed technology and cost reductions.¹⁵
- According to AEDP 2015, the country is targeting about 3 GW of wind energy by 2036, up from around 1.5 GW in 2018.¹⁶ From 2021-2030, wind technology is estimated to cumulatively reduce emissions by 6.73 MtCO₂ according to the RE NDC Action Plan. This target was, however, reduced to 1.485 GW in PDP 2018 (which means that the government does not seem to envisage any additional wind capacity up till 2037 – though this is to be confirmed through interviews).
- Considering the wind speed limitations in Thailand, there is a tendency to install wind generators with larger rotor diameters and hub heights (120 m or more). To date, the tallest completed installation in Thailand is Wind Energy Holding's Thepharak wind farm project, standing at 157 m with 137 m blades. These taller hubs are possible through 'hybrid towers' which combine both concrete and steel. However, this has implications for the transportation of the wind turbines and towers to the project site. It may also pose capacity limits on the available cranes in Thailand and require the use of special cranes for installation.
- The higher hub heights and larger rotor blades may be cost-effective in terms of their ability to harvest more wind potential, but they can also demand higher investment costs.
- On a global scale, new technology for taller hub heights and larger rotor blades continues to see broad cost reductions (about 20% over the last two years).¹⁷
- Overall, on an initial assessment, the country is not witnessing a trend (or push) to indigenise wind technology beyond small-sized turbines. For example, it has been identified that DEDE has been working with academic institutions in Thailand to develop an indigenous technology more suitable for Thailand's wind speeds.

Strategy under the AEDP (2015) Action Plan for reference

The AEDP Action plan includes the following activities for wind supply chain promotion in Thailand, detailed in Table 3. Activities are described with the level of detail provided in the Action Plan to indicate the government's line of thinking regarding the technology and industry. It is, however, unlikely that all these activities in the Action Plan will be implemented given the release of a new AEDP in 2019, which will come with its own Action Plan. The status of the AEDP 2015 Action Plan implementation needs to be further confirmed in consultation with local stakeholders.

Table 3: AEDP Action Plan activities for the wind industry

Activity	Timeframe	Budget (THB)	Responsible agency
Study of small-sized wind turbines	2018 - 2021	20 million	DEDE and the EFAI

¹⁵ Presentation by the IEA at the Thailand 4.0 Conference held 24-25 January 2019.

¹⁶ Data as of February 2018, as presented by DEDE during the Thailand 4.0 Conference held 24-25 January 2019.

¹⁷ Presentation from Mott MacDonald during the Thailand 4.0 Conference held 24-25 January 2019.

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Activity	Timeframe	Budget (THB)	Responsible agency
for the domestic market	2022 - 2036	60 million	
Study of electric generators for small-sized wind turbines	2019	15 million	DEDE, Ministry of Education, BOI, Ministry of Industry, and the EFAI
Study of bale and wind turbine generator sets	2019	6 million	DEDE and the EFAI

(Source: AEDP Action Plan, 2015)

3.2.2 Supply chain for wind in Thailand

Key players with a role in wind energy development include wind turbine manufacturers, dealers and distributors; wind project developers; consultants and contractors; electric utilities and government agencies; and landowners. See Table 4 below for more details.

Table 4: Wind supply chain in Thailand

	Raw materials, manufacturing and transportation	Project planning and development	Implementation (construction)	Use and service (operation and maintenance)	End of service
Industries typically involved (main inputs)	<p>The wind turbine tower could be made of welded steel or concrete.</p> <p>Other materials like copper, aluminium, permanent magnetic materials and ceramics are needed, mainly for the generator and the power electronics and controls.</p> <p>Mineral materials: concrete</p> <p>Bulk metals: iron, steel, aluminium, copper</p> <p>Plastics: CFRP, GFRP, PVC, PU, PE</p>	<p>Service (specialist skills) for wind:</p> <ul style="list-style-type: none"> wind power feasibility analysis; site selection; wind farm design and layout; wind turbine selection and acquisition; obtaining permits/acquiring wind rights and leases; feasibility studies; and project financing. 	<p>During construction, the developer has a managing role in the project. The main components needed could be divided into four categories: rotor, generator and electronics, nacelle and turbine tower.</p>	<p>Maintenance includes scheduled and unscheduled services.</p> <p>O&M for wind turbines is normally contracted to its turbine supplier via a service and availability agreement.</p>	<p>To be assessed (however concrete wind turbine towers are unrecyclable)</p>
	<p>To date, there is no domestic production of wind turbines; however, studies are being undertaken with the support of DEDE to develop technology that</p>	<p>The project developer typically contracts with an original equipment manufacturer (OEM) for the delivery of the complete turbines. The critical components are either fabricated in house by the OEM or to the OEM's specifications by a supplier.</p> <p>Given the rather small scale of wind projects in Thailand, finding highly specialised skills in planning, construction and O&M is a challenge.</p> <p>The availability of necessary cranes can be a limiting factor for higher hub heights.</p>			<p>To be assessed</p>

	Raw materials, manufacturing and transportation	Project planning and development	Implementation (construction)	Use and service (operation and maintenance)	End of service
Scope in Thailand (what is being done locally and what is outsourced)	<p>aligns with Thailand's wind potential (small installations).¹⁸</p> <p>Components</p> <p>There is a domestic supply of raw materials such as concrete.</p> <p>Steel is both domestically produced as well as imported in Thailand.</p> <p>Plastics are produced in Thailand.</p> <p>Domestic manufacturing of lower sophistication electronics components such as arresters, switches and circuits.</p>		<p>Case study: with transport for high towers presenting a challenge, Max Bogl Wind AC set up a mobile production plant to produce three hybrid towers (up to 180 m) for the Korat Wind Farm.¹⁹</p>		To be assessed
Main players	<p>Wind turbines are largely provided by multinational OEMs such as Nordex, General Electric, Vestas, Siemens Gamesa, Suzlong</p> <p>For cement: Siam Cement Group</p> <p>For steel: Siam Industrial Wire, Siam Construction Steel, Millcon Steel</p>	<p>Both local and multinational project developers are operating in the Thai wind sector.</p> <p>Domestic developers:</p> <ul style="list-style-type: none"> • EGCO • Energy Absolute • Khao Kor Wind Power • Wind Energy Holdings • iWind • Gunkul Engineering 	<p>Many of the large developers operate across the wind value chain, such as iWind and Gunkul Engineering</p> <p>Others include: K2 Management (foreign)</p>	<p>Both foreign and domestic entities provide O&M services for wind projects.</p> <p>Foreign: Mott MacDonald, Goldwind Asia, Siemens Gamesa, Suzlon</p> <p>Domestic: Gunkul Engineering, iWind</p>	To be assessed

(Source: South Pole, 2019)

¹⁸ Manufacturing blades locally usually requires large upfront investment, which can often only be justified with the existence of a solid project pipeline to absorb the costs.

