EVALUATING THE EFFECTS OF THE SOCIO-ECONOMIC, ENVIRONMENTAL, AND INSTITUTIONAL FACTORS ON SUSTAINABLE RENEWABLE ENERGY POLICY DEVELOPMENT IN THAILAND

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EVALUATING THE EFFECTS OF THE SOCIO-ECONOMIC, ENVIRONMENTAL, AND INSTITUTIONAL FACTORS ON SUSTAINABLE RENEWABLE ENERGY POLICY DEVELOPMENT IN THAILAND
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ABSTRACT

Title of Dissertation  EVALUATING THE EFFECTS OF THE SOCIO-ECONOMIC, ENVIRONMENTAL, AND INSTITUTIONAL FACTORS ON SUSTAINABLE RENEWABLE ENERGY POLICY DEVELOPMENT IN THAILAND

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The purpose of this study was to investigate the factors that challenged the renewable energy sector in Thailand. The literature reports that there were institutional bottlenecks in the renewable energy sector that included bureaucratic corruption, red tape, undefined queuing periods, and other factors that have placed a huge burden on the sustainability of the country’s renewable energy policy measures. The objectives of this study were fourfold: to investigate the context of sustainable renewable policy development from the Thai perspective, and the socio-economic, environmental, and institutional factors that influence sustainable renewable energy policy development in the Thai context.

The study used a mixed-methods design, using both qualitative and quantitative techniques as well as the use of secondary data from year 2007-2016. The samples included managers, engineers, senior government officers, and chief executive officers in ten power-producing companies in Bangkok and Ayutthaya provinces. Most of the participants and respondents were native Thais with the minimum age being twenty-four, and the maximum age being sixty years. Twenty-three participants were selected for the qualitative interviews, with four females, and nineteen males. The quantitative survey randomly selected four-hundred respondents from ten organizations. The study then developed hypotheses to test the direct effects of developing sustainable renewable energy policy using multiple regression analytic tools.

The analysis of the qualitative interview results showed that the policy measures, from the adder policies, the feed-in-tariff policies, up until the bidding policies, were challenged with corrupt practices, lack of stakeholders’ consultation, high costs of investments, political interferences, unclear policy goals, and high profit sharing...
between local government partners and private investors. The survey data results indicated that the social and institutional factors have a strong and significant causal effect on the development of sustainable renewable energy policies. On the other hand, the results of the secondary data using a ten years baseline data from year 2007 until 2016, suggested no significant effect of the environment and economic indicators on the dependent variable: sustainable renewable energy policy development. The study concluded that the institutional factors played a significant role in sustainable renewable energy policy development, and recommended good governance as the key ingredient in enabling the government to achieve the forty percent renewable energy target by 2036.
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Pasakorn Sakolsatayatorn
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CHAPTER 1

INTRODUCTION

1.1 Problem Statement

In the last four decades, many developing countries have made attempts to utilize their resources in a way that is sustainable from three perspectives: economic, environmental, and social (Rio Declaration on energy and Development, 1992). Consequently, many countries seek to exploit the RE (hereinafter RE) sources available locally rather than have continued dependence on traditional oil sources (Ince, Vredenburg, & Liu, 2016). Despite this commitment to sustainable futures, globally and within the developing nations, RE sources continue to struggle to be adopted into the mainstream of the energy mix (Ince et al., 2016). Several reasons have been advanced for the lack of deployment, such as the high cost of developing RE and funding opportunities for investors in many countries. Notwithstanding these economic factors, however, researchers in this area have focused on sustainable RE development by linking institutional factors to policy sustainability (Byrnes, Brown, Foster, & Wagner, 2013).

In spite of the barriers and challenges facing RE development, some countries have made significant gains and have been touted as “best practice” nations, such as Costa Rica, Australia, Germany, and China, yet they are not without seeming challenges (Eleftheriadis & Anagnostopoulou, 2015; Hua, Oliphant, & Jing, 2016; Martin & Rice, 2015). Currently, Costa Rica’s electricity is being run at 100 percent RE for the last 300 days; this is similar to Iceland and Sweden, which boast 100 percent clean sources of energy globally. However, the best practices from countries stem from the quality of the policy measures in securing sustainable RE policy development (Chen, Kim, & Yamaguchi, 2014; Martin & Rice, 2015; Menanteau, Finon, & Lamy, 2003).
The case of the Costa Rican RE success is an example for many developing countries to model itself after. In 2016, renewable energy provided 98.1% of energy for Costa Rica (Mashable UK, 2017) while in 2014, 99% of electricity in Costa Rica came from RE sources, 80% of which in turn came from hydroelectric power (MetaEfficient). It is noteworthy that for more than three months of 2015 100% of the electricity came from RE sources, and in 2016 RE accounted for about four months of energy supply (Nacion 2018). Overall by 2013, approximately 14.5% of the total energy generation in Costa Rica was provided by private companies and 23% of installed capacity in the National Power System (Sancho, 2014).

Costa Rica’s largest source of RE is hydroelectricity, but other sources include geothermal energy, biomass, solar power, and wind power (MetaEfficient). Thailand is not very different from Costa Rica when it comes to geographical features. Costa Rica receives 2,926 mm of precipitation per year, being one of the highest nations in terms of rainfall per capita, while Thailand receives 1000 mm to 1500 mm (Trading Economics). Costa Rica is also rich in the concentration of rivers, dams, and volcanoes, all of which facilitate a high RE output. In contrast, unlike Thailand, with a population of 69.04 million people, Costa Rica’s population is only 5 million, and the country has no major industry, and thus the need for a strong energy infrastructure is less than it is for Thailand, with its strong agriculture and manufacturing sectors. Although Costa Rica has abundant RE resources, more than 25% of its territory has been entitled as natural protected land, limiting the possibility to exploit the RE sources, for example geothermal energy in national parks (Reegle). Thailand, in comparison, also has “number and area of various categories within where the system is changing rapidly, with ongoing additions aimed at increasing the [protected] area to 25 percent” of the country, according to the 2003 report entitled Thailand National Report on Protected Areas and Development (Mekong 2018). However, unlike Costa Rica, which eliminated its military in 1948, thus freeing its budget for healthcare, education, and environmental protection, military expenditure in Thailand increased to 6075.70 USD million in 2017 from 5876.30 USD million in 2016 (Barash 2013).

In Costa Rica, as early as 2007, the administration of the former announced the national goal for Costa Rica to become the second carbon-neutral country in the world by 2021, with the proposal being officially presented to the United Nations
Framework for Climate Change Convention (UNFCCC) in 2010 (Tico Times 2012). Unlike Thailand, whose policies and priorities often change with each successive government, this Costa Rican initiative has been retained by the following administrations, aiming to further reduce the national economy's carbon footprint (Minae 2015). In Costa Rica, apart from a 99% reliance on renewable resources, carbon neutrality is to be achieved by resorting to electric and hybrid transportation (Go100). Additionally, the Costa Rican government is also offsetting the country's CO2 emissions with new budgeting, laws, and incentives, including measures to promote biofuels, hybrid vehicles, and clean energy. Basically, the energy policy of the current Costa Rican administration is guided by the concept of energy sustainability with low emissions.

The “VII Plan Nacional de Energía 2015-2030” (Ministerio de Ambiente y Energía MINAE; Programa de las Naciones Unidas para el Desarrollo PNUD) was crafted according to the priorities of the National Development Plan 2015-2018 and the government plan of the president. The five main objectives of this plan are:

1) to introduce changes in the National Power System in order to increase energy efficiency, savings, and to improve the management of electricity demand;
2) to encourage the development of the distributed generation and self-consumption of electricity;
3) to update the laws and institutional frameworks specialized in promoting energy efficiency;
4) to improve the calculation methods of electricity tariffs; and
5) to raise the management efficiency of the public entities in the electricity sector.

In addition, the National Development Plan of Costa Rica 2015-2018 (Costa Rica. Ministerio de Planificación Nacional y Política Económica. (2014) aimed to establish the sectorial objectives for energy policy as follows:

1) “To promote actions facing global climate change through citizens’ participation, technological change, innovation processes, research and
knowledge for ensuring the welfare, human security and competitiveness of the country” and

2) “To supply energy demand of the country using an energy matrix that ensures an optimal and continuous supply of electricity and fuels, promoting efficient use of energy for keeping and improve the competitiveness of the country.”

In recent years in Costa Rica, the private sector has been actively involved in the adoption of energy-efficiency policies and developing low carbon certification, and the National Institute of Technical Norms of Costa Rica has published regulations that private companies should follow in order to obtain carbon-neutral certification (Inteco). Thailand’s energy policy, on the other hand, epitomizes the significance placed on deploying RE and alternative sources in the country, as observed in the following statement:

“In order for Thailand to become a Regional center for the energy business based on its strategic location and achieve sustainable energy, the government shall support the production, use, research and development of renewable and alternative energy sources, with the objective of replacing 30% of the energy generated by fossil fuels within the next decade” (Department of Alternative Energy Development of Efficiency, 2012; Rennkamp, Haunss, Wongsa, Ortega, & Casamadrid, 2017).

The above statement emphasizes the importance of being an energy-secure nation and at the same time, developing a strategic framework for economic growth. However, governments the world over cannot achieve this goal without the development of effective policy measures to support the deployment of RE by both small and large independent power producers in the private sector. Therefore, the development of sustainable RE policy measures may be an alternative for countries to become energy-secure nations by 2030 as the United Nations declaration in the Rio+20 Summit in 2012 on the 17 SD goals (SDGs) has indicated. Thailand is no exception in the RE drive.
Energy sustainability has been a buzzword towards the end of the Millennium Development Goals (MDGs) deadline since 2012 (United Nations, 2012). One of the central problems that many nations face today is how to increase their energy sources to meet the growing demands of both domestic and industrial use (Beck & Martinot, 2004; World Bank, 2012). While many countries have started making giant strides, especially Germany, China, and Japan, toward RE sources in terms of policy (Cong & Shen, 2014; Urban, 2009), other countries have largely lagged behind (International RE Agency, 2012). Globally, there is a growing need for policies to promote the deployment of RE power supply (Emodi & Ebele, 2016; Lüthi, 2011; Sawin, Seyboth, & Sverrisson, 2016).

In 2010, about 100 countries passed major policy targets and policies to increase RE (REN21, 2012). First, RE can help solve climate change problems and address the increase in energy demand. Second, renewable energies bring many new business opportunities to the value chain by ensuring transformative, productive industrial development (Buckley & Nicholas, 2017; International RE Agency, 2012; World Bank, 2012), while at the same time, RE can lead to social impacts or benefits such as job creation and cheaper energy sources to reduce electricity tariffs.

Although RE deployment promises more to countries in the developing world, the ability of those countries to develop more effective policy measures to attract more investment and to build new industries, technologies and job creation (Al-Sarihi, Contestabile, & Cherni, 2015; IRENA, 2017) is mostly lacking. Among the most successful countries are China and Germany, which through effective policy development have succeeded in RE deployment and production (Emodi & Ebele, 2016; International RE Agency, 2012). At the global level, the installed capacity of RE is at 18 percent, and with the rate at which “global warming and climate change” is taking place, the reliance on RE sources that reduces the use of fossil fuels and the release of CFC gases is necessary to manage environmental sustainability (Dinica, 2006; Beck, Martinot et al., 2004; Wiser & Pickle, 1998; Sovacool, 2009b).

Thailand’s energy policy on RE has barely made gains (Square & Tongsopit, 2016; Tongsopit & Greacen, 2013). Despite the role that the production and use of RE sources provide, policy measures that support the private sector are inadequate (Jue, Johnson, & Vanamali, 2012; Keyuraphan, Thanarak, Ketjoy, & Rakwichian, 2012;...
Tongsopit & Greacen, 2013). Additionally, insufficient grid capacity, non-transparent costly procedures for grid connection, and sudden policy changes are some of the challenges facing the RE sector in the country (Pongsiri, 2009). The “installed capacity” of RE in Thailand was 10.9 percent in 2013, 11.3 percent in 2014, and it is expected that by 2021 and 2036, the installed capacity will increase to 25% and 30% respectively (AEDP, 2015).

Currently, the country’s primary source of energy is natural gas, which constitutes about 67%, an average of 119,434 GWh; hence, the current energy sources will not be sustainable because of the unreliable nature of the traditional sources of power (National Alternative Energy Development Authority, 2015). The AEDP (2015) maintains that the policy is expected to achieve full generation capacity by 2040. Nevertheless, Thailand is motivated to transition to RE because energy imports are likely to rise from 42% (2013) to 78% in 2040. The proportion of gas imports may also double due to the decline in domestic production and the high demand for energy in the industrial sector.

Consequently, in order to limit imports on power, the energy power plan under the Alternative Energy Development Plan (AEDP 2015-2036) foresees that by 2040, biomass will have the largest share at 13% (11GW), solar photovoltaic (PV) at 9% (8 GW), wind at 6% (5GW), and hydropower at 5% (4 GW). In order to be able to address the energy gap and to provide a sustainable energy future, the government of Thailand has developed a roadmap or policy guidelines for increasing the current stock of RE through the Alternative Energy Development Policy, which is known as the “Fit” policy, to replace the “Adder rates” policy (Achawangkul, 2017; Keyuraphan et al., 2012; Square & Tongsopit, 2016; Tongsopit & Greacen, 2013; Wattana, 2014).

