Prioritized challenges of energy transition in Thailand's power sector

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Abstract

For years, there has been growing interest in the energy transition, the transformation of the energy sector from fossil based to zero-carbon of energy use and generation. Digitization, decarbonization and electrification are the three key trends driving the energy transition around the world. The concept of energy transition has been widely adopted by national governments, international and regional organizations. In Thailand, energy transition means that the Thai energy sector is moving to a cleaner system with a higher share of renewable energy and energy efficiency. However, several major challenges must be overcome to achieve the energy transition. In this paper, we identified the challenges of energy transition in the context of the Thai power sector. The challenge issues in energy transition of power sector in Thailand were collected, and categorized into 9 main groups, namely investment, market entry, supply chain, grid integration, social acceptance, fossil industry, capabilities, political will and joint visioning, and actors and institutions. Then questionnaires were be conducted to identify the level of likelihood of these issues being solved and high impact on energy transition for power sector in Thailand. The results of this study present four major groups of prioritized energy transition challenges that should be addressed: power sector investment, entrance, supply chain, and grid integration challenges.

Keywords: Energy transition, challenges, power sector

Introduction

The need to address climate change is the key driver for shifting from a fossil-fuel-dominated energy industry to one focused on renewable energy sources. Currently, the energy sector is the leading source of greenhouse gas emissions (GHGs). In 2021, the energy sector's greenhouse gas emissions from energy combustion and industrial processes accounted for about 89 percent of all emissions (IEA, 2021). To achieve the Paris Agreement's targets, GHG emissions from the sector must be reduced rapidly and eliminated by mid-century.

Emerging energy-sector transitions in many countries are being supported by fundamental technological advancements and rapid cost reductions. (UN, 2021) The expansion of renewable energy installations pushed by the market and the emerge on energy efficiency, including in end-use sectors like industry, agriculture, buildings, appliances, and transportation, supports this process. Digital technology solutions open up new possibilities for integrating supply and demand, accelerating the transition to electrification of more end users, including elements of the transportation sector.

Thailand is moving toward carbon neutrality targets in line with the Conference of Parties (COP 26) commitment to limit temperature rise to 1.5 degrees Celsius. Thailand has set a goal of reaching carbon neutrality by 2050 and net-zero carbon emissions by 2065 as part of its long-term climate action plans. To meet the climate target, the Thai government has developed The National Energy Plan, or NEP (2018-2037), is a long-term energy plan that provides strategic energy directions and guidelines by combining top-down and bottom-up methodologies, with the goal of reaching 50% renewable energy share of all energy types by 2050. (EPPO, 2021). Thailand needs immediate action to reduce carbon dioxide emissions from several sectors such as transportation, energy, industry, and households. Solar power generation and electric vehicle (EV) adoption are primarily encouraged in order to boost clean energy supply and reduce emissions.

However, achieving the energy transition will face a number of significant challenges. This includes technological limitations, financial investments, and geopolitical concerns. To meet these challenges, a major transition in the energy sector is required in all countries, including Thailand.

Therefore, this study aims to investigate the prioritized challenges in energy transition of power sector in Thailand with a high likelihood of being solved and a high impact on Thailand's energy transition. The results can support policymakers to identify the high impact issues of energy transition that should be tackled first. In addition, recommendations to deal with these key issues are presented.

Literature Review

The concept of energy transition and its global context were explored in this study. According to the International Renewable Energy Agency, the energy transition is "a pathway for transformation of the global energy economy from fossil-based to zero-carbon. Energy transitions are complex processes with major uncertainties and ambiguities in management and governance, according to the World Economic Forum (WEF), which describes energy systems as being extremely complex and at the core of each country's economy.

Decentralization, electrification, and digitization are critical components of the energy transition. The cost of distributed energy resources such as distributed solar PV, energy storage, demand flexibility, electric cars, and energy efficiency is driving decentralization. Electrification in the transportation and industrial sectors remains an essential step toward a low-carbon future. The power grid will need to be modernized with smart metering, smart sensors, automation, and other digital network technologies in order to integrate and manage these distributed energy resources as shown Fig 1.