¹⁹ Further engagement with Max Bogl regarding the on-site production of hybrid towers would be helpful in identifying the local value added.

3.3 Biomass (for electricity and heat generation)²⁰

3.3.1 Status quo of technology

- Biomass is an important source of RE for Thailand, as the country has plenty of biomass sources, especially in rural areas. The installed capacity of biomass across Thailand in 2018 was:
 - Electricity generation: 3,289.84MW; and
 - thermal heat: 6,900 ktoe of biomass, 634 ktoe of biogas and 124 ktoe of municipal solid waste.²¹
- Many agro-processing industries, such as starch, sugar, ethanol, palm oil, use biomass fuel for thermal energy and electricity generation as biomass by-products and waste are produced from their main production processes.
- The type of feedstock utilised depends on the availability of sources, handling and preparation process (including transportation) and price. For example, oil palm, para rubber and coconut waste in the south and rice, sugarcane, maize and cassava waste in the central, north and north-eastern parts of Thailand.
- While feedstock is sourced domestically, the combustion and generation technology is largely sourced internationally.
- The total investment in biomass power plants in 2017 was the largest of alternative energy technologies at approximately THB 10.92 billion, or 80.6% of the total investment in Thailand's alternative energy industry.²²
- If the demand for biomass in the industrial sectors is increased, there may be potential to enhance local biomass processing, transforming and burning, including local manufacturing for machine and equipment, to serve specific types of biomass available for energy generation in the country.
- To meet rising demand for bioenergy, power plants may need to pioneer a new type of biomass from other types of agricultural residues that are plentiful. One obstacle is that the biomass preparation machines are not yet available in the market and need to be newly designed at a high cost. Introducing this innovation into Thailand's feedstock market could help to increase the use of various types of biomass in the country.

Strategy under the AEDP (2015) Action Plan for reference

The AEDP Action plan includes the following plans for biomass supply chain promotion in Thailand (shown in Table 5). Activities are described with the level of detail provided in the Action Plan to indicate the government's line of thinking regarding technology and industry. It is, however, unlikely that all these activities in the Action Plan will be implemented given the release of a new AEDP in 2019, which will come with its own Action Plan. The status of the AEDP 2015 Action Plan implementation needs to be further confirmed in consultation with local stakeholders.

²⁰ Biomass for fuel-production (biofuels) is not included in this scoping study.

²¹ More information can be found in the Thailand Alternative Energy Situation Report (2017) [here](#).

²² It is assumed that this figure includes power generation and heat for biomass, however not explicitly specified by DEDE. More information can be found in the Thailand Alternative Energy Situation Report (2017) [here](#).

Table 5: AEDP Action Plan activities for the biomass sector

Activity	Timeframe	Budget (THB)	Responsible agency
Study of minimum local content requirement	2020-2021	15 million	DEDE, the EFAI and Mol
	2022-2036	45 million	
Preparing the industry to utilise renewable fuel	2017-2021	10.5 million	Responsible agencies are DEDE and the EFAI
	2022-2036	36 million	
Promoting private-sector investment in research and development regarding biomass fuel technology	2019		DEDE and the EFAI
Establishing a standard requirement for producing renewable equipment and machines domestically	2018	10 million	DEDE and the EFAI
	2022-2036	15 million	
Research and development for biomass generator systems, e.g., hydrothermal, superheated pyrolysis and bio-oil	2020-2021	100 million	DEDE and the EFAI
	2022-2036	300 million	
Study and demonstration of biomass technology implemented in the whole-loop of community activities	2021	20 million	DEDE and the EFAI
	2022-2026	20 million	

(Source: AEDP Action Plan, 2015)

3.3.2 Supply chain for biomass in Thailand

The key players in the value chain of biomass to energy are farmers and gardeners as primary producers, manufacturers as a secondary producer and biomass suppliers, power plants and manufacturing facilities using biomass as an alternative source of energy.

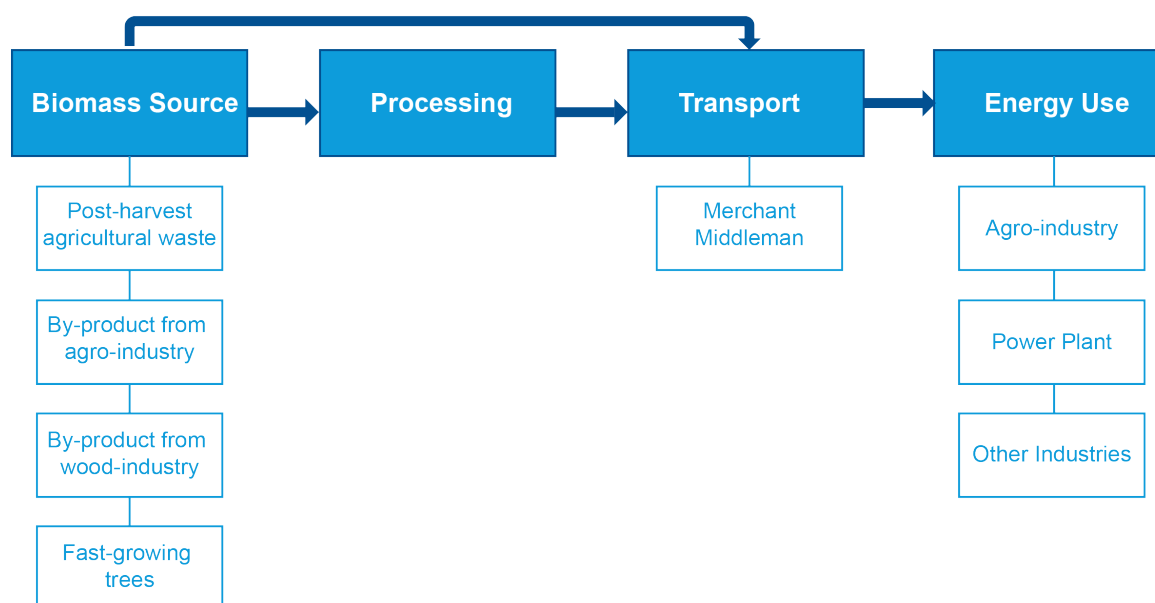


Figure 1: Typical biomass value chain in Thailand

The biomass supply chain includes:

Biomass sources

- Post-harvest agricultural waste: agricultural residues left after harvesting such as straw, para rubber stump and trunks
- By-products from the agro-industry: waste from processing agricultural products such as rice milling, sugar, palm oil and animal feed
- By-products from the wood industry, such as that produced by sawmill or furniture factories
- Fast-growing trees: eucalyptus trees

Biomass processing

- The processing of biomass depends on the type of feedstock and the intended combustion technology to be utilised in energy use. For example, woodchip factories buy large pieces of wood and then process them through shredding, chopping and drying into dried wood chips ready for burning.
- This process is typically undertaken by either the power plant itself or the feedstock supplier.