Although the policy is a measure to motivate the private sector to partner with the government to provide electricity and power to meet the growing demands of the domestic and industrial sectors, recent studies suggest that lack of clarity of policy objectives, low technical and institutional capacity, regulatory barriers, and access to capital investments (Keyuraphan et al., 2012; Square & Tongsopit, 2016) are the major challenges that may affect the drive towards energy sustainability in Thailand. Accordingly, Achawangkul (2017) has argued that full deployment of RE sources
depends to a large extent on the ability of a country to develop effective policy measures and to minimize the barriers that militate against private sector involvement (Achawangkul, 2017; Al-Sarihi et al., 2015; Beck & Martinot, 2004; Buckley & Nicholas, 2017; Emodi & Ebele, 2016; Menanteau, Finon, & Lamy, 2003).

For example, studies on Australia’s RE sector suggests that policy derivation is mainly due to the relatively small size of Australia in terms of population, technology origination, and global influence (Australian RE Agency, 2017; Byrnes et al., 2013; Martin & Rice, 2015). To that end, Australia has been one of the 96 countries that have embraced government policies designed to facilitate greater investment in RE technologies despite the advantage of abundant low-cost fossil fuel energy reserves. Globally, concerns about energy security have motivated policymakers to introduce mechanisms designed to deploy RE. Within Australia, the main challenge to RE development is the consistent uncertainty regarding its RE policy created by the intense debate around climate change policy (Nelson, Nelson, Ariyaratnam, & Camroux, 2013, pp. 386-387).

Similarly, studies such as those of Beck and Martinot (2004), EModi and Ebele (2016) (Beck & Martinot, 2004; Emodi & Ebele, 2016; International RE Agency, 2012), have focused on energy policy analysis globally by looking at the effect of privatization and public-private partnership arrangements (IEA, 2011;Nsasira, Basheka, & Oluka, 2013; Pongsiri, 2004). Obviously, these studies have provided explanations of RE policy risk assessment analysis (Beck & Martinot, 2004; Menanteau et al., 2003) and economic analysis (Al-Sarihi et al., 2015; Timmons, Harris, & Roach, 2009). Environmental analysis (Al-Sarihi et al., 2015; Denholm, 2004; Konkel, 2013), political or institutional analysis (Emodi & Ebele, 2016), tax exemption and subsidies (Emodi & Ebele, 2016), and financial returns analysis (Hu & Cheng, 2013; Jue et al., 2012) have been explained. However, the discussion of how sustainable policy measures may be drivers for or barriers to RE deployment is still lacking in the literature in Thailand (Jensen & Jensen, 2017).

It is worth mentioning that few studies have studied the sustainability of energy policies considering three dimensions of sustainable RE policy development—environmental, economic, and social factor—or the institutional factors that drive RE policies (Emodi & Ebele, 2016; Engineering, 2012; Konkel, 2013; Musango & Brent,
2010; Nilsson, Lucas, & Yoshida, 2013; Okundamiya, Emagbetere, & Ogujor, 2014; Urban, 2009; Vilanova, Magalhães Filho, & Balestieri, 2015). Even though these studies have focused on social impacts, most of them have not been able to explain what factors influence sustainable RE in developing countries and what the possible pitfalls of policies are that do not meet the demands of key stakeholders in the RE sector. It is interesting to note that the sustainability of RE policy outcomes to date has been assessed based on economic, social, and environmental factors, while few attempts have been made to explain the factors that drive and challenge sustainable RE policy development (Emodi & Ebele, 2016).

Additionally, most studies have focused on the assessment and values that define equity in policy-making quantitatively (Kumetat, 2012; Urban, 2009; Warren, 2015). While equity and the impact assessments of policies are not bad, focusing on these principles of policy-making is largely not enough to trigger sustainable RE deployment (Emodi & Ebele, 2016; IEA, 2016). Hence, others have sought to argue that the public sector can support governments to solve their energy crisis by developing effective policy measures that can attract capital investment in RE technologies (Denholm, 2004; Emodi & Ebele, 2016; Konkel, 2013; Menanteau et al., 2003; Timmons et al., 2009). It is important to observe that insufficient analysis of the factors that drive or hinder sustainable RE development may lead to spillover effects within society and can affect the long-term sustainability of energy policies. Therefore, by thinking about how economic, environmental, social, and institutional factors may drive or limit sustainable RE deployment, governments and stakeholders can assess alternative ways to develop effective policy measures to enhance the rapid supply of alternative technologies to replace fossil fuels.

The fundamental quest for and the need to develop sustainable RE policy in Thailand by qualitatively and quantitatively analyzing the drivers, barriers, and measures for RE policy development will form the focus of this study in order to explain how policy development in the RE sector can contribute to energy security and reduce the environmental impacts of climate change. Therefore, the study seeks to address the lack of both quantitative and qualitative analyses of the drivers, barriers, and effective policy measures of RE policy development in the context of Thailand’s energy sector (Misila, Winyuchakrit, & Limmeechockchai, 2015; Pongsiri, 2003;
Tongsopit & Greacen, 2013; Wattana, 2014). Further, the study aims to evaluate the Alternative Energy Policy of Thailand in order to critically examine the pitfalls and promoters that drive RE energy development by analyzing the “economic factors, environmental impacts and social” impacts of RE deployment in the country. This is because these impacts will inform the kind of policies that the government of Thailand can develop in order to benefit from RE sources due to employment generation, health implications, and growth in national income. Socio-economic factors refer to the social behavior of the people towards RE development as well as the economic impacts that RE deployment are likely to make in terms of growth in GDP, trade, and the cost of producing and investing in RE supply (Lucas, Fifita, Talab, Marschel, & Cabeza, 2017).

1.2 Research Objectives

One objective of this study is to examine the factors that sustain the deployment of RE development in the Thai context. In addition, the study investigates optimal policy measures by focusing on the socio-economic, environmental, and institutional factors that will promote investment in renewable technologies in the country by focusing on the various roles played by industry actors in the RE sector. Lastly, the study assumes that the drive towards Sustainable Development (hereinafter SD) can be achieved by renewable sources of energy supply by analyzing the economic, environmental, and social impacts of RE deployment in which communities will serve as secure places for human habitation devoid of fossil fuel impacts. The following are the purposes for the study:

i. To examine the determinants of sustainable RE policy development
ii. To investigate the environmental factors that impact RE policy development
iii. To explain how socio-economic factors, influence RE policy development in Thailand
iv. To examine how institutional factors, policy goals, and objectives, as well as major actors influence RE policy development in Thailand


1.3 Research Questions

To enable the study and to achieve its objectives, the main questions asked were as follows: What are the determinants of sustainable RE policy in Thailand?; What are the factors that drive RE policy development in Thailand”; and What are the institutional factors that promote or limit the deployment of RE in Thailand? The specific questions of the study include:

i. What are the determinants of sustainable RE policy development in Thailand?
ii. How do environmental factors impact sustainable RE policy development in Thailand?
iii. How do socio-economic factors influence sustainable RE policy development in Thailand?
iv. How do institutional factors impact Thailand’s sustainable RE policy development? How do policy goals and objectives influence sustainable RE deployment? And how do major actors influence the RE policy development cycle?

1.4 Significance of the Study

This study aims to describe how effective policy measures will support sustainable RE deployment by exploring the experiences of Thailand. Additionally, to examine Thailand’s ability to become an energy-secure country and to provide a constant supply of energy for industrial and manufacturing. This research will help to provide more information on how policy measures affect strategy, market performance, production capacity, and investment in RE technologies in the alternative energy sector from the Thai perspective. Most especially, the focus of the study is to explain how economic, social, and environmental drivers may offset RE deployment. Further, how barriers such as regulatory restrictions and low technical capacity impact negatively sustainable RE policy development in Thailand will be discussed. Equally the study will contribute to the understanding of the effective policy measures that will benefit stakeholders in the RE sector. In addition, special
emphasis is given to the three theoretical models—rational decision model, incrementalism, and system frameworks—which reinforce RE policy development globally.

1.4.1 Theoretical Contributions

This study aims to advance the discussion of the sustainable RE policy development phenomenon from a developing country perspective. It will bridge the gap between theories that focus on the risks and financial analysis of RE policy development. The study focuses on three theoretical contributions. First, explaining how social, economic, and environmental factors drive sustainable energy deployment, and the barriers to RE development and perceived policy measures, are investigated for the first time in this study by concentrating on the Thai case. Second, the organizational level of analysis will provide diverse means by which effective policy measures can be used to increase the supply of renewable deployment by encouraging investment in alternative energy technologies. Third, by combining the two theoretical models which are the foundation of modern policy-making process and evaluation in this study.

1.4.2 Practical Contributions

This study contributes to a better understanding of renewable policy development in developing countries by using the Thai model to explain how ASEAN member countries are implementing their RE policy frameworks to increase alternative sources of energy. This study will show the complex and embedded nature of policy drivers that may affect energy supply. The findings from the study will allow practitioners and government and private partners to be more aware of the drawbacks of sustainable energy deployment to achieve energy security by 2036. This will also offer an opportunity for policy implications for the major regulators in the alternative energy sector.
1.5 The Scope of the Study

The context of this study is Thailand, which has a population of 68 million people and is within the Southeast Asian sub-region. Thailand is part of the regional bloc “ASEAN” and has been one of the leading members in the deployment of RE sources. The study focuses on the analysis of the factors that contribute to the deployment of RE in the country and how these factors serve as drivers or barriers to the green energy goals of Thailand towards the SDG deadline of 2030 and the RE development target of 30% by the end of 2036.

Additionally, the study will focus on secondary data sources that cover a period of 12 years by analyzing the renewable contributions to the national grid for this timeline. The baseline for comparison will focus on environmental and socio-economic factors from 2008 to 2017 by dividing them into seasonal time series for the 12-year analysis. Additionally, the study scope is to analyze the institutional factors using both quantitative and qualitative techniques since the study assumes that not all institutional factors can be measured because some of the indicators are subjective in nature. Therefore, the study will ensure that some of the data for the indicators of the institutional factors will be collected using semi-structured and in-depth interviews.

Finally, the choice of the various organizations for the case study was made in order to obtain feedback from policymakers, implementers, and stakeholders in the RE sub-sector. This is because the perspectives of these three categories of actors are central to the sustainable approach to energy security in the country. Focusing on qualitative interviews will highlight the different experiences, views, and opinions on this category of actors to reshape the RE policy in Thailand. Regarding the choice of RE sectors for analysis, the study chose to analyze 14 public and private organizations whose activities are most fundamental in the energy sector. The reasons for the choice of these organizations are provided in the methodology chapter.

1.6 Limitations of the Study

Research designs are not without limitations; hence, this study perceived that there were likely to be some fundamental pitfalls in the proposed techniques to be
used for the data collection and that may have affected the outcome of the study; however, these shortfalls were managed in order to ensure that they did not substantially affect the results of the study. Firstly, the study choice of the analysis of environmental, socio-economic, and institutional factors posed a limitation because of the equally-substantial indicators of the variables that have not been chosen to measure that are very important in determining sustainable RE deployment. For instance, the environmental variable only focuses on air quality, greenhouse gas (GHG) emissions, and RE technology efficiency, while the economic factor deals with GDP growth, trade, generation cost, etc. Although these measures may not deviate from previous findings in the literature, it may limit the generalizability of the study to the sample population.

Secondly, the study is only interested in studying the context of Thailand without a major comparison with other countries with best practices such as Costa Rica, Iceland, Sweden, China, and Germany that have to pursue RE policies and that are considered leaders in the sector globally. Consequently, this limitation may affect the country’s policy effectiveness in meeting the 30% RE target by 2036. However, a “desk analysis” of the policy measures of Japan and South Korea for an RE deployment framework will be discussed in chapter four of the study in order to draw lessons and to make recommendations for the Thai context. Thirdly, the use of secondary data may affect the outcome of the study because of the availability of data. Most of the variables being used in the study required existing data, yet access to the data for some of the variables was missing, which could have affected the analysis process. However, the study used other means to ensure that this challenge was mitigated by collecting qualitative data that could later be transformed into quantitative measures for the regression analysis. In addition, the in-depth and semi-structured interviews will augment the shortfall in the secondary data.

Lastly, the use of qualitative interviews is likely to be affected by self-reported data. Interviews with participants may be biased depending on how the questions are posed and this can make participants want to impress the interviewer by providing information that does not constitute the real facts “on the ground.” Consequently, the study includes document analysis in order to cross-validate the self-reported interviews
1.7 Definition of Terms

This section focuses on the definition of the key terms of the study. This is important because it provides an opportunity for the researcher to eliminate any form of ambiguity associated with the use of the terms in different settings. Subsequently, the study defines the main variables: sustainable renewable policy development, socio-economic factors, environmental factors, and institutional factors.