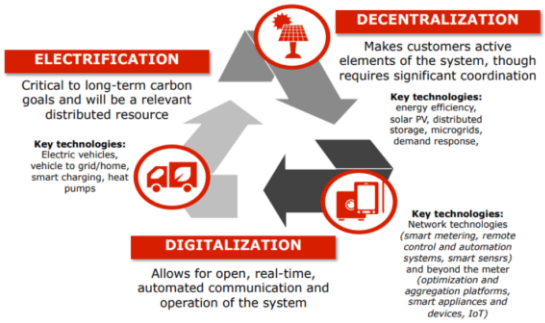

Figure 1: Three key enablers of energy transformation

The Thai power sector's energy transition aims to be shifted to a cleaner generation system and efficient electricity consumption with a higher share of renewables and higher improvement of energy efficiency (ITA, 2022). The energy transition will be driven by disruptive technologies such as energy storage systems (ESS), electric vehicles (EV), monitoring and control, political will such as high-level signals, government ownership, consistency of policies and strategies, and joint visioning such as cross sector alignment, legitimacy, and stakeholder coordination; however, it must also be socially inclusive in order to achieve long-term liberalization with consumer benefits and a fair and appropriate market structure for stakeholders.

Thailand's electricity sector is regulated by an "Enhanced Single Buyer Model," with natural gas dominating current generation. Three major state-owned utilities dominate the electricity market. The Energy Generating Authority of Thailand (EGAT) is in charge of electricity generation, transmission, and wholesale. The Metropolitan Electricity Authority (MEA) and the Province Electricity Authority (PEA) are both distribution utility enterprises, with the MEA in charge of the metropolitan area (Bangkok, Nonthaburi, and Samutprakarn) and the PEA in charge of the provincial area. Thailand's regulated power structure has resulted in excess reserve capacity, an inflexible power system, and fossil fuel infrastructure lock-in. The government prioritizes energy system cost, dependability, and supply security.

Framework and Methodology

We conducted a literature review and energy transition comprised of nine challenge groups, adapted the World Economic Forum (WEF) framework (WEF 2021), and collected nine challenge groups with thirty-seven subgroups from country teams to address energy transition challenges in Thailand's electricity industry as follows;

- Investment challenge include four potential challenges: power market risk, financial risk, access to capital, and regulatory risk.
- Entry challenge include four potential challenges: permits risk, grid access, market and regulatory barriers.
- Supply chain challenge include three potential challenges: hardware availability risk, skilled staff, developer risk.
- Grid integration challenge includes six potential challenges: load balancing and reserve, monitoring and control, stability related challenges, network congestion, reduced use of dispatchable plants, system balance and negative residual load.
- Social acceptance challenge includes three potential changes: societal engagement in policymaking, societal engagement on energy issues, customer engagement and influence.
- Fossil industry challenge includes four potential challenges: geopolitics and perception of energy security on fossil fuel, incumbent’s dominance to fossil fuels, public finance dependence on fossil fuels, lock-in fossil fuel infrastructure developments
- Capacity challenge includes three potential challenges: stakeholders’ knowledge gap, lack

of knowledge infrastructure, barriers in entrepreneurship.

- Political will and joint visioning challenge include four potential challenges: high-level signal on clean energy, cross-sector alignment, government ownership of ET process, consistency of policies and strategies affecting ET.
- Actors and institutional challenge include five potential challenges: legitimacy, institutional inertia, coordination of actors and institutions within the power sector, vertical and horizontal coordination of policy action, transparency.

We conducted a survey with academia from the energy sector to identify prioritized challenges in Thailand's power sector for energy transition by CASE Thailand on October 29, 2021. In the survey, the respondents were asked to provide a rating to each sub-challenge based on its likelihood of being solved and its impact on the ET and other challenges.

Results and Discussion

Our survey of 14 academics in the energy sector revealed fifteen prioritized challenges have a high likelihood of being solved and have a high impact in regard to Thailand's overall energy transition challenges as shown in Fig 2:

We classified these challenges according to nine challenge groups, which are categorized into four groups with fifteen subgroups of prioritized challenges as follow:

Investment challenge: access to loans and market design were identified as the prioritized challenges for renewable energy investment in Thailand. Since Thailand electricity market structure is enhanced single buyer. The majority of large RE projects are dependent on the government's power purchasing policies, in which the market favors RE-generated electricity and provides easy access to funds. As the trend towards smaller and community-based RE projects for self-consumption and distribution (i.e., prosumers) increases, access to funding for such projects is now more difficult due to the nature of their revenue stream. This may necessitate the development of innovative financial mechanisms for small and community-based RE projects. The regulatory tool must be amended to allow prosumers or third parties to access the grid via an open TPA regime and allow various types of market to enhance the RE investment in Thailand.

