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Scenario Analysis of Disruptive Technology Penetration on the Energy System in Thailand

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Abstract

Since the idea of disruptive technologies has been discussed recently in the energy sector, these advanced technologies would transform the future of energy system. However, this paradigm shift might have great impacts on the countries that depend on the import of energy and technologies. To understand how the energy sector in these countries would change under this trend, Thailand was selected as a case study to analyze changes in its energy sector. In the analysis, 2 different scenarios, which are the reference (business as usual) scenario and the disruptive technology scenario, are compared. The reference scenario assumes the current Thailand energy plan or Thailand Integrated Energy Blueprint (TIEB) is continued, while the disruptive technology (DTECH) scenario is a projection of where exponential growth of potential disruptive technologies—electric vehicle (EV), energy storage system, and solar photovoltaic—are introduced to the energy sector. The results of this study show that the high penetration of disruptive technologies in DTECH scenario will decrease the greenhouse gas (GHG) emission by 37 million tCO_2eq or 8.9% compared with the TIEB scenario; such reduction is observed in the transportation sector for 7 million tCO_2eq and the power sector for 30 million tCO_2eq. Moreover, the results show that EVs require appropriated management of EV charging period; otherwise they may not provide enough benefit on energy system and GHG emission reduction. Hence, EVs should be promoted as an alternative fuel to replace the use of oil in the transportation sector in Thailand, and policy makers have to re-shape portfolio of power generation mix to avoid negative effect on additional primary energy requirement and increasing of GHG emission.

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Keywords: disruptive technolocy; scenario analysis; energy system in Thailand

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Nomenclature

BEV	Battery Electric Vehicle
DTECH	Disruptive Technology Scenario
eMC	Electric Motorcycle
ESS	Energy Storage System
EV	Electric Vehicle
GHG	Greenhouse Gas
LDV	Light Duty Vehicle
MC	Motorcycle
PHEV	Plug-in Hybrid Electric Vehicle
PV	Photovoltaic
TIEB	Thailand Integrated Energy Blueprint (Reference Scenario)

1. Introduction

Recently, there are several movements on energy issues around the world especially to the countries who depend on the energy and technology import such as Thailand. The current technologies will be disrupted by new technologies, although those advanced technologies will bring better energy consumption [1]. Ministry of Energy of Thailand is now conducting research on the future innovation which is focusing on energy-related technologies such as EV, bio-economy, smart grid management, ESS, or other renewable incentives [2].

The objective of this study is to explore the impacts of disruptive technologies in a broad view of energy demand and supply in Thailand. In the analysis, we compare 2 different scenarios between the reference or business-as-usual scenario and DTECH. The reference scenario assumes the TIEB [3], which is the current Thailand energy plan is continued, while the DTECH is a projection of where exponential growth of potential disruptive technologies— EV, ESS, and solar PV [4]-[6] —are introduced to Thai energy sector.

2. Methodology

This study deployed Long-Range Energy Alternative Planning System (LEAP), which is a scenario-based energy accounting model, to construct the reference scenario and DTECH based on the energy calculation structure as shown in Figure 1. LEAP is particularly designed for balancing energy demand and supply sides. In the demand module, final energy demand in each sector is derived by the product of key drivers and energy intensities. In the energy transformation module, the requirement of final energy is initially fulfilled with the production of existing capacities. Primary resource is withdrawal by the required feedstock during the transformation process. The entire energy system is balanced by exporting the surplus and importing the shortage energy.

In DTECH, PVs and ESSs will be included in the supply side, while EVs will be considered in the demand side. The analysis is based on the assumption that the advanced technologies are fully supported by the government. This would make the new technologies be able to compete with existing technologies. For the supply side, the increases of PVs and ESSs in the Thai energy system are based on the assumption that the GHG emission will not raise the temperature over 2 degrees Celsius [6]. For the demand side in the transportation sector, the end-use energy demand model [7] will be applied for stock turnover including the additional EV. The systematic of End-Use Energy Demand Model for the transport sector in this study is illustrated in Figure 2.