Biomass transport

- Merchant middlemen: collect biomass directly from producers, for example, rice mills, sawmills, palm and coconut gardens, and transport it to end users by truck or train. Biomass purchasing contracts are made to guarantee that a minimum quantity of biomass will be supplied to ensure fuel availability for a certain period.

Energy use (electricity and heat)

- Power plants and other industries: the biomass for electricity generation is either sourced from merchant middlemen or contract farmers. The electricity is sold to the national utility grid, pending a PPA.
- Agro-industry: most agricultural processing factories have their own biomass sources as a by-product of the main production process and use it to generate thermal energy and electricity to meet internal demand. The excess electricity generated can be sold to the grid if a PPA is in place.

It is important to note that it is not easy to identify the main players in the biomass value chain in Thailand, as biomass sourcing and supply are operated at the local level, within the same boundary (internal use within factories) or clustered by merchant middlemen and limited by their transfer distance capabilities. Most of the agro-industry will operate their own power plants; for grid-connected stand-alone power plants, the key players in Thailand may be local companies that could provide access to certain biomass supply sources.

Table 6: Biomass supply chain in Thailand

	Raw materials, manufacturing, transportation		Project planning and development	Implementation (construction)	Use and service (operation)	End of service ²³
	Feedstock supply	Technology				
Industries typically involved	Agriculture Agro and wood processing factories Biomass suppliers (processing and transport)	Technology suppliers	Project appraisal and financing services	Contractors, engineering firms	Power plant owner (factory and power plant) or industrial factory using biomass as a source of alternative fuel	Industries/factories with the operating permit for disposal (includes recycle/reuse) of industrial waste or hazardous waste
Scope in Thailand (what is being done locally and what is outsourced)	Local: 100% of biomass supply is sourced domestically (producing, sourcing, processing and delivering of biomass to the users). Logistic companies, Merchant middlemen	Basic feedstock processing tools are domestically sourced. The generation technology is largely sourced from outside of Thailand and sold through local companies.	Both local and foreign companies partake in project planning and development.	Local: consultant, construction and installation	Local: operation and maintenance	Local/international (in case the machine can be returned to the manufacturer)
Main players in Thailand (both local and international)	Local: Farmers: straw Gardeners: sugarcane, maize, cassava,	Local: Shaiyo Tripple A Group, Demco PCL, Advance Power Conversion Co., Ltd.	Local: Shaiyo Tripple A Group, Engineering Evolution, Demco PCL, Advance Power	Local: Shaiyo Tripple A Group, Engineering Evolution, Advance Power Conversion	Local: RATCH, Saha Group, Gulf, EGCO, BANPU, Engie Glow, PEA ENCOM, TPC Power	To be assessed further It has to be done under the supervision of the

²³ Some power plants have machines registered under the Machine Registration Act B.E.2514. A permit is required from the Central Office of Machinery Registration in the Department of Industrial Works to relocate, remove or dispose of the registered machines.

	Raw materials, manufacturing, transportation		Project planning and development	Implementation (construction)	Use and service (operation)	End of service ²³
	Feedstock supply	Technology				
	coconut, oil palm, para rubber and pineapple Sugar: bagasse Animal feed: cob maize, starch (cassava root) Palm oil factories Food factories: coconut shells and husks, pineapple stalks Furniture factories: sawdust and wood chips Woodchip factories: STC Group, PTC Holding, etc. Wood pellet factories: ²⁴ Asia Biomass, SYS Pallet Mill, B.P.15 Co., Ltd., S.R.2015 Co., Ltd., Green Energy Trading, Quality pallet, etc. Fast growing trees: Eucalyptus International: Waste wood imported from Singapore	(APCON), Owl Energy, ATT Consultants Company Limited, KPN Green Energy Solution, BANG Sustainable Energies Ltd. International: LAWI Engineering, DGA Thailand, Orano USA, Burmeister & Wain Scandinavian Contractor A/S, Industrial Power Technology Pte., Toshiba, Pöyry	Conversion Co., Ltd. (APCON), ATT Consultants Company Limited, KPN Green Energy Solution, TW.Tech 1711. Co., Ltd., BANG Sustainable Energies Ltd. International: Black & VeatchJERA Power (Thailand) Co., Ltd., <u>LAWI</u> Engineering, DGA Thailand, Pöyry, Burmeister & Wain Scandinavian Contractor A/S, Industrial Power Technology Pte.	Co., Ltd. (APCON), ATT Consultants Co., Ltd., Demco PCL, KPN Green Energy Solution, TW.Tech 1711.Co., Ltd., BANG Sustainable Energies Ltd., Sino Thai, EEC, TEAM Group International: Black & Veatch, LAWI Engineering, JERA Power (Thailand) Co., Ltd., DGA Thailand, Pöyry Burmeister & Wain Scandinavian Contractor A/S, Industrial Power Technology Pte.	Holding, B.Grimm, TPIPP, Power Solution Technology, UAC Global, Absolute Clean Energy PCL, Thai Bev Energy, Thai Solar Energy, Precise Energy, Energy Absolute Sugar: Mitr Phol Sugar, ES Group, Thai Rungrueng Group, KI Sugar Group Rice milling: Bua Sommai, Palm Oil Mill, Natural Group, Univanich	Department of Industrial Works, which deals with machine registration and industrial waste control.

(Source: South Pole, 2018)

²⁴ More information can be found [here](#).

4 Stakeholder mapping: institutional framework for industrial development

This section will cover the ‘who’ in industrial development in Thailand. The role of each stakeholder and how they fit within the overall governance/decision-making framework will be described briefly. Special attention is paid to the current or potential role of a given stakeholder in assisting RE promotion in the country through industrial development.

Figure 2 below, provides a visual representation of the roles and responsibilities among stakeholders. More detailed information can be found per entity in the section.

It is important to note that the roles and responsibilities listed under each stakeholder include those listed within the entity's official mandate. An assessment of the actual application of these responsibilities is beyond the scope of this study but is worth further exploration.