Entry challenge: This challenge has a large number of prioritized challenges that are likely to be solved and have a major impact on Thailand's overall energy transition challenges. Unpredictability of key processes, bureaucracy as permits risk, connection costs, non-friendly DER grid codes, and synergized grid codes as grid-access barriers, and market size as a market barrier were identified as the prioritized challenges with a high likelihood of being solved and a high impact of RE entry challenge in relation to energy transition in Thailand's power sector.

Permit risks included the unpredictability of vital processes (permits) and bureaucracy as a result of the complex permit and licensing systems. Several entities must be contacted by the project developers. To shorten the permission process and save project developers time and money, a one-stop service should be formed.

In addition, connection costs, non-friendly DER grid codes, and synergized grid codes as grid-access barrier were identified as the major challenges for RE entry in the Thai electricity market. Power plants must pay for the connection cost, which includes technical evaluation, grid connection cost, including transformer costs, and transmission line if the connect point does not support that power plant. Concerning grid codes, Thailand's power system has numerous grid codes that have been defined differently by transmission and distribution utilities, EGAT, MEA and PEA. The current grid codes must be improved and synergized to accommodate the growing number of VRE, including EV, ESS, demand side (energy management, demand response), and to provide supply security while discouraging investment in the energy sector.

Meanwhile, distribution utilities are attempting to reduce DER integration costs by limiting DER penetration because the distribution network was not designed to accommodate a power source. This could be related to how utilities' investments and revenues are governed.

Another challenge associated with RE entry in Thailand is market size as market barrier. As previously said, the current structure of the electricity market is single buyer, and the third-party access (TPA) is not yet open. So, the market size of RE is limited. Under the structure of enhanced single-buyer model, private companies or prosumers are not allowed to trade electricity among each other at the distribution grid. Under existing regulations, emerging business models such as peer-to-peer (P2P) energy trading cannot be fully implemented (Junlakarn et al., 2022). Major renewable energy plants have few