1.7.1 Sustainable RE Policy Development

Sustainable RE policy development is the integration of the philosophy of SD into policymaking activities and to establish and promote sound environmental and economic impacts in the deployment of RE (Nelson et al., 2013). In line with this understanding, sustainable RE policy development is the ability to manage robust policies, standards, and systems by managing social, environmental, and economic impacts through the quality policy-making process. In this study, the use of the term “sustainable RE policy development” refers to effective policy measures, policy stability, the Feed-in-Tariffs/Adder Rate, national installed capacity, RE installed capacity, and the RE rate of development (Eleftheriadis & Anagnostopoulou, 2015; Tongsopit & Greacen, 2013).

1.7.2 Socio-Economic Factors

Socio-economics is a subfield of economics that focuses on the relationship between social behavior and economics with the goal of examining how social norms, ethics, and social philosophies influence the behavior of consumers and shape the general economic outlook of a country. Socio-economic factors emphasize the role of social determinants and the potential benefit of these variables for society and the economy. In this study, socio-economics refers to the relationship between the social and economic factors that the use of RE is likely to generate in the long run. There are five indicators of socio-economic factors that are referred to in this study: perception, knowledge, GDP, trade, and the investment cost of RE.
1.7.3 Environmental Factors

Environmental factors refer to the quality of the ecosystem, which may be affected by human activities and the release of poisonous substances into the atmosphere. The environment is most crucial in terms of the energy mix because all sources of energy have some form of impact on the environment. For example, the use of fossil fuel—coal, oil, and natural gas do some form of harm more than RE sources, especially regarding air quality, pollution, and damage to public health and global warming emissions (Al-Sarihi, Contestabile, & Cherni, 2015; Santoyo-Castelazo & Azapagic, 2014). Following Al-Sarihi et al. (2015), two environmental factors were central to this study: air quality and CO2e.

1.7.4 Institutional Factors

Institutions have been defined by North (1990) as formal institutions that relate to legal aspects such as policies, laws, administrative procedures, and regulations, and informal institutions related to culture or taken-for-granted issues. Following North (1990), this study uses the term institutional factors to refer to policy measures, laws, administrative procedures, and regulations. Additionally, informal institutions can relate to factors such as green culture, the role of champions, and networks of stakeholders (Ince et al., 2016). Based on North’s conceptualization of institutional variables, the study builds on the two categories of institutions by focusing on the laws, regulations, administrative procedures, policies, and stakeholder involvement as the main variables to explain the relationship between institutional factors and sustainable policy development in the RE sector in Thailand.

1.8 Organization of the Chapters

The study is divided into six main chapters. Chapter I focuses on the problem statement, and the research questions and objectives. Additionally, the chapter outlines the benefits and significance of the study, its scope, limitations, the thesis chapters, and chapter conclusions. Chapter II highlights the theoretical review of public policy analysis. There are three major policymaking models of central significance to the study: the rational decision-making model, the incremental model,
and the system model. These models are discussed, and various reflections are derived from the review. The chapter’s major point of focus is conceptual framework development, which was derived from the theoretical review to serve as a guide to the execution of the study during the data-collection phase. In addition, the chapter outlines the Thai context in terms of RE policy development and the various government's inputs into sustaining the release of renewable sources to the grid capacity of the country. The global perspective is explored with key highlights from Japan and South Korea as a comparison with the Thai experience. Further, the chapter provides an empirical review of the literature on RE in general.

Chapter III highlights the discussion of the research design and how the study can be executed in the field. The sampling strategy for the secondary data is clearly spelled out and the operationalization of the variables is explained for the quantitative data analysis procedures. Further, the case study design is clarified with each of the proposed organizations detailed for the field interviews. The chapter provides the detailed steps of the data analysis techniques for the two data sets to be collected. Chapter IV discusses the data management procedures and the manipulation of the qualitative interviews and content analysis of the reports from secondary sources. The chapter analyzes the interviews collected from the field. The interviews are organized into themes and categories using codes and pattern procedures in order to select the dominant themes that emerged from the transcripts. The qualitative data also made use of descriptive statistics for the respondents. Additionally, the chapter discusses the findings of the qualitative interviews.

Chapter V discusses the two sources of data for the quantitative section of the study. The descriptive statistics analysis, along with regression analysis were performed for the survey and secondary datasets. A correlation matrix was performed for the variables in order to observe the relationship between the independent variables and the dependent variable indicators. The analysis of the two data sets was separated, and the survey quantitative results were analyzed, followed by the secondary data. However, the findings of the two datasets are discussed jointly. Chapter VI will discuss the summary of the major findings for the mixed-methods data sources. Key overall findings will be highlighted. Additionally, the study will
draw conclusions and discuss possible contributions as well as recommendations for policy, practice, and research.

1.9 Chapter Conclusion

The chapter discusses the research problem, objectives, and the questions of the study. Additionally, the chapter explained the benefits of the study, which were captured as theoretical and practical contributions. Further, the chapter provided the scope, limitations, and organization of the chapters. The purpose of this chapter was to provide a strong background for the rationale for this study which has been established in the preview to the problem statement.
CHAPTER 2

LITERATURE REVIEW: TOWARDS THE DEVELOPMENT OF A CONCEPTUAL FRAMEWORK

2.1 Introduction

This chapter provides a theoretical and empirical review of the extant literature with the main purpose to elucidate the concept of sustainable RE and to ultimately develop a conceptual framework that the study shall subsequently use to analyze the deployment of sustainable RE. The chapter is divided into two broad parts. The first part unpacks the concept of SD, RE and sustainable RE (SRE). The chapter further discusses sustainable RE in the context of Thailand, Japan, and South Korea. The second part discusses some of the decision-making models including the rational-comprehensive model, the incremental decision model, and the system approach model. From these models, a conceptual framework is developed to aid in the analysis of sustainable RE in Thailand.

2.2 What is Sustainable Development?

The concept of sustainability has seen increased usage in the last four decades. The increased concern with sustainability arose out of the increased human activity, which has the capability to alter the world's climate. Economic activities, in particular, have been singled out as the major driving force of sustainability (Chichilinisky, 1997). The history of “SD” can be traced back to the “World Commission on Environment and Development (WCED)” initiated by the “United Nations’ General Assembly in 1982” and its report on “Our Common Future was published in 1987” (Brundtland, 1987). It is also known as the “Brundtland Commission” because the then Prime Minister of Norway, Gro Harlem Brundtland, was its chair. However, its roots were in the “Stockholm Conference on the Human
Environment in 1972” (Kates, Parris, & Leiserowitz, 2005), where the “conflict between the environment and development was first acknowledged.”

The entire notion of SD is based on the notion that the pursuit of one cherished value requires others. The Brundtland Commission was thus committed to the unity of the environment and development; in other words, the dual emphasis on the developmental environment (Kates et al., 2005). According to Brundtland:

“The environment does not exist as a sphere separate from human actions, ambitions, and needs, and attempts to defend it in isolation from human concerns have given the very word “environment” a connotation of naivety in some political circles. The word “development” has also been narrowed by some into limited focus, along the lines of “what poor nations should do to become richer,” and thus again is automatically dismissed by many in the international arena as being a concern of specialists, of those involved in questions of “development assistance.” But the “environment” is where we live; and “development” is what we all do in attempting to improve our lot within that abode. The two are inseparable” (Brundtland, 1987).

The Brundtland Commission then went ahead to define SD as the “ability to make development sustainable—to ensure that it meets the needs of the present without compromising the ability of future generation to meet their own needs” (Brundtland, 1987). Additionally, SD has been referred to as a conflict between economic development, environmental protection, and equity and social justice (Campbell, 1996). Thus, it is suggested that a balance of these three (economic, environmental, equity, and social justice) factors define sustainability (Wheeler 2002 cited in Chapman, 2016). However, SD does have some limitations, which may not include absolute limits, but some type of restrictions posed by technology, social, and other factors on the environmental resources and issues related to the biosphere and human activities (Brundtland, 1987).

According to Kates et al. (2005), the use of such a description led to the notion that SD only focuses on “intergenerational equity.” However, Kates et al. (2005) have
noted that whilst it is generally agreed that the three key pillars of sustainability, economic and environmental factors are commonly featured and most understood in the literature. These two pillars are commonly featured in the literature because it is easy to quantify economic and environmental factors. Furthermore, while the three aspects were adopted, there is an absence of a universal agreement regarding what they really are. For example, in identifying the social factors, three main usages have been identified (Kates et al., 2005). The first usage is basically a general “noneconomic social designation” that imply terms such a social development and social progress. The second highlights human development, well-being, or just people. The third relates to issues such as “justice and equity: social justice, equity and poverty alleviation” (Kates et al., 2005) (figure 2.1).

<table>
<thead>
<tr>
<th>WHAT IS TO BE SUSTAINED:</th>
<th>FOR HOW LONG?</th>
<th>WHAT IS TO BE DEVELOPED:</th>
</tr>
</thead>
<tbody>
<tr>
<td>NATURE</td>
<td></td>
<td>PEOPLE</td>
</tr>
<tr>
<td>Earth</td>
<td>25 YEARS</td>
<td>Child survival</td>
</tr>
<tr>
<td>Biodiversity</td>
<td>&quot;NOW and in</td>
<td>Life expectancy</td>
</tr>
<tr>
<td>Ecosystems</td>
<td>the future&quot;</td>
<td>Education</td>
</tr>
<tr>
<td></td>
<td>Forever</td>
<td>Equity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Equal opportunity</td>
</tr>
<tr>
<td>LIFE SUPPORT</td>
<td>LINKED BY</td>
<td>ECONOMY</td>
</tr>
<tr>
<td>Ecosystem services</td>
<td>Only</td>
<td>Wealth</td>
</tr>
<tr>
<td>Resources</td>
<td>Mostly</td>
<td>Productive sectors</td>
</tr>
<tr>
<td>Environment</td>
<td>But</td>
<td>Consumption</td>
</tr>
<tr>
<td></td>
<td>And</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Or</td>
<td></td>
</tr>
<tr>
<td>COMMUNITY</td>
<td></td>
<td>SOCIETY</td>
</tr>
<tr>
<td>Cultures</td>
<td></td>
<td>Institutions</td>
</tr>
<tr>
<td>Groups</td>
<td></td>
<td>Social capital</td>
</tr>
<tr>
<td>Places</td>
<td></td>
<td>States</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Regions</td>
</tr>
</tbody>
</table>

Figure 2.1 Definitions of Sustainable Development

SOURCE: U.S. National Research Council, Policy Division, Board on Sustainable Development, Our Common Journey: Transition Toward, adapted by the author.
From the figure above, it can be observed that the Board on SD identified three key areas that SD seeks to achieve. A distinction is made between what is to be sustained and what is to be developed, the association between the two, and the time span in the future. The question of sustainability bothers on three themes: nature, life support, and the community. What is sought to be designed has three themes; namely, people, the economy, and society. These themes have many sub-categories as observed in the figure above. There is also the need to link sustainability to what is expected to be developed. Further, the duration of concern ranges from now to the future; in other words, both intra-generational and inter-generational. Ultimately, a holistic and precise definition of SD will be the one that takes into account the three overarching pillars of sustainability: “economic, social, and environmental protection”—at the local, national, and global levels (United Nations, 2002).

### 2.3 Renewable Energy

Rising socio-economic development with corresponding rapid population growth, a huge expansion of intensive industrial energy consumption, urbanization, increased demand for transportation, high standards of living, and power generation have resulted in rising demands on domestic energy supplies. These pressures have generated huge challenges to the energy sector, including energy insecurity and climate insecurity (A. Al-Sarihi, Contestabile, M., & Cherni, J. A., 2015) Such pressures have compelled nations to move away from fossil energy usage that is exported to alternative energy sources that can be generated locally. These alternatives to fossil fuel are termed RE due to the fact that they are not degradable.

RE sources are those energy sources that use natural resources that can be replaced and are not degradable or run out (Australian RE Agency, 2017). Examples include wind, sunlight, rain, tides, and geothermal heat, and other forms of biomass. There are many RE technologies, such as solar, which is one of the most developed sources of energy in most countries, followed by wind power and hydropower, which can be considered as the oldest form of RE sources. Other types of renewable technologies include geothermal energy, and bioenergy used to produce heat or electricity (Australian RE Agency, 2017).
RE is central to a country’s development efforts since it has the ability to meet the required energy needs. RE types such as biomass, wind, solar, hydropower, and geothermal can be used to sustain energy-related activities principally because they are available and largely indigenous to rural communities, and they are relatively cheap (Herzog, Lipman, & Kammen, 2001). RES supplies about 15% and 20% of the world’s total energy demand. It is predominantly traditional biomass, fuelwood used in cooking and heating, in most parts of the developing countries in Africa, Asia, and Latin America (Herzog et al., 2001). Many studies have indicated that the 2nd half of the 21st century will see an increase of 20% to more than 50% but with the major policy change.

2.4 Sustainable RE Policy

Fundamentally, the WEC (2014) has argued that energy sustainability does not occur in a vacuum because it is determined by policy content, clarity of goals or objectives, and the stakeholders’ willingness to partner with the state in RE provision. However, there are few studies that focus on assessing energy policies and their impact on sustainability (Kettle, 2002). RE policies aim to increase the “installed capacity” of renewable technologies and electricity generation through renewables (Hodge & Greve, 2017). In order to ensure better policy outcomes, high technology powered by low-cost pricing, a “secure energy system,” “public awareness and social acceptance” of RE, “job creation,” “domestic production,” and a reasonable market share in RE technologies must be encouraged (The International RE Agency, 2012). However, there is little information about how these factors determine policy outcomes (The International RE Agency, 2012).