Office of the National Economic and Social Development Council (NESDC)

The NESDC is charged with formulating the five-year National Economic and Social Development Plan (NESDP) before submitting it to the Cabinet for approval on the basis of the following four national agendas:

- alleviating poverty and income distribution imbalances;
- enhancing Thailand's competitiveness;
- promoting social capital development; and
- promoting sustainable development.

The current plan is the Twelfth National Economic and Social Development Plan (2017-2021)²⁵ (see more details below). The objectives of the Twelfth Plan are consistent with the targets of the 20-Year National Strategy (2017-2036).²⁶

In addition, the NESDC, according to its mandate: (1) provides opinions and recommendations on national economic and social development to the Cabinet and Prime Minister; (2) sets up a coordination mechanism between the NESDB, concerned agencies and state enterprises regarding the planning and implementation of development programmes and projects in line with the NESDP; (3) establishes development indicators; and (4) creates and maintains a database of economic and social development indicators, especially for GDP data.

²⁵ The Twelfth National Economic and Social Development Plan can be found [here](#).

²⁶ The 20-Year National Strategy (2017-2036) can be found in Thai [here](#).

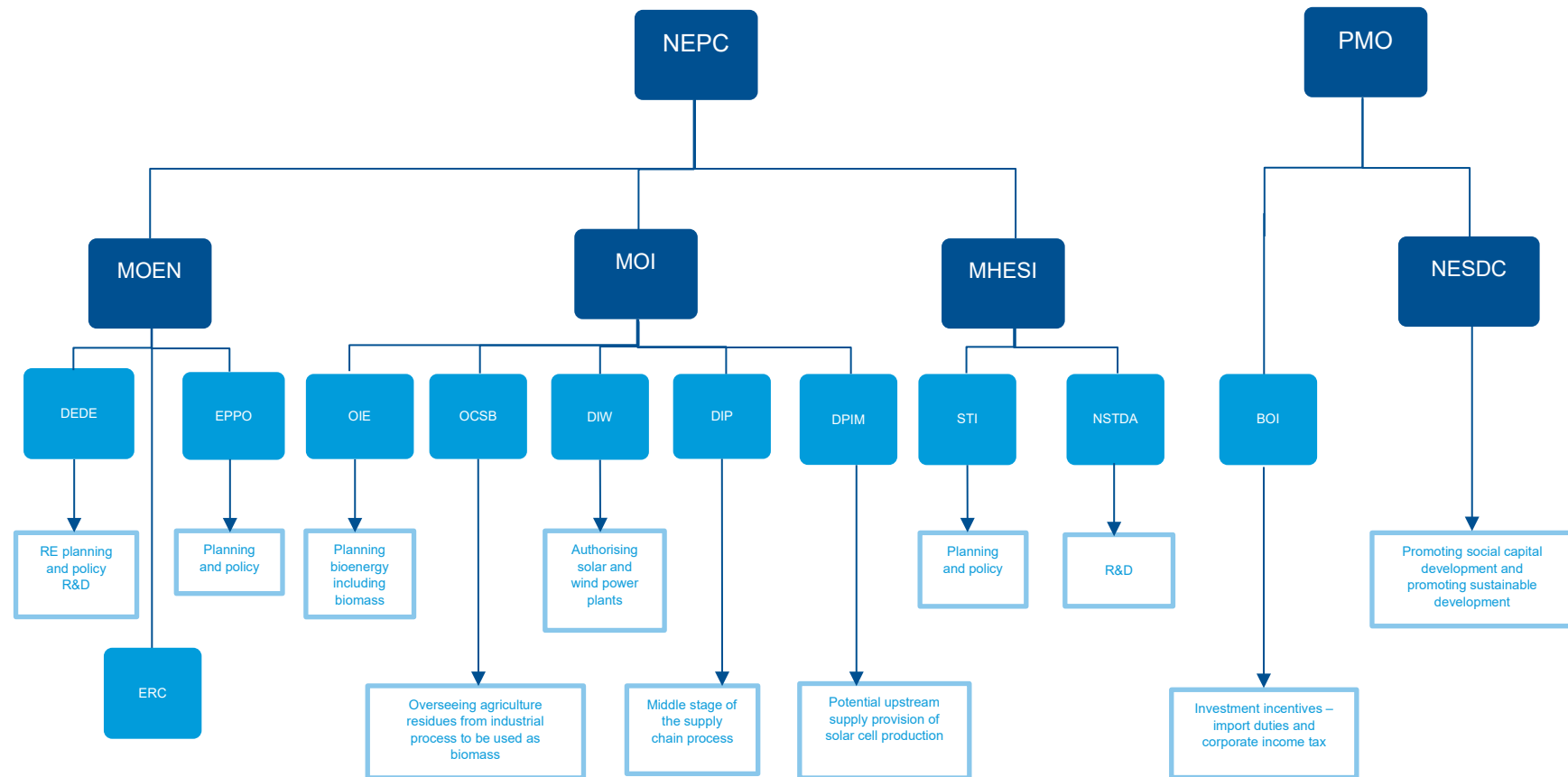


Figure 2: Organigram of key public sector institutions

(Source: South Pole, 2019)

National Energy Policy Council (NEPC)

The NEPC is responsible for the promotion of energy conservation and the management of the Energy Conservation Promotion Fund as per the Energy Conservation Promotion Act, B.E. 2535 (1992). The NEPC's responsibility is to approve and recommend national energy policies and national energy management and development plans (drafted by line ministries and related departments) to the Cabinet. Other responsibilities include:

- setting rules and conditions for prescribing energy prices in accordance with national energy policies and national energy management and development plans;
- monitoring, supervising, **co-ordinating, supporting and expediting the operations of all committees with authority and duties related to energy, including government agencies, state enterprises and the private sector**; ensuring that operations are in accordance with national energy policies and national energy management and development plans;
- evaluating the implementation of national energy policies and national energy management and development plans; and
- performing other functions as assigned by the Prime Minister or the Cabinet.²⁷

Importantly, NEPC includes representatives from across ministries (including the MoI), and with the mandate to create and supervise sub-committees, may potentially be considered as the high-level political body to promote RE industrial development.

Ministry of Energy (MoEN)

MoEN is directly responsible for managing the energy sector in Thailand, including granting energy operating licenses and issuing energy pricing regulations. The responsibility of MoEN also covers conventional fuel, RE, and energy efficiency in Thailand.

Department of Alternative Energy Development and Efficiency (DEDE) under MoEN

In relation to RE, DEDE is responsible for planning the AEDP together with the Energy Policy and Planning Office (EPPO), setting RE targets, conducting R&D on RE technologies and studying the RE potential of different geographic areas. It operates the Bureau of Alternative Energy Development and Bureau of Solar Energy Development and provides operating permits to RE projects in line with the 'Energy Development and Promotion Act 1992'.