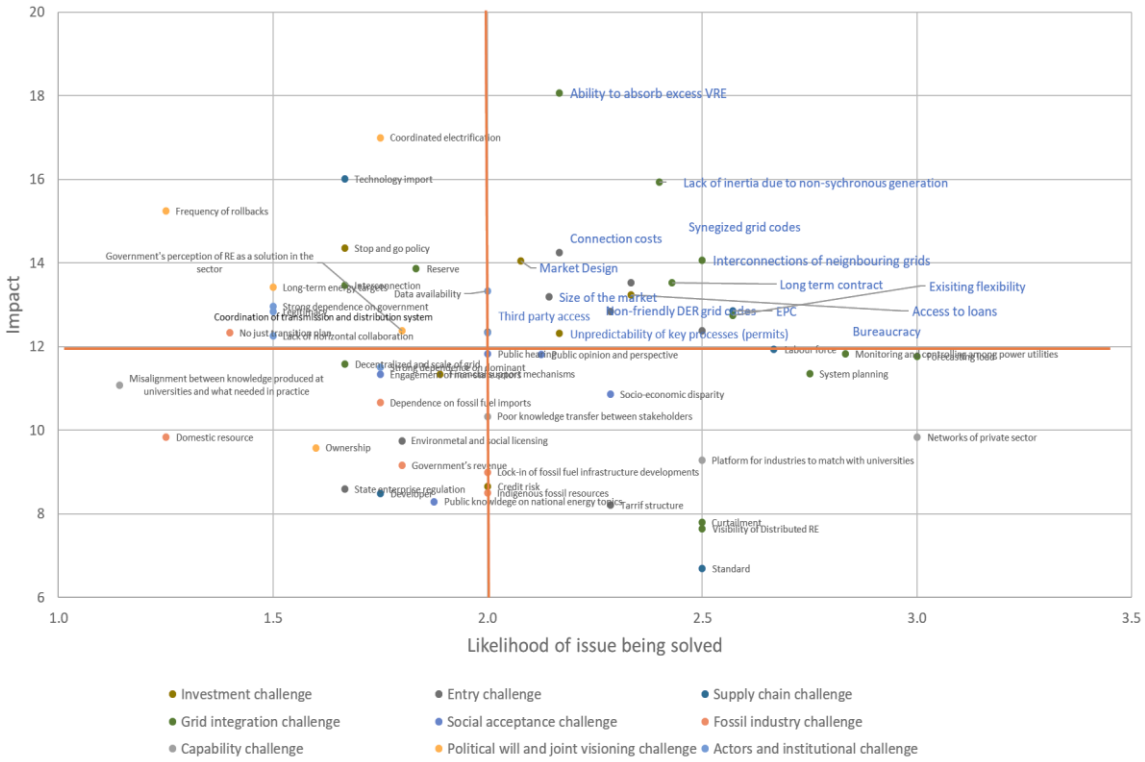

Figure 2: The challenges with high likelihood of being solved and high impact to energy sector relative to the average overall challenges (orange lines)

opportunities to sell electricity with the national grid.

Supply chain challenge: EPC as a developer risk was identified as the most important challenge in the supply chain challenge. Despite the fact that most EPC for DPV installations is reliable, there should be a monitoring standard/platform for residential DPV installations due to consumers' inaccurate information. A monitoring process should be designed to follow the progress of the project.

Grid integration challenge: This challenge has a large number of prioritized challenges that are likely to be solved and have a major impact on Thailand's overall energy transition challenges. Existing flexibility as load balancing and reserve, lack of inertia to non-synchronous generation as stability related challenge, interconnection as network congestion, long-term contract as reduced use of dispatchable plants, and ability to absorb VRE and electronification of end-use sector as system balance and negative residual load were identified with high likelihood of being solved and high impact on RE integration for power system in Thailand.

Concerning load balancing and reserve, existing flexibility was identified as prioritized challenge for RE integration to the grid. In addition, lack of inertia to non-synchronous generation was identified as a priority challenge to be overcome in order to stabilize grid integration to promote RE and prosumer entry. Considering the current target of RE, the system has no problems of congestion. However, the increase of RE or prosumers can cause this problem, which network congestion was identified as challenges with high likelihood of being solved and high impact to power sector. This challenge is related to interconnection, which must be assessed in order to plan to support RE and prosumers in various places for future transmission line extension.

For the issue of reduced use of dispatchable plants, increasing the share of VRE and prosumers leads to a decrease in variable power generation from conventional power plants. In addition, most RE are viewed as uncertain generation, thus they are prioritized for grid integration. However, the majority of power purchase agreements (IPPs and EGAT) are long-term contracts usually 20 years contract, with EGAT required to pay even if the system does not consume electricity from such power plants (called "must take"). Some power plants are also regarded as "must-run" in order to maximize system efficiency.

Furthermore, the issue of ability to absorb excess VRE and electrification of end-use sector

as system balance and negative residual load were identified as priority in Thailand. Although the system's ability to absorb excess VRE is now low, it does not have the capability to absorb excessive surplus VRE. This leads to the concept of electrifying the end-use sector by promoting EVs and batteries as future potential solutions.

Conclusion

Investment, entry, supply chain, and grid integration challenges are the most identified as prioritized challenges with high likelihood of being solved and high impact on energy transition to power sector in Thailand. The current Thailand electricity market structure, which is based on a single buyer, limits market size and access to financing. Furthermore, under this structure, private companies or prosumers are not allowed to trade electricity at the distribution grid. Emerging business models such as peer-to-peer (P2P) energy trading cannot be fully implemented under current regulations. There are few opportunities for major renewable energy projects to sell electricity to the national grid.

To encourage more renewable energy investment in Thailand, the regulatory instrument must be amended to allow prosumers or third parties to connect to the grid through an open TPA system, as well as to allow for different types of markets, new innovative business models, and market size expansion.

Additionally, the ability to absorb excess VRE must be enhanced. This promotes the concept of electrifying the end-use sector by promoting EVs and batteries as potential future solutions.

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