Additionally, there have been huge investments in RE policies globally, and governments around the globe will spend an estimated $44 billion to $175 billion between 2010 and 2030 (The International RE Agency, 2012). Hence, a timely assessment of renewable policies globally has become necessary because it offers opportunities for policymakers to adapt and modify their policy goals to achieve their intended outcomes. Another concern regarding RE deployment at the global center stage is the ability to achieve sustainable energy policies that address several
dimensions of SD. The sustainability of energy policies focuses on the environment, economic and social impacts on the larger society. While there are several studies on environmental and economic impacts, there are few studies that have studied the drivers of and barriers to RE policies (Buckley & Nicholas, 2017a; Emodi & Ebele, 2016).

### 2.5 Dimensions of Sustainable RE Deployment (SRED) Impacts

SRED policy development depends on the three main aspects of SD, environment, economic, and social dimensions, as indicated above (Buckley & Nicholas, 2017b). These three dimensions are considered criteria for ensuring that countries develop effective policy measures in order to deploy RE solutions for both domestic and industrial purposes (Beck & Martinot, 2004; Nsasira, Basheka, & Oluka, 2013). The concept of SRED refers to the development and production of RE that serves the energy “needs of the present generation,” which takes into account the needs of the future generation without compromising future energy production (Konkel, 2013; Okundamiya, Emagbetere, & Ogjur, 2014).

#### 2.5.1 Environmental Impacts of RE Deployment

RE sources have some level of impact on the environment. Traditional sources of energy such as fossil fuels such as coal, natural gas, and oil have had substantially greater effects on the environment than RE sources (Al-Sarihi et al., 2015). While the sources such as water and air pollution, public health issues, wildlife and “habitat loss, water use, land use and global warming,” transitions to RE sources are well-placed (Union of Concerned Scientists, n.d.). Additionally, RE sources such as biomass, biogas, waste, hydropower, and solar and wind are beneficial to the environment and the impacts depend on the technology used, the country or operational zone, and other contextual factors (Buckley & Nicholas, 2017b). By focusing on the potential impact of RE on the environment, strategies can be put in place to reduce these impacts. The environmental impacts of renewable are considered at the regional or national level to explain the average impact of RE installations, and at the local level where the
specific site or location impacts the effects of wildlife and local water supplies can be assessed by looking at the effects on wildlife and local water sources.

2.5.2 Economic Impacts of SRE Deployment

SRE contributes to the economic sector in two areas. First, energy creates jobs and value “by extracting, transforming and distributing energy goods and services throughout the economy” (Yergin & Gross, 2012). Second, it provides a trickle-down effect on other sectors of the economy. For example, power is used in both the product and service sectors of the economy and hence, reinforces economic activity across the different sectors in the long run (Al-Sarihi et al., 2015; Konkel, 2013), because of low economic growth and solutions to improve countries’ economic performance and reduce CO2 emissions (Shahmohammadi, Yusuff, G, & Mahmoud, 2014). Consequently, RE is necessary in order to ensure that energy security takes place for increased industrial growth and economic diversification.

2.5.3 Social Impacts of RE Deployment

Social impacts refer to the effect of RE on the society and the benefit to the people in the community. Social impacts? Can be defined as follows:

“…the consequences of human populations of any public or private actions that alter the ways in which people live, work, play, relate to one another, organize to meet their needs and generally cope as member of society”

Society can be impacted by RE decisions and may also affect future plans or decisions regarding RE deployments or developments. Social impacts exist in the four stages of RE project life: “planning and policy development,” “construction and implementation,” “operations and maintenance, and decommissioning” (Al-Sarihi et al., 2015). Four major social impacts can be identified as “public perception,” “employment,” “health and safety,” and “local infrastructure development” (Sheikh, Kocaoglu, & Lutzenhiser, 2016).
2.6 RE Policy Strategies in Thailand, Japan, and South Korea

This section discusses and compares the three countries’ policy strategies regarding RE deployment. The purpose of this analysis is to provide an opportunity to draw lessons from Japan and South Korea for the Thai model. First Thailand’s policy strategies are discussed, followed by those of Japan and South Korea.

2.6.1 RE Policy Strategies in Thailand

The economic success story of Thailand has led to a steady increase in energy consumption, resulting in rising dependence on the fuels and related publicity to international trade (International Energy Agency, 2016). One of the four pillars of energy sustainability is the efficient use of “energy to keep energy consumption growth lower than economic growth” (Berrah, Feng, Priddle, & Wang, 2007). However, it appears that the case of Thailand is completely the opposite. For example, the average “Gross Domestic Product (GDP) growth of 3.6 percent” per year between the years 2005 to 2010 increased the primary energy consumption by 4.1 percent per year (Asian Development Bank, 2015). Thai electricity consumption is unstable due to the relative changes in the country’s economic circumstances. In 2010, the Thai economy grew by 7.8 percent and electricity demand increased by 9.11 percent (International Energy Agency, 2016).

Affordable electricity is crucial to Thailand’s continued economic growth and development, and digital technology infrastructure and industrial activities rely on the constant and efficient supply of electricity. Most of Thailand’s energy generation is driven by imported natural and domestic gas supplies, which are projected to have a huge burden on foreign reserves and the gradual depletion of the country’s own natural resources. Consequently, natural gas imports are bound to rise, leading to increasing concerns about the security and affordability of the power sector (International Energy Agency, 2016). Traditional forms of power generation, including natural gas and coal, are feasible technologies as viewed by many stakeholders in the electricity sector. However, the development of these traditional sources in Thailand faces major obstacles, partly due to their high levels of emissions and their reliance on external sources of fuel. Nuclear energy is another feasible
option which neither comes with any associated emissions nor reliance on imported fuels. However, it has major costs and public perception challenges. Meanwhile, hydropower generation is also feasible to use as it is free from significant levels of emissions, but it has potentially dire consequences on the environment as well as being subject to seasonal variability, a problem that may increase due to climatic changes, rising erratic rainfall patterns, and high-temperature levels in the Mekong area and other parts of the country. Similarly, wind and solar power have made significant high-tech progress and are being rapidly deployed around the world (International Energy Agency, 2016).

Thailand has recently recovered from the negative impacts of political turmoil. The political crisis that resulted led to a decline in economic activities, resulting in a growth rate of 0.9% in 2014, which increased slightly to 3.1% in 2015, and it is anticipated to average around 3.6% between 2016 and 2020 (Organisation for Economic Co-operation and Development, 2015). Thailand remains a major producer of energy, “with a total production 78.1 Mtoe” in 2013. Natural gas constituted 36.3% of “all production, followed by biofuels and waste (31.5%), oil (24.8%) and coal (6.5%). Additionally, hydro, wind and solar energy are produced although at a lower share at around 0.8 percent of production for all of them combined (International Energy Agency, 2016). The important question for the Thai government to answer is whether current “policies, market design and regulatory frameworks will deliver reliable, efficient” and progressive cleaner electricity supply in a timely manner (International Energy Agency, 2016).

2.6.1.1 RE Policy

“Alternative Energy Development Plan (AEDP)”

The “Power Development Plan (PDP)” is a 21-year plan, which includes the types of energy generation and a schedule for the development of RE. The guiding principles of the PDP are:

1 “Security: ensuring adequate supply and increasing the overall diversity of the generation fleet”

2 “Economy: ensuring that all relevant costs can be recovered via the tariff and that the development plan is affordable”
3 “Ecology: limiting the environmental impact of the generation fleet as a whole” (Ministry of Energy, 2015)

Inherent in the PDP is the “Alternative Energy Development Plan.” The plan is robust on the development of RE compared to others in Southeast Asia (International Energy Agency, 2016; Ministry of Energy, 2015). The AEDP has a target of 30% gross “energy consumption from renewable sources” by 2036 (International Energy Agency, 2016). The plan targets 20% GWH of “installed capacity” by 2036 to meet 20% of the energy load. Since 2009, the Thai government has proposed four RE plans and the plans are incremental with the improvements in the targets for each of the REs in successive plans. This points to the growing confidence in RE technologies. Table 2.1 presents the current “AEDP and compares it against past RE plans”: Thailand’s RE Plan.

Table 2.1 Thailand’s RE Plan

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar</td>
<td>500</td>
<td>2000</td>
<td>3000</td>
<td>6000</td>
</tr>
<tr>
<td>Wind</td>
<td>800</td>
<td>1200</td>
<td>1800</td>
<td>3002</td>
</tr>
<tr>
<td>Hydro (domestic)</td>
<td>324</td>
<td>1608</td>
<td>324</td>
<td>3282</td>
</tr>
<tr>
<td>Hydro&gt;15MW</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2906</td>
</tr>
<tr>
<td>Hydro ≥ 15MW</td>
<td>324</td>
<td>1608</td>
<td>324</td>
<td>376</td>
</tr>
<tr>
<td>Biomass</td>
<td>3700</td>
<td>3630</td>
<td>4800</td>
<td>5570</td>
</tr>
<tr>
<td>Biogas</td>
<td>120</td>
<td>600</td>
<td>3000</td>
<td>1280</td>
</tr>
<tr>
<td>Napier grass</td>
<td>0</td>
<td>0</td>
<td>3000</td>
<td>0</td>
</tr>
<tr>
<td>Energy crops</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>680</td>
</tr>
<tr>
<td>Wastewater</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>600</td>
</tr>
<tr>
<td>Waste-to-energy</td>
<td>160</td>
<td>160</td>
<td>400</td>
<td>550</td>
</tr>
<tr>
<td>Others</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>5607</strong></td>
<td><strong>9201</strong></td>
<td><strong>13927</strong></td>
<td><strong>19684</strong></td>
</tr>
</tbody>
</table>

Note: MW = megawatt; REDP refers to the Renewable Energy Development Plan; the target for hydropower above 15 MW is based on exiting domestic capacity.


RE has seen “continuous growth due to supportive policy frameworks and incentive measures in the feed-in-tariffs (FITs)” and tax exemptions by the government of Thailand. As of “September 2015, total grid-connected renewable
power stood” at 4,348 MW or 8.5 percent of installed generation (Energy Regulation Commission, 2015), with the exemption of “hydro, renewables [accounting]” for 5% of “installed generation” (International Energy Agency, 2016). In 2013 and 2015, the solar energy sector grew substantially with an average growth rate of 59%, “waste-to-energy power, 51.5%, wind power, 33.5%, biogas, 23% and biomass, 11.1%.” Table 2.1 shows the status of RE expansion in Thailand vis à vis the AEDP2015 target for 2016. Table 2.2 Renewable Power Growth in Thailand and the AEDP2015 target for 2036

2.6.1.2 Thailand’s “Energy Efficiency Plan” (EEP)

The EEP is from 2015-36 and it is the foundation for improving energy security and a regular supply of electricity security, meeting the increased demand, and reducing the additional energy generation and state investment. With the EEP, the government has implemented several measures aimed at increasing total energy capacity by 90 terawatt hours by 2036. This will reduce energy intensity by 30% as improved over the 2010 plan (International Energy Agency, 2016).

The EEP has five (5) strategies to increase energy efficiency by strengthening and expanding the energy capacity as follows:

1) “Mandatory requirements with rules, regulations, and standards”
2) “Energy conservation promotion and behavior change”
3) “Promotion of technology development and innovation”
4) “Development of human resources and institutional capacity”
5) “Public awareness of energy efficiency and behavior change”

The policy actions in the EEP involve “minimum energy performance standards (MEPS),” and “energy efficiency resource standards (EERS).” It also includes “energy management systems” in residential and manufacturing industries. The measures seek to increase the markets for “light-emitting diodes (LEDs)” and “lighting systems” as well as to “promote energy efficiency” and financial incentives to would-be investors (International Energy Agency, 2016).
2.6.2 Fiscal Measures and Regulatory Mechanisms

The Permit Process for Renewables

The process of acquiring a permit for Very Small Power Producers (‘VSPP’) projects is difficult. It requires substantial bureaucratic procedures, third-party contractors, and the approval of the Metropolitan Electricity Authority (MEA), the Provincial Electricity Authority (PEA) and the Energy Regulation Commission (ERC). In the case of the VSPP, the mandatory permits are a generation license, an industrial permit, a building permit, and a zoning permit and an environmental safety assessment for plants larger than 5MW and less than 10 MW” (IEA, 2016a). It also takes one year to acquire all of the needed permits (International Energy Agency, 2016).

Fiscal Measures

The Thai government has put in place many supportive measures to stimulate the private sector to invest in electricity from RE. There have been several fiscal measures to support renewables in the country since 2007, the Adder tariff primarily because it involved a “premium paid on top of prevailing wholesale electricity rates” (International Energy Agency, 2016). In terms of fiscal policy measures, the Thai government has introduced two major measures: Adder tariffs and feed-in-tariffs in 2007 and 2015 respectively.