Energy Policy and Planning Office (EPPO) under MoEN

The role of EPPO is to co-convene plans from each department and produce development plans for every energy type. Thus, EPPO is responsible for power sector planning the PDP together with the EGAT and DEDE and AEDP with DEDE.

Energy Regulatory Commission (ERC) under MoEN

The ERC is the power sector regulator in Thailand. It issues regulations, rules, announcements and criteria, procedures and conditions to regulate various issues in the energy industry. Among its responsibilities are regulating electricity tariffs, issuing licenses for energy projects (including RE), issuing power procurement standards and overall protecting consumers from any negative impacts from the power sector. The ERC is responsible for giving operating permits to RE projects in line with the 'Energy Business Act 2007'. While the ERC has been positioned as an independent regulator, MoEN retains budgetary control over the entity and is responsible for nominating the ERC's commissioners.

²⁷ More information on NEPC can be found [here](#). The NEPC's members include the Prime Minister as Chairperson, a Deputy Prime Minister designated by the Prime Minister as Vice-Chairperson, the ministers for Energy, Transport, Interior, Defense, Foreign Affairs, Finance, Commerce, Agriculture and Forestry, Industry, Natural Resources and Environment, Science and Technology (Ministry of Higher Education, Science, Research and Innovation (MHESI) since May 2019), Secretaries-General of various governmental boards, and Director General of EPPO as the Director and Secretary of the Council.

Ministry of Industry (Mol)

Mol has direct responsibility for the industrial sector, which is the country's largest energy consumer. The utilisation of RE sources is important for Thai industries in their efforts to reduce their dependence on traditional (mostly imported) energy sources. The Mol, in cooperation with the DEDE, is tasked with enforcing the 'Energy Conservation Act' in factories.

Department of Industrial Promotion (DIP) under Mol

The role of the DIP is to support industrial development during the middle stage of the supply chain process, i.e., cost reduction, product standards, lean production, product design and new technology development (e.g. automation). However, RE industrial development is not included in their plan yet.

Department of Industrial Works (DIW) under Mol

In addition, the DIW, under the Mol, is authorised to issue the license for factory operation (*Ror.Ngo.4 Permit*) on electricity generation for various power plants, including: (1) those that only sell to the grid; (2) hybrid models with in-plant utilities that also sell to the grid; and (3) in-plant utilities only. The power plants are required to obtain this permit before starting construction or modifications.

Office of Industrial Economics (OIE) under Mol

Under the Mol, the OIE's mission is to "prepare, integrate and drive industrial development policies, plans and strategies towards sustainable growth". The Bureau of Macro Industrial Policy under the OIE was responsible for drafting the 20-Year National Industrial Development Master Plan (2012-2031), which includes a detailed section on RE promotion in the country as well as the Thailand Industrial Development Strategy 4.0 (2017-2036).²⁸ A more in-depth look into the status of implementation of these relevant strategies and plans is advised.

Department of Primary Industries and Mines (DPIM)

The DPIM is responsible for suggesting policy formulation, strategies, action plans and measures for mining, primary and downstream industries' management to support the raw material demand of industrial and related sectors. Moreover, its mandate includes encouraging and facilitating raw material developments in both quality improvement and value-added, in which R&D, technical services and related information are also provided to support the mining, primary and downstream industries' requisition.

Office of The Cane and Sugar Board (OCSB) under Mol

The OCSB is responsible for studying and conducting environmental impact assessment reports for by-product usage from sugarcane, such as in a biomass power plant.

Ministry of Commerce (MoC)

The MoC's responsibility is to monitor and control the prices of agricultural products and incomes of agriculturists, safeguard the rights of consumers under the legal framework of the MOC, promote and develop businesses related to goods and services and protect intellectual properties.

Board of Investment (BoI)

The BoI under the mandate of the Prime Minister's Office (PMO) offers a wide range of tax and non-tax incentives for projects that meet national development objectives. BOI's investment promotion policy is to promote sustainable development to enhance the country's competitiveness in science and technology, encourage improvements in manufacturing quality and reduce environmental impacts.

The target groups are the eco-friendly, RE and high-tech industries. Tax-based incentives include the exemption or reduction of import duties on machinery and raw materials and corporate income

²⁸ The Thailand Industrial Development Strategy 4.0 (2017-2036) can be found only in the Thai language [here](#).

tax exemptions of up to eight years. Non-tax incentives include the permission to bring in expatriates, own land and take or remit foreign currency abroad. Recognising the important role that alternative energy can play in Thailand's socioeconomic development, the BOI offers attractive incentives to alternative energy projects. The production of electricity or steam from waste or refuse-derived fuel has been classified as an activity of special importance and benefit to the country. As such, projects involving this activity will be granted eight-year corporate income tax exemptions without being subject to a corporate income tax exemption cap, as well as exemptions for import duties on machinery and non-tax incentives.

RE power plants need to apply for BOI approval²⁹ before obtaining import duty and income tax exemptions. A higher number of power plants will apply for such tax privileges during the opening of the bidding round from EGAT and DEDE. Large machinery and some highly-specific equipment that cannot be produced within Thailand and needs to be imported will be exempted from import duties. Currently, the BOI supports the use of energy in power plants that is sourced from solar, wind, biomass, biogas and waste-to-energy projects, which indirectly aligns with the PDP plan to purchase electricity produced from renewable sources. Some imported machinery for each renewable type includes:

- **solar:** inverters, solar cells;
- **wind:** wind turbines (only specific sizes will be exempted); and
- **biomass:** generators, boilers.³⁰

In addition to being exempt from import duties, projects approved by the BOI will also be exempt from corporate income tax for eight years with a cap on the total investment amount (including investment in machinery purchased within the country). Currently, solar projects represent the highest number of RE projects registered with the BOI, while biomass projects have the highest registered capacity.

Ministry of Science and Technology (MoST)

As of 09 May 2019, the Ministry of Science and Technology has been dissolved, replaced by a the newly established **Ministry of Higher Education, Science, Research and Innovation (MHESI)**. Policy and planning under the newly established MHESI (which merges the former MoST and Office of High Education Commission) is mandated to Office of The National Higher Education, Science, Research and Innovation Policy Council (STI).

Under MoST, there were two agencies which may be relevant to RE industry development: (1) the National Science Technology and Innovation Policy Office (STI) that had prepared a Science, Technology, and Innovation Development Plan and Policy (2012-2021) which referred to the challenges identified in solar and wind technologies, noting that biomass has been perceived as the most achievable target due to its abundance in supply; and (2) the National Science and Technology Development Agency (NSTDA; see NSTDA's responsibility in the next section).