Adder Tariff Program in Thailand

The first fiscal policy measure to support the RE sector was called the Adder tariff. This tariff refers to a “premium paid on prevailing wholesale electricity rates” (TESA, 2016). Thailand’s utility RE started in 2007 with Thai “state-owned electricity distributors,” who offered to purchase electricity from RE producers through the “power purchase agreements (PPAs)” under the Adder rate, which was payable on the prevailing wholesale electricity prices.

The Adder payments were based on the type of technology and the price was 8 Baht per ‘kWh’ for solar energy. The Adder program motivated the RE sector by providing a “guarantee attractive power purchasing rates.” Investors were expected to enter into “long-term contracts” with a local utility company and to sell electricity at a pre-determined tariff for a specified period. The policy was implemented by three Thai utilities operatives: the “Electricity Generating Authority of Thailand (EGAT),”
the “Metropolitan Electricity Authority (MEA),” and the “Provincial Electricity Authority (PEA).” These three utility bodies purchased electricity from renewable electricity generators using three types of regulations:

1) “Very Small Power Producers (VSPP) regulations: for generators sized less than or equal to 10 MW. Electricity produced by the VSPP is sold to PEA or MEA.”

2) “Small Power Producers (SPP) regulations: for generators sized greater than 10 MW and less than 90 MW. Electricity produced by the SPP is sold to EGAT.”

3) “Adder rates are distinguished by technology type, installed capacity, contracted capacity, and project location.”

As a result since the introduction of the Adder rate, the policy has been in place from 2007 to 2014 and has been progressively replaced by the new tariff system in which the National Energy Policy Commission (NEPC) changed the Adder tariff payment structure with the “Feed-in-Tariff” (FIT),” where a “fixed amount per” ‘kWh’ is “paid during the life of the PPA.” According to the “NEPC”, the FIT uses a competitive bidding process for Very Small Power Producers.

*The “Feed-In-Tariff” Program in Thailand*

The “FIT rate” includes some specific projects that “deliver[s] power into the grid in the year 2017” (Watson Farley & Williams, 2015, p. 4). However, post-2017 the FIT rate is likely to increase based on the prevailing inflation rates in the country. This policy change will only apply to “waste (integrated waste management), biomass and biogas energy plants and projects” (Watson Farley & Williams, 2015, p. 4). Watson Farley and Williams note that this type of FIT only affects RE plans in Yala, Pattani, Narathiwat, and four sub-districts in Songkla: Jana, Tepha, Sabavoi, and Natawee Sub-districts. Table 2.2 depicts the FIT prices for VSPPs.
Presently, the plan has a fixed Feed-in-Tariff structure due to the changes in the price for the solar projects in 2010, and technologies in 2014 by the National Energy Policy Council. There are basically two types of FIT—the fixed FIT for solar power and the fixed FIT for non-solar power. In 2013, the Thai government implemented the FIT policy for solar PV, replacing the Adder program, which had been introduced in the energy plan in 2007. The quota allocated to the solar power generation under the PV scheme was limited to 200MW for “residential, commercial, and industrial rooftop solar installations” by the government (Watson Farley & Williams, 2015, p. 4). Table 2.3 below details the FIT for various power plant capacity.

Furthermore, an “800 MW quota” was approved for “ground-mounted solar systems” in communities. This was changed in the 2014 and 2015 plans by allocating “400 MW to ‘agricultural co-operatives’ and ‘400 MW’ to public properties,” as detailed in Table 2.4.

### Table 2.2 Feed-in Tariffs for Very Small Power Producers (VSPP)

<table>
<thead>
<tr>
<th>RE power status (MW)</th>
<th>AEDP 2036 target</th>
<th>Progress 2012</th>
<th>Progress 2013</th>
<th>Progress 2014</th>
<th>Progress 2015 (Jan-Aug)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar power</td>
<td>6000</td>
<td>377</td>
<td>823</td>
<td>1299</td>
<td>1314</td>
</tr>
<tr>
<td>Wind power</td>
<td>3002</td>
<td>112</td>
<td>223</td>
<td>224</td>
<td>225</td>
</tr>
<tr>
<td>Biomass</td>
<td>5570</td>
<td>1960</td>
<td>2321</td>
<td>2452</td>
<td>2679</td>
</tr>
<tr>
<td>Biogas</td>
<td>600</td>
<td>193</td>
<td>265</td>
<td>311</td>
<td>359</td>
</tr>
<tr>
<td>Energy crops</td>
<td>680</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Waste-to-energy</td>
<td>500</td>
<td>43</td>
<td>48</td>
<td>66</td>
<td>135</td>
</tr>
<tr>
<td>Total</td>
<td>16352</td>
<td>2685</td>
<td>3680</td>
<td>4352</td>
<td>4712</td>
</tr>
</tbody>
</table>

**Source:** DEDE (2015), “Performance on alternative energy policy” (Jan-Aug 2015), adapted by the author.
Table 2.3 FITs for Rooftop Solar

<table>
<thead>
<tr>
<th>Technology</th>
<th>Power plant capacity</th>
<th>Period of time</th>
<th>Feed-in tariff rate in THB/kWh</th>
<th>Quota</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rooftop solar</td>
<td>0-10kW</td>
<td>25 years</td>
<td>6.85</td>
<td>100 MW</td>
</tr>
<tr>
<td></td>
<td>10-250 kW</td>
<td></td>
<td>6.40</td>
<td>100 MW</td>
</tr>
<tr>
<td></td>
<td>250kW-1MW</td>
<td></td>
<td>6.01</td>
<td></td>
</tr>
</tbody>
</table>

Note: installations to be operational by December 2015; kW = kilowatt.
Source: Ministry of Energy, Technology, power plant capacity, adapted by the author.

Table 2.4 Ground-mounted Solar in Agricultural Co-operatives and Public Properties

<table>
<thead>
<tr>
<th>Technology</th>
<th>Period of time</th>
<th>FIT rate in THB/kWh</th>
<th>Quota</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ground-mounted solar for agricultural co-operatives</td>
<td>25 years</td>
<td>5.66</td>
<td>800 MW</td>
</tr>
<tr>
<td>and government properties</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: installations to be operational by December 2015; kW = kilowatt.

The fixed FIT for non-solar was introduced in 2014 because of the widening of the solar FIT program to cover non-solar generation. The FITs for this category are issued for 20 years except for bio-gas “power from landfill gas,” which is 10 years. These changes place a huge burden on the application processes for the non-solar renewable sector mostly for a year. The “FITs for ‘non-solar’” renewables have three (3) components:

1) “FIT (F): the fixed portion of remuneration”
2) “FIT (V): the variable portion of the remuneration, adjusted according to inflation rate”
3) “FIT (P): the feed-in-premium that is split according to the fuel type and location of the installation”

The “renewable power procurement” in this program is through a competitive bidding process, with thorough regulation released in 2016. The details of the “competitive bidding schemes” are as follows: “the biomass,” “biogas
(waste/wastewater and energy crops),” and “wind” in the areas around the regions of the northern, eastern, western, southern, central Thailand, and Bangkok. These projects are scheduled to compete for capacity and quota allocation through the FIT system by each project. Further, the merit system through the FIT program, the “winning bidder” “offers the highest discount from the announced FIT (F).” The bidding process ends if the “total quota for each type of renewables in each region” is completed.

### 2.7 Key Government Institutions

There are several institutions that are involved in the development of RE policies in Thailand and each one of them plays a vital role to ensure that the government’s agenda for 30% renewable sources of energy is added to the national grid by 2036. Figure 2.2 depicts the key players in the RE sector.

**Figure 2.2 Institutional Framework for the Thai Energy Sector**

**Source:** Ministry of Energy, official-structure 2018, adapted by the author.

### 2.8 Japan’s RE Policy

In Japan, RE is viewed as a “strategic opportunity and a practical challenge” (IEA, 2016 a). The earthquake and tsunami in 2011 led to a “shutdown” of the
country’s nuclear power fleet, and the country depended heavily on energy imports. The gap created by the “nuclear power” electricity “mix had to be filled with fossil generation in the short term and increased the country’s domestic carbon dioxide (CO2) emissions and import costs (International Energy Agency (IEA), 2016 b). Thus, for Japan, an “accelerated deployment of RE” can be useful in many ways. RE has the potential to reduce import dependence as well as increase energy security through the diversification of the energy mix of Japan.

Japan has a wide variety sources of RE, such as “geothermal,” “hydropower,” “wind,” and “solar power” as well as “biomass.” The topography and population density of Japan make it difficult for the development of RE projects; thus, good and available resources are unexploited in remote locations (IEA, 2016 b). Japan has the “second lowest share” of the renewable in “total primary energy supply (TPES)” among “IEA member countries,” higher only than Korea (IEA, 2016 b). Figure 2.3 below presents the share of RE as a “percentage of TPES in Japan and IEA member countries” (IEA, 2016 b).

Figure 2.3 Renewable Energy as a percentage of TPES in Japan and in IEA member countries, 2015, adapted by the author.

RE constituted about “24.9 million tonnes of oil equivalent (Mtoe) or 5.7%” of “Japan’s TPES” in 2015. RE included “biofuels” and “waste (11.4Mtoe or 2.6% of TPES),” “hydropower (7.3 Mtoe or 1.7%),” “solar power (3.4 Mtoe or 0.8%),” “geothermal (2.4 Mtoe or 0.5%),” and “wind energy (0.5 Mtoe or 0.1%).” Table 2.6
shows the renewable generation capacity of Japan from 1990 to 2014. Table 2.6
Renewable electricity generating capacity, 1990-2014 (MW)

### 2.8.1 RE Policy Measures in Japan

"The Strategic Energy Plan and the Long-Term Energy Supply and Demand Outlook"

The plan generally highlights the measures to be implemented between 2018 and 2020, and it incorporates a set of best practices learned after the introduction of the first FIT policy in 2012. The plan is typically a diversified RE deployment of sources, and measures to support wind, geothermal power sources and promote even distribution of RE resources in four areas: biomass, hydropower, solar PVs, and heat energy. Additionally, a FIT policy has been reformed and is being replaced by a center of the RE industry (IEA, 2016, b). The “Strategic Energy Plan” has been supported by the “Long-term Energy Supply and Demand Outlook” in 2015. The new supplementary plan involves a more robust quantification of the evolution of the energy mix by 2030 in Japan. The new outlook seeks to increase RE supply and the country’s self-sufficient move by 24%, which will be driven by the desire to increase RE sources to 13% and increase TPES by 14%. Further, the country’s energy mix as indicated earlier includes nuclear energy, which is expected to add 10% to 11% to the national grid, and “installed capacity.” There are major changes to reduce liquefied natural gas (LNG) and petroleum products, as well as increased coal production (IEA, 2016, b). Particularly, in reference to renewable sources, the plan suggests that its share (13.5% by 2020) of the energy mix is higher than in previous plans. Subsequently, at this pace, Japan is likely to achieve 23% of RE supply by the 2030s. Japan seems to have a more robust RE policy in the sense that it has different policy measures for different sectors as discussed below.

The FIT was introduced in 2012 in Japan. Before the introduction of the FIT system, the major policy an investment in research and development (R&D) supported by a RE certificate system, which purposively aimed at a low share (1.19%) of RE in total installed capacity and power. Meanwhile, when the FIT policy was introduced, the government of Japan ensured clear policy objectives of the FIT program, which was aimed at increasing the generation capacity of most RE sources.
The result of this approach was nevertheless mixed; for example, RE recorded a substantial and sudden rapid increase, and its growth was mainly confined to certain geographical locations with regards to solar PV. With the FIT policy, power producers are mandated to buy electricity from RE sources on a fixed-period contract basis at a fixed price.

According to the IEA (2016), the price of electricity generated from RE sources are fixed and within a specific period. The cost involved in purchasing electricity is obtained from consumers through surcharges as per unit of the additional electricity consumed. The electricity power companies contribute to FIT payments at an amount equivalent to their avoided generation. With the FIT policy, the tariffs are revised on an annual basis, while solar PV tariffs applied to new installation plants have seen a reduction more frequently than the others. See Table 2.5 below.