National Science and Technology Development Agency (NSTDA)

NSTDA, is a public research agency and now under the newly formed MHESI. Within NSTDA there is a department called The National Metal and Materials Technology Center, which works extensively on various technologies including ESS and RE technologies. Some of their relevant research in RE technologies includes:

- research on different wind turbine technologies that will work with low-speed wind; and
- research on biomass from agricultural residues or agri-industrial residues to be used as fuel and energy, including heat and electricity generation from biomass.

The Federation of Thai Industries

- The Federation of Thai Industries represents the private sector across industries in Thailand. A Renewable Energy Club comprising private industry players for RE has been

²⁹ More information on BOI criteria for project approval can be found [here](#).

³⁰ Market intelligence from BOI interview.

established under the framework of the Federation. The Federation of Thai Industries may participate in the formulation of policy and the government's plan for national economic development and on matters related to the country's industries; in various activities contributing to the country's industrial economic development to offer recommendations for solving industrial problems related to the economy; and in the formulation of the country's industrial standards to ensure compliance potential.

Initial assessment

Based on interviews with MoEN representatives, there is no working group across ministries for the promotion of RE technology manufacturing and services across the value chain, but there is an ongoing discussion between the MoEN and other relevant ministries, such as the MoI, on establishing such a group. The extent of this engagement remains unclear and requires clarification.

As a suggestion worth perhaps exploring, the issue of local industrial development for RE could potentially be included in the NEPC agenda, as NEPC already incorporates high-level representatives of key line ministries like MoEN, MoI and MHESI. It may be worth exploring the role the NEPC may play in, for example, establishing an inter-ministerial working group on industrial development to support localisation for RE in the country. This and other recommendations on the institutional set-up and policies/regulations needed for RE industrial development could be explored in more detail in the in-depth study (see Annex I for its tentative scope).

5 Strategy and policy framework: high-level and those specifically relevant to RE development in Thailand

Industrial development in Thailand is driven by various philosophies, strategies and policies. The following sections provide an overview of those most relevant to RE development.

Sufficiency Economy Philosophy

The Sufficiency Economy Philosophy is based on fundamental principles embedded in Thai culture. It is a method of development based on “moderation, prudence and “self-immunity,”³¹ one that uses knowledge and virtue as guidelines for living.” Significantly, a combination of intelligence and perseverance will enable one to live their life with real happiness. The philosophy consists of three pillars: moderation, reasonableness and resilience. Decisions and activities must be carried out at a sufficient level depending on two conditions: knowledge and virtue. Employing the Sufficiency Economy Philosophy can lead to greater economic stability. Fundamentally, Thailand has been an agricultural country; therefore, the country’s economy should be oriented towards agro-economy and food stability to ensure, to a certain degree, a stable economic system. This is an economic system that can help lessen economic risks and instability in the long run. The Sufficiency Economy Philosophy is not limited to the agricultural or rural sectors and can be applied to all levels, branches and sectors of the economy, including even the financial, real estate, international trade and investment sectors, by applying similar principles that emphasise moderation in performance and reasonableness³² and creating immunity for oneself and society.

In the energy sector, King Rama IX has been designated as the ‘Father of Thailand’s Energy Development’. His initiatives relating to water management and the construction of dams for hydropower generation all over the country developed what are now the most important electricity sources for Thailand. RE innovation that he helped spur includes gasohol from sugar and bio-diesel from palm oil (patent registered), electricity generation from waste (Chaipattana Foundation), electricity generation from cattle manure (Chitlada project), hybrid solar and wind for electricity generation (Chitlada project) and a hybrid solar-wind-hydropower project (Chang-Hua-Mun project). The Royal Chitlada project is a demonstration project of the New Theory of self-sufficient agriculture which aims to maximise the use of agricultural by-products and waste, such as rice husks, to produce effective fuel sources and electricity using simple technology that farmers can adopt and adapt.

King Rama IX laid a solid foundation for the country’s energy development by actively encouraging the use of alternative energy. He pioneered the philosophy still upheld as a principle for the management of the country’s natural resources by moving from an exclusively centralised energy management and planning system to one that encouraged people’s participation at the local community levels. The government also encouraged communities and industries to produce electricity themselves using available RE and enabled them to sell excess energy produced to the government at a higher price. This energy management philosophy decreases energy imports by producing energy from abundant, domestic resources, encourages the efficient use of self-produced energy and helps to drive the search for new types of RE resources for each area to reduce the risk of energy shortages and the depletion of traditional energy sources.

20-year National Strategic Plan (2017-2036)³³ and the Twelfth National Economic and Social Development Plan (2017-2021)³⁴

The Twelfth Plan constitutes the first five years of the implementation of the 20-year National Strategy (2017-2036). The five-year strategy document covers various aspects of development

³¹ Self-immunity refers to the ability of people to protect themselves against any external turbulence and to cope with events that are unpredictable or uncontrollable. More information [here](#).

³² Reasonableness is a term applied by the Thai government to indicate an approach that “requires that the choices we make be justifiable by using academic approaches, legal principle, moral values or social norms.”

³³ The 20-year National Strategic Plan can be found only in Thai [here](#).

³⁴ The Twelfth National Economic and Social Development Plan can be found [here](#).

in Thailand including issues related to the country's overall economy, agriculture, health, cities, social equality/inequality, infrastructure and technology. The 10 strategies that compose the Twelfth Plan address RE from multiple angles – these include:

- R&D in science and technology;
- developing systems of agricultural and food product standards that are internationally accepted;
- prescribing measures and mechanisms to support GHG reduction in all sectors (by reducing fossil fuel generation in the power sector and increasing RE);
- building the capacity of the workforce to excel with various forms of RE; and
- enhancing RE production in the Central and Lower Northeastern provincial clusters.

National Industrial Development Master Plan (2012-2031)³⁵

It is important to note that the National Industrial Development Master Plan (2012-2031) has been replaced by the Thailand Industrial Development Strategy 4.0 (2017-2036) however, it is presented here to better understand the trajectory of the government's strategy regarding industrial development. The National Industrial Development Master Plan has an overall objective of helping Thai entrepreneurs utilise human capital to create innovative and value-added products. It is also tasked with further enhancing the capacity of Thai entrepreneurs to carry out R&D for their products. For the RE industry, the Plan focuses on challenges to the sector, including:

- the misalignment of policy for each technology, the lack of one-stop service and a weak Monitoring, Reporting and Verification system. These challenges are, at least in part, a result of insufficient coordination between the focal point agencies for each technology;
- the application of agricultural residues for energy generation;
- an abundance of RE developers – indicating an oversupply compared to the existing infrastructure (sector not specified);
- investment in RE from the public sector failing to lead to commercialisation;
- obtaining access to banks and financial institutions, which is difficult as these entities do not understand RE projects;
- transportation of biomass to the end-user, which is often difficult and costly since biomass sources are typically far away from power plants; and
- research institutes, which must update their academic and teaching method, especially their curriculum relating to RE. The research in academic institutes should support the development of RE technology and help pave the way to finally commercialise it. There is also currently a lack of patents for researchers, thus discouraging them from conducting research.

Thailand 4.0 (Industry 4.0): the 'new economic model' for Thailand

Thailand 4.0 is an economic model that aims to address several economic challenges that the country faces as a result of past economic development models. The past models placed an emphasis on agriculture (Thailand 1.0), light industry (Thailand 2.0) and advanced industry (Thailand 3.0). These challenges include a middle-income trap, an inequality trap and an imbalance trap.

Thailand 4.0 is a growth model that aims to transform Thailand into a high-income country/economy with a focus on knowledge, innovation and value addition. In the next phase, the growth of the power sector will be aligned with the transition to a low-carbon economy while ensuring energy security, affordability and sustainability. The Thailand 4.0 development plan is focused on 10 targeted industries and developing existing industrial sectors by adding value through advanced technologies for five industries: next-generation automotive; smart electronics; high-income tourism and medical tourism; efficient agriculture and biotechnology; and food

³⁵ The National Industrial Development Master Plan (2555-2574) can be found [here](#).

innovation. The government has targeted the five additional ‘growth engines’ (i.e. the New S-curve) to accelerate Thailand’s future growth: automation and robotics, aerospace, bioenergy and biochemicals, digital and medical and healthcare.

- **The Thailand 4.0** (Industry 4.0 and Energy 4.0) policy will encourage investment for the domestic production of RE components and advances in technology research and innovations.
- **The Industry 4.0**³⁶ is being driven by several core factors. The first is hyper-connected products or the IoT. The second driver is supercomputing or ‘Big Data’, and smart technology, encompassing robotics, artificial intelligence, simulation, augmented reality and 3D printing, comprises the third driver. Cybersecurity and cloud computing make up the remaining two. The Industry 4.0 policy has highlighted the bioenergy industry; however, the policy does not clearly call for the use of other RE technologies such as wind and solar.
- **The Energy 4.0** strategy is composed of four major energy areas including the promotion of electric vehicles such as e-tuk-tuks, ESSs, hybrid power generation from renewable sources and ‘smart city’ and ‘smart grid’ advanced technologies.

The direction for industrial development in Thailand is towards an industry that is knowledge-based, innovative and sustainable. This Master Plan is the platform for Thailand 4.0, Energy 4.0 and Industry 4.0 policies to provide the direction for green growth in the national economy by considering the lost advantage instead of the cost advantage.

Thailand Industrial Development Strategy 4.0 (2017-2036)³⁸

Current promotion of industrial development is to be guided through the principles of ‘Green Growth’ as one of the strategies presented in the Industry Development Strategy 4.0. In the context of RE, this means supporting businesses and developers in using environmentally friendly technologies, recycling technologies and RE or alternative energy to support an environmentally-friendly development strategy while simultaneously building capacity and providing guidance to enhance sustainability in the industrial sector.

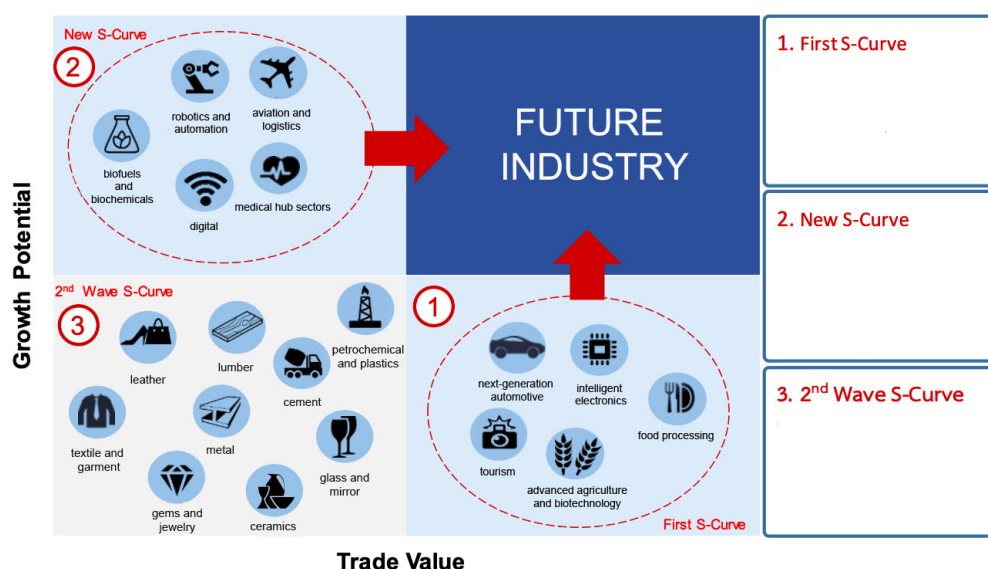


Figure 3: Thailand Industry 4.0 mapping

(Source: Translated from Thailand Industrial Development Strategy 4.0)

³⁶ ‘Thailand 4.0 and the Future of Work in the Kingdom’ from [here](#).

³⁷ More information on Industry 4.0 can be found [here](#).

³⁸ The Thailand Industrial Development Strategy 4.0 can be found in Thai [here](#).

The whole strategy refers to RE in the context of green development (more specifically in the context of alternative energy), among the various technologies, only **biofuels** are included the 10 targeted industries featured in the strategy (see Figure 3).

First and 'New' S-Curve industries

Thailand is undergoing an economic transformation and moving towards becoming a valued-based and innovation-driven economy under the Thailand 4.0 policy. The Thailand 4.0 policy has highlighted opportunities and investment trends in **10 targeted industries**, which can be divided into two broad categories:

- **First 5 S-Curve industries**³⁹: next-generation automotive, intelligent electronics, advanced agriculture and biotechnology, food processing and tourism; and
- **5 New S-Curve industries**⁴⁰: the digital, robotics and automation, aviation and logistics, **biofuels** and biochemical and medical hub sectors.