Table 2.5 “Feed-in-tariff purchase prices, FY2012 to FY2016” in Japan

<table>
<thead>
<tr>
<th>Technology</th>
<th>Size</th>
<th>Eligibility period [years]</th>
<th>FY2012</th>
<th>FY2013</th>
<th>FY2014</th>
<th>FY2015</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>FY2016</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Solar</td>
<td>&lt; 10 kW</td>
<td>42</td>
<td>38</td>
<td>37</td>
<td>33-35</td>
<td>31-33</td>
</tr>
<tr>
<td></td>
<td>10 kW or more</td>
<td>20</td>
<td>36</td>
<td>32</td>
<td>29-27</td>
<td>24</td>
</tr>
<tr>
<td>Wind onshore</td>
<td>&lt; 20 kW</td>
<td>55</td>
<td>55</td>
<td>55</td>
<td>55</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td>20 kW or more</td>
<td>22</td>
<td>22</td>
<td>22</td>
<td>22</td>
<td>22</td>
</tr>
<tr>
<td>Wind offshore</td>
<td>20</td>
<td>-</td>
<td>-</td>
<td>36</td>
<td>36</td>
<td>36</td>
</tr>
<tr>
<td>Geothermal</td>
<td>&lt; 15 MW</td>
<td>40</td>
<td>40</td>
<td>40</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>More than 15 MW</td>
<td>26</td>
<td>26</td>
<td>26</td>
<td>26</td>
<td>26</td>
</tr>
<tr>
<td>Hydro – new facilities</td>
<td>&lt; 200 KW</td>
<td>34</td>
<td>34</td>
<td>34</td>
<td>34</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>200-1 000 kW</td>
<td>29</td>
<td>29</td>
<td>29</td>
<td>29</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>1-30 MW</td>
<td>24</td>
<td>24</td>
<td>24</td>
<td>24</td>
<td>24</td>
</tr>
<tr>
<td>Hydro – existing facilities</td>
<td>&lt; 200 KW</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>200 - 1 000 kW</td>
<td>21</td>
<td>21</td>
<td>21</td>
<td>21</td>
<td>21</td>
</tr>
</tbody>
</table>
Since the introduction of the FIT, there has been significant investment in RE, with the dominant one being solar PV. Between 2012 and 2016, Japan’s RE capacity was 26.6 GW with the FIT program; however, since January 2016, Japan had registered a large quantum of projects in the FIT system which had not been installed on 59GW which included 53 GW from commercial PV, 2.2 GW from wind, and 2.4 GW from biomass (IEA, 2016, b). The cost of the FIT system for fiscal year (FY) 2016 was about JPY 2.3 trillion.

2.9 South Korea’s RE Policy

Policy and legal frameworks for RE in South Korea date to the 1970s. The Promotion Act 1972 for “New & RE (NRE) Development, Utilization, and Deployment” was introduced. The implementation of the NRE can be grouped into three broad time periods. The first deployment of the Act was in the 1980s and focused on “solar thermal heating devices” and “waste incineration.” The second phase was in the 1990s, resulting in a 10-year (1997-2006) when the national plan for “NRE technology development” was established; and the third phase began in the
early part of the 2000s under which the “NRE deployment” was more progressive and strategic in promoting RE development, such as the “NRE procurement for the public sector and the implementation of feed-in-tariffs” (Chen, Kim, & Yamaguchi, 2014).

In 2008, the country introduced the “3rd basic plan for NRE Technology Development and Deployment,” aimed to provide robust strategies to support the green power generation industry and NRE policy targets to 11% of the “TPES” by 2030. The aim of the policy is to expand RE generation, for example solar, wind, and biomass, while reducing the dependence on waste power from 71% in 2010 to 33% by 2030. Furthermore, the NRE requirement for public buildings has been implemented and enforced. The plans require that public buildings larger than 100m2 use about 5% of NRE as their total energy supply in 2012. Recent evidence suggests that the public buildings that are larger than 300m2 use 5% of their construction expenditure on NRE. The “3rd Plan” aims at competition within the domestic NRE market to achieve a Low Carbon Green Growth (LCGG) goal as a new national vision in the next fifty years (Chen et al., 2014).

Figure 2.4 Current NRE Production Profile and Future Targets in South Korea

The objective of the government of South Korea is to increase the proportion of domestic green energy technologies both locally and internationally (Chen et al., 2014) by 57% in 2010 to 98% by 2030, as well as to increase 1.2% of green energy technologies to 18%. The government’s goal is to develop wind technology by 2020 and to export wind energy by supporting the deployment of reliable and high-efficiency performing large wind turbines to about 2-3MW onshore, and 3-5MW offshore wind power (Ministry of Trade Industry and Energy, 2010) (figure 2.4).

Besides these policy measures, the South Korean government has promoted a market-oriented path. Since 2012, the “Renewable Portfolio Standards (RPS)” has been implemented to replace the FIT policy that was introduced in 2012. Although South Korea had started to achieve concrete results from the FIT policy measure, the program was discontinued since the cost burden was placed on the government. Due to the fast growth of solar PV systems, the real payments of the FIT were exceeded, and this placed a huge burden on the budget for the FIT system. The FIT to a very large extent constituted a huge portion of the total budget for the NRE R&D, and RE deployment of about 39% in 2011 and 30% in 2012 (Chae, 2014; Kwon, 2009). The “RPS” demanded that six (6) state-run and private power utilities with more than 500MW capacity to generate about 2% of RE in 2012, which would increase annually to about 10% by 2022. Additionally, a separate target for the solar PV sector demands an additional installation of 220MW in 2012, which will increase by 10MW annually by 2016. The “RPS” was introduced with the “RE Certificates” (REC) trading program. Furthermore, the “GHG cap-and-trade” program was introduced in 2015. Table 2.6 presents a summary of the various RE policies and support schemes in Thailand, Japan, and South Korea.

Table 2.6 RE Policies in Thailand, Japan, and South Korea

<table>
<thead>
<tr>
<th>Nation</th>
<th>Policy Document</th>
<th>Fiscal Support Measures</th>
<th>“RE Target”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thailand</td>
<td>“Alternative Energy Development Plan (AEDP) (2015-2036)”</td>
<td>Feed-in-tariff for solar PV</td>
<td>30% by 2036</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Feed-in-Tariff for non-solar (Fixed, Variable, Premium)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tax Exemptions</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Feed-in-Tariff for agricultural cooperatives and</td>
<td></td>
</tr>
<tr>
<td>Nation</td>
<td>Policy Document</td>
<td>Fiscal Support Measures</td>
<td>“RE Target”</td>
</tr>
<tr>
<td>-----------</td>
<td>---------------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>Japan</td>
<td>The Strategic Energy Plan (2018-2020)</td>
<td>Feed-in-Tariff (Electricity)</td>
<td>23% by 2030</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Subsidy – (biofuels)</td>
<td></td>
</tr>
<tr>
<td>South Korea</td>
<td>“Promotion Act for New &amp; RE Development, Utilization and Deployment (1972)”</td>
<td>FIT (defunct since 2012)</td>
<td>11% by 2030</td>
</tr>
<tr>
<td></td>
<td>The “3rd basic plan for NRE Technology Development and Deployment” (2008)</td>
<td>Renewable Portfolio Standards</td>
<td></td>
</tr>
<tr>
<td></td>
<td>“NRE requirement for the construction of public buildings” (2012)</td>
<td>RE Certificates</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>GHG cap-and-trade program</td>
<td></td>
</tr>
</tbody>
</table>

**Source:** Author’s compilation from Chen et al., (2014); IEA (2016a); IEA (2016b).

### 2.10 A Theoretical Review of Public Policy Decision Models

Explaining the policy decisions of the government has been a long-standing practice in public administration (Perri, 2014). One of the ways that this puzzle of policy explanation has been solved was through political or policy models. A model is basically a simplified representation of a part of the real world. It may be presented as a miniature physical representation, such as a tabletop building that an architect uses to project how a building will look when a proposed project is completed. A model may also be presented in the form of a diagram, for instance, a flowchart that is used to show how policy goals will be accomplished (Dye, 2011). Many models of policy have been identified by public policy scholars. Each of these models in one way or the other has some form of utility in the study of public policy. Some of the well-known models include: the “system theory,” “group theory,” “elite theory,” “institutional
model,” “rational/public choice model,” “process model,” “the rational model,”
“incremental model,” and “the game theory model” (Anderson, 1994; Dye, 2011).

This study does not intend to discuss all of the policy models listed above;
instead, it focuses attention on three of the above models to present a detailed
discussion. The three selected models include:

1) The rational model/rational comprehensive model
2) The incremental model/incrementalism
3) The system model

2.10.1 The Rational Decision-Making Model

According to Dye (2011), a “rational policy” is a policy that attains
“maximum social gain.” In other words, a government’s choice of a policy should
produce benefits to the society that exceeds the cost by the utmost amount, and
governments should as much as possible desist from policies if the costs far outweigh
the gains. It has also been defined as the decision-making that pursues logical
consequences. Additionally, Stewart, Hedge, and Lester (2008) explained a rational
decision as one based on the assumption that individuals arrive at decisions based on
the back of the rational calculation of costs and benefits. All of these definitions place
a premium on the ultimate consequence of decisions, where the benefits should
always cross out the costs. Kørnøv and Thissen (2000) further point out that the
processes leading up to a decision under the rational model should be based on insight
into the consequences of alternatives and thus, the selection of any alternative follows
the assumption that the said alternative will best achieve societal goals or objectives.

The rational decision model entails five major steps or processes including: (1)
to “identify all the society’s value” preferences and “their relative weights;” (2) to
“identify all the policy” alternatives; (3) to identify “all the consequences of each
policy” alternatives; (4) to “calculate the ratio of benefits to cost for each policy
alternative;” and (5) to “select the most efficient policy alternative” (Anderson, 1994;
Dye, 2011; Kørnøv & Thissen, 2000; Stewart et al., 2008). In explaining these
processes further, Dye (2011) argued that “rationality assumes that preferences of
society as a whole can be known and weighted” (Dye, 2011, p.3). It is also not enough
to identify and weigh the values of some groups to the neglect of others; thus, the
rational model assumes a complete appreciation of societal values. The rational model further necessitates information about alternative policies and the prognostic capacity of policymakers to forecast precisely the consequences of alternative policies, as well as the acumen to compute with accuracy the ratio of costs to benefits.

Indeed, the task of decision-making via the rationale is not only complex but impossible; it is a highly idealistic approach. It does not, therefore, come as a surprise that the model has been criticized widely by academics. A rational process does not necessarily translate to a rational choice because of imperfect information and multiple objectives, coupled with the “fact that people do not always behave as assumed in the rational model for decision making,” the cost of information, and limited time (Dye, 2011p., 4; Kørnøv & Thissen, 2000). Furthermore, this model of decision-making is a normative one, in the sense that its application will result in the enhancement of real-world decision-making over current practice (Kørnøv & Thissen, 2000). According to Dye (2011), policymakers may not be motivated by social goals; rather, they attempt to maximize “their own rewards (power, status, re-election, and money).” Further, instead of maximising “net social gain,” they only “satisfy demands for progress;” in other words, they rarely “search until they find” “the one best way;” rather, they stop “their search when they find an alternative that will work,” what Simon referred to as “satisficing” or the “administrative man” (Dye, 2011; Kørnøv & Thissen, 2000).

Moreover, the issue of sunk costs prevents policymakers from re-evaluating alternatives foreclosed by prior decisions. However, with advanced technologies, policymakers do not have the requisite intellect to calculate with precise “costs and benefits when a large number of diverse” institutional, “social, economic and cultural” values are involved. Besides the above criticisms, almost all empirical research indicates that decision-making in practice usually does not follow the rigor of the rational procedure (March 1987, 1988, 1994; Scott, 1972). Rather, attention is viewed as a scarce resource (Kørnøv & Thissen, 2000). Decision-makers therefore “have a natural limited mental capacity and are” compelled to work with these limitations “with a limited amount of information.” Consequently, “common decision-making procedures may not follow “rational decision making patterns but make use of standards such as “habit,” “tradition,” the doing of things like others,
replicating what worked in the past, and better still, mimicking successful people (Kørnøv & Thissen, 2000). Figure 2.5 depicts the rational decision model.

**Figure 2.5** A Rational Model of Decision-Making. Adapted from Thomas R. Dye (2011). Understanding Public Policy.

**Source:** Ministry of Energy, resource for pure rationality process, adapted by the author.

### 2.10.2 The Incremental Model/Incrementalism

The incremental model or as it is popularly termed, incrementalism, appears to be the most favored decision-making model among policymakers. The overwhelming receptiveness it enjoys stems from the assessment that it does require monumental revision of existing policies. According to Stewart et al. (2008), incrementalism views public policy formulation as a continuance of previous government activities with only minimal adjustments. Charles E. Lindblom is credited as the father of incrementalism and he first presented the idea in a critique of the rational model. Dahl and Lindblom (1953) explained incrementalism as follows:

“... a method of social action that takes existing reality as one alternative and compares the probable gains and losses of closely related alternatives by making relatively small adjustments in existing reality or making larger adjustments about whose consequences approximately as much is known
as about the consequences of existing reality, or both. Where small increments will clearly not achieve desired goals, the consequences of large increments are not fully known, and existing reality is clearly undesirable, incrementalism may have to give way to calculated risks. Thus, scientific methods, incrementalism, and calculated risks are on a continuum of policy methods” (Dahl & Lindblom, 1953 cited in Bailey & O'Connor, 1975).

According to the above definition, Bailey and Robert (1975) identified three underlining issues that are apparent in the incremental decision-making model: (1) “incrementalism is one of the several methods of decision making;” (2) “the incremental method may produce both small and large increments;” and (3) “the decision between large increments and calculated risks” is found in the decision maker's “knowledge of consequences of his actions;” This borders on “methods of problem-solving;” however, it is imperative to state that the concept of calculated risks is not a critical concept in incrementalism, especially as it is applied in analyses of budgetary decision-making.

More importantly, the limitations of time, intelligence, and cost make it extremely difficult for policymakers to identify the whole gamut of “policy alternatives and their consequences.” It is thus considered a conservative approach because “existing policies” are regarded “as a base and attention” is focused on “new policies” or increases (Stewart Jr. et al., 2008; Dye, 2011). However, the processes of seriality, remedially, and feedback allow the decision-maker continually to readjust policies at the margin through a series of estimates. Incrementalism viewed in this way is used as a strategy to cope with complexity and the cost of analysis (Bailey & Robert, 1975).