The overall goal of introducing the **5 New S-curve industries** is to establish these industries to enhance Thailand's competitive advantage through advanced digital technology transformation. The target areas are robotic and automation in smart manufacturing, internet of things (IoT) and blockchain in aviation and logistics, and biochemicals and bioindustry from agricultural products and medical technology.

Eastern Economic Corridor (EEC) Development Plan⁴¹

The EEC Development Plan under Thailand 4.0 aims to revitalise and enhance the well-known Eastern Seaboard Development Program that has enabled Thailand to become a powerhouse in industrial production for over 30 years. Under this initiative, the Eastern Economic Corridor Office of Thailand has been assigned the task of driving the country's investment in innovation and advanced technology for the future. The EEC Development Plan will lead to significant development and transformation of Thailand's investment in physical and social infrastructure in the area. The EEC project will be focused initially on the three eastern provinces of Chachoengsao, Chonburi and Rayong. The EEC Policy Committee is the primary Royal Thai Government collective force chaired by the Prime Minister of Thailand. For instance, solar panel manufacturers have established their factories in the EEC zone. It may be worth exploring how this project can support the localisation of other RE technology components

The theme of EEC is targeting the new-S curve industries for the Mini MOC⁴², business solution centre and one-stop service. The benefits from investment in EEC (top-up from BOI) are 50% of corporate income tax reduction for five years and unlocking rules and regulations for investment through the integration of tools from all relevant agencies at One Stop Service centres within the EEC's area.

The target industries applicable to EEC also include the electric and electronic industry. The investment approved by EEC for the electric and electronic industry was ranked third out of the seven industries under EEC's scope. This enhances the opportunity for RE technology to use more locally made equipment, which in turn reduces the investment and maintenance cost of power plants.

Science, Technology, and Innovation Development Plan and Policy (2012-2021)

The **National Science Technology and Innovation Policy Office (STI)** is responsible for the Science, Technology and Innovation Development Plan and Policy (2012-2021). It includes increasing the RE share to 20-25% and reducing waste and pollution by 5% per year. Moreover, it also highlights the readiness of Thailand's supply of agricultural residues to be used for biomass energy production. Both solar and wind technology face challenges: solar technology still needs

³⁹ More information on S-Curve industries can be found [here](#).

⁴⁰ More information on the New S-Curve can be found [here](#).

⁴¹ More information on EEC can be found [here](#) and [here](#).

⁴² Mini MOC is the new policy from Ministry of Commerce to support and drive local investment (clustering or provincial level).

to be imported while wind technology needs to be capable of being used with low wind speed. However, because areas with good wind geography are often protected, wind technology is still not widely used in Thailand. The actual implementation status of the plan still requires further study.

6 Bibliography

Asia IoT (2018). Thailand 4.0: Opportunities in the S-Curve 10 Targeted Industries. Available [here](#).

Bangkok Post (2019). K-Research predicts Thailand headed for EV battery leadership. Available [here](#).

Board of Investment (2019). Investment promotion in EEC. Available [here](#).

Department of Renewable Energy Development and Energy Efficiency (2015). Alternative Energy Development Plan: AEDP 2015. Available [here](#).

Department of Renewable Energy Development and Energy Efficiency (2017). Thailand Alternative Energy Situation. Found [here](#).

Department of Renewable Energy Development and Energy Efficiency and King Mongkut's University of Technology Thonburi (2015). Thailand PV Status Report, 2014-2015. Available [here](#).

Policy and Planning Office (2019). NDC Action Plan for Energy Sector (draft in Thai). *Unpublished*.

International Energy Agency (2017). Southeast Asia Energy Outlook 2017. Available [here](#).

International Energy Agency (2018). Partner Country Series – Thailand Renewable Grid Integration Assessment. Available [here](#).

International Renewable Energy Agency (2017). Renewable Energy Benefits Leveraging Local Capacity for Solar PV. Available [here](#).

International Renewable Energy Agency (2017). Renewable Energy Outlook: Thailand. Available [here](#).

International Renewable Energy Agency and European Investment Bank (2015). Evaluating Renewable Energy Manufacturing Potential in the Mediterranean Partner Countries. Available [here](#).

Ministry of Industry (2016). Thailand Industrial Development Strategy 4.0 (2017-2036). Available [here](#).

National Science Technology and Innovation Policy Office (2012). Science, Technology, and Innovation Development Plan and Policy, the first plan (2012-2021). Available [here](#).

Office of Natural Resources and Environmental Policy and Planning (2017). Thailand's Nationally Determined Contribution Roadmap on Mitigation 2021 -2030). Available [here](#).

Office of the National Economic and Social Development Board (2017). Twelfth National Economic and Social Development Plan (2017-2021). Available [here](#).

Pugnatorius (2018). Biomass facilities in Thailand. Available [here](#).

Will Baxter (2017). Thailand 4.0 and the Future of Work in the Kingdom. Available [here](#).

Wind Power Monthly (2018). Towers produced from Thailand mobile site. Available [here](#).

Annex I

Leveraging local capacity for RE: potential topics for further study

Little has been written regarding the local manufacturing potential within the RE sector in Southeast Asia, and Thailand in particular. This scoping study has provided initial insights into the current status of RE industrial development in Thailand, existing policy framework, key institutions and market players, but a detailed assessment of the market potential and recommendations on future actions were beyond its scope.

A more in-depth study, supported by concrete numbers, could help provide a strong basis for decision-making, raising awareness and improving the understanding among policymakers of the potential benefits that RE promotion could bring for industrial (and socioeconomic) development in the country. This could be further bolstered with best-practice examples from successful cases in other countries. In addition, the study could recommend areas and mechanisms for cooperation between agencies, provide recommendations for how local industrial manufacturing can be promoted in Thailand and suggest an implementation plan.

Such a study may include the following activities:

- reviewing best practices and international experience on policy measures and interventions that are needed to increase local content and boosting the industrial capability of domestic firms within the RE sector (including industrial upgrading programmes, supplier development programmes and the development of industrial clusters and investment for promotion schemes);
- analysing the current status of Thailand's market for RE industrial development:
 - assessing the current status of the country's industrial development;
 - identifying the most promising segments that could benefit from RE development and support RE promotion in the country, while taking into consideration international best practices;
 - assessing perspectives for local RE manufacturing;
 - identifying current gaps (political, financial, capacity-related, etc.);
- developing a roadmap and an action plan to close current gaps; and
- providing recommendations on institutional arrangements to leverage local capacity for RE industries.

Annex II

List of consulted stakeholders

Public sector institutions
MoEN, Office of the Minister
EPPO, MoEN
DEDE, MoEN
OIE, Mol
DIP, Mol
NSTDA
STI, MOST
BOI, PMO