Stewart et al. (2008) have identified some key assumptions and components of incrementalism as follows:

Principal Assumptions

1) “Decision makers do not have different predictive capabilities to know all the consequences of each alternative”.

2) “Decision makers accept the legitimacy of the consequences of each alternative”.
3) “Sunk cost prevents serious consideration of all policy alternatives and especially any radical change in policy”.
4) “Incrementalism reduces conflict and is politically expedient”.
5. “The characteristics of the decision makers themselves are more suited to the incremental model, in the sense that humans are not valued maximizers but satisficers acting to merely satisfy particular demands”.

The key components of the model are:

1) “Selection of goals and empirical analysis of actions needed to attain them are closely intertwined with one another rather than distinct”.
2) “The decision maker considers only some of the alternatives for dealing with a problem, which differs only incrementally from existing policies”.
3) “For each alternative, only a limited number of important consequences are evaluated.”
4) “The problem is continually defined”.
5) “There is no single best solution for a problem. The test of a good decision is that various analyst finds themselves directly agreeing on it without agreeing that the decision is the most appropriate means to an agreed upon objective”.
6) “It is essentially remedial and geared more to the amelioration of present concrete social imperfections than to the promotion of future social goals”.

The incremental decision model has its fair share of challenges and these have been pointed out by scholars of public policy. It has been criticized for its inability to “explain dramatic policy change or reversals.” Likewise, it cannot “explain recent governmental efforts at long-range planning” (Stewart et al., 2008). Dye (2011) on his part believes that the incremental model may possibly fail when policymakers are confronted with crises. Using the financial crises in the USA in 2008 as an example, it
is asserted that the President, Congress, the “Treasury Department, and the Federal Reserve Board” came together to agree on a “record non-incremental” expansion of federal power. Federal spending and deficits increased dramatically, well beyond any levels that might have been foreseen by the incremental model. The Treasury Department was granted $700 billion to bail out the main financial establishments. The Federal Reserve Board reduced interest rates to their lowest in history and provided unparalleled amounts of credit to the financial system. Congress itself passed a stimulus package, the largest single spending bill in the US history. Incrementalism was abandoned completely (Dye, 2011).

The above point amplifies earlier studies which raised the question of what constitutes an incremental adjustment. Bailey and Robert (1975) defined adjustments between 0 and 10 percent as incremental, adjustments between 11 and 30 percent as intermediate, while modifications beyond 30 percent were viewed as non-incremental. Incrementalism defined in this manner suggests that 47 percent of House appropriations in the US are non-incremental (Fenno, 1966). Because of this high rate of non-incremental appropriation, Fenno proposed raising the cut-off to 20 percent, thereby roping in about three-quarters of the agencies as having grown at incremental rates. Such flexibility occurs despite statements that even a 5 percent shift can weaken an agency (Fenno, 1966). Questions pertaining to the basis on which one can double the range may be considered incremental. This certainly relates to the basic criticism that the criteria are left far too vague (Bailey & Robert, 1975). Consequently, it is suggested that a “reorientation of research strategy to measure” to the degrees of policy “outputs and to define what levels of adjustments may be considered non-incremental” (Bailey & Robert, 1975). In other words, there should be a clear distinction between incremental and non-incremental adjustments in policy. Figure 2.6 depicts the incremental decision-making model.
2.10.2.1 The System Theory

The system model was pioneered by a biologist and used in the field of politics in the classic analysis of policymaking by David Easton (Stewart et al., 2008). The system theory proposes that public policymaking is initially affected by demands for policy or the support for existing policies. According to Easton (1966) a “system is any set of variables regardless of the degree of interrelationship among them,” while a “political system can be designated as those interactions through which values are authoritatively allocated for a society” Rapopart (1966) set out to identify certain key components that qualify an entity as a system. He maintains that a fully-rigorous definition of a system will single out from all classes, aggregates or phenomena those that can meet the following criteria:

1) “A set of identifiable elements”
2) “Identifiable relations”
3) “Certain relations imply others”
4) “A certain complex of relations at a given time implies a certain complex at a later time”

A complete specification of the elements and the relations among them defines the state of a system. There are no restrictions on the elements of the system. They
can be living or non-living, material or non-material. Nor is there any restriction on the sort of relations that can be obtained among the elements. The restriction which is implied by the requirement of rigor is that both the elements and the relations are unambiguously specifiable. This does not mean that the entities and relations are known as soon as the system is defined. Indeed, the investigation of any system is frequently directed at uncovering the identities of the elements, the nature of the relations, and the dynamic laws governing the evolution of the system in time (Ibid).

To explain the above point further, let us consider the human rights system in the US under the lens of system theory. We can observe that the entities within the various elements (institutional, economic, and social) have evolved tremendously over time. Take for example the social element of human rights in the 19th century. You will notice that Black Americans were slaves without any form of rights, such that their masters could use them in any way they wanted. Thus, a slave master could have sex with his slave without her consent and that would not be considered as rape. The Blacks had no property-owning rights, and they could not intermingle with whites and could not inter-marry. Two centuries down the line, slavery was completely abolished, and Blacks can now own property and can also marry whites. The elements—institutional, economic, and social—have remained the same throughout these centuries but the entities or contents of the elements have been dynamic.

Easton (1966) further illustrates that the environment in a political system may be “divided into two parts: the intra-societal and the extra-societal.” The first comprises “those systems in the same society as the political system,” which are not “political systems due to the definition” of the nature of “political interactions.” Intra-societal systems consist of such “sets of behavior,” “attitudes and ideas” as the “economy,” “culture,” “social structure,” and “personalities”; “they are functional segments of society of which the political system is itself” a component. The second part of the “environment,” the extra-societal, includes “systems that lie outside the given society itself.” They are “functional elements” of the “international society,” a supra system of which “any single” society is part. The intra-societal and extra-societal together constitute the “total environment of the political system.” Because of these disturbances that influence the system and thereby change it, the system is
Dynamic. Some of the disturbances strain the system, others are favorable, yet still, others remain neutral.

This concept of dynamism “links the elements of the system in a dynamic relationship” to explain the rise and decline of the system. Development (change) occurs when the existing “structure and culture” of the “political system” is not able to cope with a challenge that confronts it without further “structural differentiation” and “cultural secularization.” Any significant change in the low of inputs may result in a change in a “negative” or positive way (Scott, 1972) (figure 2.7). This theory of dynamism “liberates the model from being a static ‘snap-shot’” likely to become “irrelevant in a highly volatile situation” (Scott, 1872, p. 79-80). Below is a diagrammatic condensation of the dynamic system model.

![Figure 2.7 The Dynamic System Model](image)

**Source:** Dynamic model of Easton’s political system, adapted by the author.
As observed from the model above, the dynamic system model has five main components:

1. The input
2. The political system
3. The output
4. The environment
5. The feedback

There is some form of linkage between the components of the system in the form of an input-output relationship. The effects of movement of “transmitted across” the boundary of a “system” towards some “other system” as an “output of the system,” and hence, correspondingly as “input of the second system” (Easton, 1966). The rest of the section reviews the various components of the system theory. Inputs serve as summary “variables that concentrate” and reflect everything in the “environment” that is significant to the “political stress” (Easton, 1966). In the simplest form, inputs are responses entering into the system (http://www.politicalsciencenotes.com, n.d.). The environmental influences focus on two main “inputs;” namely, demands and support. They serve as the major indicators via which environmental influences and conditions modify and shape the operations of the political system (Easton, 1966). The demand is the expression of the opinion of the authoritative allocation with respect to a specific subject concerning who is responsible for carrying out an action (http://www.politicalsciencenotes.com, n.d.).

The primary intention of demands is to modify, influence, or change the political system and these demands can come in the form of undifferentiated wants, and articulated recognizable demands or specific issues (Ibid). The political system also receives some form of support from its environment. They are “positive responses towards” some level of a “political system.” The support of a political system is usually obtained through the allocation of values and implementation thereof. Without some form of support at a “minimum level, no political system” can persevere (Ibid).

The supports and demands in the system are complementary inputs. Future support for the “political system” will be “conditioned” by the degree to which the
“system satisfies current demands.” The “failure to meet demands” results in “withdrawal” of support and the “collapse of the system,” which Easton referred to as “stress” caused by “overloading” of the “input channels” without simultaneous “widening of the output channels” (Scott, 1972; http://www.politicalsciencenotes.com). The output is another significant component of the system. They consist of “decisions and actions of authorities,” and they produce “effects and consequences” which may have a “direct relation with the members’ attitude and behavior for the system” (http://www.politicalsciencenotes.com). Easton refers to them as authoritative allocation of values (Easton, 1966). In other words, they are decisions that are binding on any entity or individual within the system. Outputs are typically responses that flow from the system to the environment, and through outputs, we can trace the “consequences” of behavior within a “political system for its environment” (Easton, 1966).

According to Scott (1972), the “feedback” of “information responses to decisions” was introduced in later works of Easton. This feedback to “decisions” (outputs) affects the “nature of new demands and of internal modification and control” over the levels of demands by “institutional filters,” referred to as “gatekeepers” (“political parties” and interest groups), who contribute to “inputs” not drawn from the “external environment” of the “system” and known as “within inputs” (Easton, 1966). Generally, feedback helps to organize the “consequences flowing” from the “behavior” of the members of the “system” rather than from “actions” in the environment. Hence, the “system” may take “advantage of what has been happening by trying to adjust its future” behavior (Easton, 1966). All “systems” to take “collective action” entail those that “speak” on behalf of the system, termed the authorities. If outputs are to be taken to satisfy demands or to create situations that will do so, information must provide feedback, at least to these authorities on the effects of outputs. Without feedback, authorities will have to operate in the dark (Ibid). The feedback loop entails the production of outputs by authorities, a response by the members of the society to these outputs, the communication of information about this response to the authorities, and finally, possible succeeding actions by the authorities (Ibid).
Finally, system analysis of policy rests on the idea of a system embedded in an environment and subject to possible environmental influences that threaten to drive the essential variables of the system beyond their critical range. Such analysis means that the system must be able to respond with measures that alleviate that stress (Easton, 1966). The policy environment consists of the intra-societal and extra-societal environments, which have been explained earlier in this section.

2.11 Reflections on the Theoretical Expositions

The three models discussed above can each be deployed to aid in the analysis in the present study. By their nature, they are more competing theories than complementary theories. As such, it will be appropriate that the best help us in understanding the problem the thesis seeks to resolve. Consequently, the pros and cons of each of the three models discussed above are examined in line with the deployment of sustainable RE in Thailand, leading to the selection of an appropriate model among the three models to further develop a conceptual framework.

Beginning with the rational-comprehensive model, a number of challenges have been associated with the model by critics. Many of the problems associated with the model have already been discussed, but to recap a few, critics have argued that the model is not as rational as proponents will have you believe. It has been argued that policymakers are motivated by social good and that most of the time they tend to seek personal rewards (consolidating power, winning election, money, etc.). As such, they may choose to continue to deploy fossil fuel despite the debilitating effects associated with it. The problem of sunk costs can also make the consideration of an entirely new set of policies unattractive. Furthermore, the limitations of time, resources, and the intellectual capability of policymakers make it nearly impossible to adopt a rational model in policymaking. It is therefore not surprising that decision-makers do not follow the rigor of the rational comprehension model. Further, with the difficult criteria of the rational decision-making model, scientists have already established the worth of RE deployment, as well as the negative impacts of fossil fuel usage on both the environment and human health.
Empirical support for the above claim will be provided in the next section. Similarly, the economic and social consequences of RE adoption have well been documented at the global level. Therefore, when it comes to selecting energy options for countries, it is no longer a question of which alternative provides the most benefit at the least cost. RE has been established by both the natural and social sciences to be the optimal way to go. With this knowledge in the grip of policymakers, the rationale becomes irrelevant when it comes to the deployment of an energy alternative. The incremental model was discussed to determine its suitability for analyzing sustainable RE deployment in Thailand. One of the criticisms leveled against the incremental model is its inability to explain recent shifts in government effort toward long-run planning. RE requires medium to long-term planning if its energy deployment is going to be successful. The construction of plants, deployment, usage, and feedback on the impact of RE usage may take not less than five years. For this reason, incrementalism may not be an appropriate model for a comprehensive analysis of the deployment of RE.

The model to be assessed here is the systems model. Two main criticisms have come up against this model. The first is that the model has a vast problem about delimiting the boundaries of the environment of a political system. The model does not place any form of limitation or can be included in the environment of a system. This makes the system very lax. Secondly, the system model has been criticized for not having a rich content with regards to the conceptualization of the identities within an element. Critics argue that the identities within the elements cannot be identified with precision. For example, in the study of energy policy in a country such as Thailand, the main elements in the policy environment include economic, social, environmental, and institutional elements. However, the precision with which we have identified the elements cannot be extended to the identification of the identities within the elements. Take the institutional dimension for example, Add-in tariffs, feed-in tariffs, tax holidays for energy companies, and carbon prices are some of the identities that can be associated with the institutional element of energy policy, but these identities may not be the same in every system. Some jurisdictions may not even have an energy policy, to begin with, and others may have a policy but may not have
these kinds of institutional identities, which makes one wonder if the model is universal at all.

Apparently, it is this lack of clear boundary demarcation as well as the imprecision of identities within the elements that make the system approach appealing. This behavior of the system model is a recognition that policy rests on the idea of a system rooted in an environment and is prone to possible environmental influences. With these characteristics, a researcher has the discretion to decide which elements and identities to include in a study, taking into consideration the uniqueness of every policy environment. This also means that the system is a dynamic one, and for that matter elements and identities in the system are bound to change with time. This element of dynamism further makes the system model a realistic approach to the study of policy. Consequently, this study employs the dynamic system model since it has the potency to provide robust explanations for sustainable RE deployment in Thailand.

2.12 A Conceptual Framework for the Analysis of the Deployment of Sustainable RE in Thailand

After a careful examination of the assumptions of various decision-making models, this study chose to adopt the system theory to analyze the deployment of sustainable RE in Thailand. To achieve this end, the study developed a conceptual framework via an extensive review of both the conceptual and empirical literature on RE in order to determine the extent to which the system theory helps to explain the deployment of sustainable RE in Thailand. Thomas R. Dye adapted the system theory to the study of American politics. His model suggested that socio-economic variables in the state (urbanization, industrialization, income, and education) create demands on or support for a political system (constitutional framework, interest groups or power structure), which in turn produce state policy outcomes (welfare, highway, education, and tax) (Dye, 1970).

Dye’s application of the system model simplifies and to a great extent exemplifies a real-world application of the model. Following the work of Dye (1970), this study applies the system model to the study of Thai RE policy deployment.
Linking the sustainable RE policy environment to the system model, it is observed that the concept of sustainability has three main components: social, economic, and environment. However, considering that the study is examining sustainability from a policy perspective, the study deemed it prudent to include an institutional dimension to the sustainability components. Consequently, four elements are identified as factors that influence the deployment of RE (social, economic, environmental, and institutional). These four factors jointly create demands on and support for policymakers, which in turn produce state policy outcomes; in the case of this study, the decision to deploy RE projects. The four elements identified above are made up of identities or sub-elements that are either drivers or barriers. Drivers work to enhance or support the deployment of RE, while barriers work to impede the deployment of RE. The four elements are discussed in the following paragraphs.

2.12.1 Environmental Factors

The quest for economic growth by countries around the world has increased the demand and consumption of energy in the past decades. In other words, energy drives growth (“RE Benefits: Measuring Economics,” n.d.). This quest for growth has brought about increasing climate change, prompting governments the world over to look for means of supplying energy to fuel the growth of their economies while minimizing greenhouse gas emissions and other environmental impacts (“RE Benefits: Measuring the Economics,” n.d.). Consequently, there has been a great shift from the use of fossil fuel towards alternative energy sources (wind, solar, hydro, biogas, and biomass), not just as a means to address climate change through greenhouse emissions (Buckman & Diesendorf, 2010; Chapman, 2016; “RE Benefits: Measuring the Economics,” n.d.) but as a strategy to achieve energy security (Berrah et al., 2007). The deployment of RE technologies has seen remarkable growth and as such, remarkable sustainable environmental benefits have been associated with RE deployment worldwide.

Many indicators have been used as proxies for the environmental factors from the deployment of RE. The most commonly used indicators are air quality, greenhouse gas emissions (GHG)/carbon dioxide equivalence emissions (CO2e), and RE technology system efficiency (Al-Sarihi et al., 2015; Byrnes, Brown, Foster, &
However, two indicators are of interest to this study: air quality and CO2 emissions. With regards to the measurements of these indicators, the air quality has been measured as the annual reduction in CO2 emissions (Al-Sarihi et al., 2015). GHG/CO2e has been measured as annual GHG emissions or tonnes of CO2 equivalent (Al-Sahiri et al., 2015), whilst elsewhere, it has been measured as \( \text{Generation} \times \frac{t \text{CO2}\text{e}}{GWh(g)} \), where \( g \) = generation source, and \( t \text{CO2}\text{e} \) = tonnes of CO2 equivalent (Chapman, 2016). With regard to the measurement of GHG/CO2e, this study has chosen to adopt the measure of Al-Sarihi and others (Al-Sarihi et al., 2015).

Much of the empirical literature supports both arguments—that the use of fossil fuels increases GHG/CO2e emissions and that the use of RE sources reduces these emissions. It is reported that “Oman’s emissions” are likely to increase by 8% a year as a result of fossil fuel usage. In 2001, electricity generation alone contributed to more than 60 percent of CO2 from fossil fuel, and industrial emissions contributed to over a third of Oman’s “total carbon pollution, making it the largest source of carbon” emissions in 2011, while the transport and other sectors contributed to about 15 percent in 2011 (Al-Sarihi et al., 2015).

2.12.2 Social Factors

The social factors in a political system also create demands and supports, leading to policy outcomes—in the case of study, the decision to deploy RE in Thailand. Social impact assessment (SIA) has been defined by the “International Association of Impact Assessment” (IAIA) as “managing the intended and unintended social consequences.” These consequences encompass both the positive and negative impacts of “planned interventions” (“policies, programs, plans, and projects”), and the social change processes invoked by such interventions (Assefa & Frostell, 2007). Social impact has also been defined as the “effect on society” and the well-being of the “community” and its “members;” that is, families and individuals. It has also been defined as the “consequences on the population of any public or private actions that alter the ways in which people live, work, play, relate to one another, organize to meet their needs and generally cope as members of society” (Sheikh et al., 2016, p.). The commonly-used indicator for the social benefits derived from RE sources (RES) are
job creation or reduction in the unemployment rate (Al-Sarihi et al., 2015; del Río & Burguillo, 2009; “RE Benefits: Measuring the Economics,” n.d.), social acceptance (knowledge and perception), the impact on property values, poverty alleviation and development, and improvement of the infrastructure (Assefa & Frostell, 2007; Bergek, 2010; Gallego Carrera & Mack, 2010; Goldemberg, 2012; Hinkle & Kenny, 2010; Mulugetta, 2008).

Studies have shown that increased RE deployment contributes to “job creation” (Del Rio & Burguillo, 2009; Al-Sarihi et al., 2015; IRENA, 2016). Depending on the nature of the policy introduced, employment can “increase anywhere from a few” thousand jobs? to “over a million in 2030.” These jobs may likely offset job losses in the fossil fuel sector because the sectors involved in the renewable supply chain are usually more distributed and labor intensive than the traditional “energy sector” (IRENA, 2016). Furthermore, the jobs created in the RE sector can be direct or indirect (Del Rio & Burguillo, 2009). Direct jobs include: “taxes on property,” “revenues for owners,” “short-term benefits” (“linked to employment creation in local sales and construction”), and “permanent benefits (“O&M employment”). The “indirect jobs” may be greater than the direct jobs created” from the sector but they are rather more “difficult” to calculate (Ibid). It is also important to note that the impact of employment due to an increase in RE sources “depends to a large extent on the combination of renewable electricity technologies,” “on the employment intensity of the different stages of the renewable electricity chain,” and “on the cost-efficiency in achieving the national RE” target (Pflüger, Jansen, Gialoglou, & Egenhofer, 2005).

Some scholars have “gone the extra mile” to differentiate between “two types of impacts on employment” (Hillebrand, Buttermann, Behringer, & Bleuel, 2006). The first is an “expansion effect” on “production and employment” arising from “RES investments.” There is also the “contraction effect” which arises because of an increase in electricity prices due to “greater costs of RES,” which leads to investment reduction in the “conventional energy sector.” This higher “cost burden” falls on the “electricity consumer,” which results in the “reduction” of “production and employment” in the “electricity sector” (Ibid). A higher electricity cost for “manufacturing firms” also implies a “reduction in their production and employment
levels.” The negative effect from the “contraction effect” may “outweigh the positive” effects from the “expansion effects,” which may result in “a net negative effect on employment” (Ibid). In Germany, it was observed that the “expansion effect” dominated in the early years, resulting in “33,000 new jobs in 2004, 14,000 in 2006 and 2400 in 2008.” However, in 2010, the “contraction effects” outweighed the expansion effects with 6,000 jobs being lost. Thus, for RE to succeed, it requires the support of the government (Ibid).

Employment creation or reductions in the unemployment rate has been measured as the number of new jobs arising from RE deployment (Chapman, 2016). Several scholars have reported empirically the impact of RES on job creation and employment generation. According to IRENA (2016), the solar PV “creates at least twice the number of jobs per unit of electricity generated compared with coal or natural gas.” Thus, substituting fossil fuel for RE can lead to “higher number of jobs” overall. Similarly, IRENA (2015) estimated that the RE sector supported around “7.7 million direct and indirect gross jobs in 2014,” accounting for an 18 percent increase from the previous year. It further reported that China is the “largest RE employer,” creating jobs for “3.4 million people.” Brazil, the “second largest employer,” has almost “1 million employed,” mostly in liquefied biofuels. Furthermore, in an analysis of the “impact on rural development of achieving the UK target for renewable electricity in 2010,” it was reported that 2,465 full-time jobs were created, although most of the “equipment” and “expertise” was imported (Del Rio & Burguillo, 2009). Many other authors report similar findings on job creation emanating from the RE sector (Chapman, 2016; European Photovoltaic Industry Association, 2012).

Social acceptance is one of the indicators under social factors that has a profound impact on RE deployment (RED). The implementation of any long-term technical system as part of the RE requires some of form of social acceptance (Assefa & Frostell, 2007; Byrnes et al., 2013; Lüthi & Prässler, 2011). The deployment of large-scale RE technologies is relatively new, and institutions and consumers are therefore faced with the choice between two competing technologies, renewables and non-renewables (Byrnes et al., 2013). While they are familiar with one, in terms of its inputs and the predictability of the issues surrounding it, they are “in the dark” with the other due to its immaturity (Ibid). Consequently, social acceptance becomes an
inevitable component of RE if its deployment must succeed. Assefa and Frostell (2007) assert that social acceptance is a function of many factors, but they identified three factors as the most significant due to the need to communicate assessment results. These indicators include knowledge, perception, and fear, mainly because of their role in affecting social acceptance.

Knowledge as an indicator has to do with the public’s “knowledge of the different aspects of the technologies in focus.” The question that needs to be answered is: What does the public know? Assefa and Frostell (2007) limited the analysis of the knowledge of the public to “gathering information about different levels of knowledge;” that is, whether respondents consider themselves as having knowledge about specific issues and technologies or holistic knowledge. The purpose of using perception is to gather information on the psycho-sociological health effects of different RE technologies. The main question here is what does the public think? Perceptions include acquiring, interpreting, selecting, and organizing sensory information. According to Assefa and Frostell (2007), new information has the power to change perceptions, and perception can be based on knowledge or just feeling. Finally, fear has to do with unpleasant feelings of perceived risks or danger, real or not. The underlining question here is: What does the public feel? Fear is often regarded as too strong to describe the level of feeling. Consequently, it is often interchanged with the level of worry and concern. Fear can be created by both the presence and absence of knowledge. Knowledge-driven fear takes some time to develop and is informed by the content of knowledge.

Santoyo-Castelazo and Azapagic (2014) discussed the following issues with regard to social acceptability and public perception of RE technologies:

- Distrust or uncertainty towards the development of unknown technologies
- Local or regional issues (land-use change issues, landscape, and visual impact, noise)
- Perception of health and safety risks

In Mexico, it was reported that power producers have issues with land purchases, such that producers buy land legally, only to find out that people are living on it illegally and relocating these occupants has been problematic and time-
consuming (Ibid: p. 14). In the instance of hydro-electricity, public acceptability issues had to with land and water irrigation issues as well as public awareness. According to Lokey (2009), a private company has to convince locals that power plants that are to be built near farmlands will not electrify crops and that the farms will not affect water irrigation. Additionally, issues surrounding wind power are often associated with land requirements, visual intrusion, and noise (Evans, Strezov, & Evans, 2009). The lack of public acceptance with regard to large hydro-power plants has to do with the transformation of land and the relocation of the population (Lokey, 2009). For biomass, the main concerns are related to competition for agricultural land, and water and food production (Jacobson, 2009); and with nuclear energy, the concerns are related to health and safety issues, as well as nuclear accidents and radioactive waste management and storage (Jazayeri et al., 2008).

2.12.3 Economic Factors

The energy sector contributes to economic activities in two ways. First, energy is an important economic sector that creates jobs and value by extracting, transforming, and distributing energy goods and services throughout the economy (Yergin & Gross, 2012). Secondly, the energy sector’s influence ripples throughout the economy. “Energy is input to almost every product and service in the economy and underpins the economic activity across each of its sectors” (“RE Benefits: Measuring the Economics,” n.d.).

Many indicators have been used as proxies for the economic benefits derived from RE deployment. GDP growth, national energy security, high up-front capital costs per unit of electricity, RE investment costs, and grid connection costs have been identified as some of the economic indicators of RE deployment (Al-Sarihi et al., 2015; Byrnes et al., 2013; Luthra, Kumar, Garg, & Haleem, 2015; Nasirov, Silva, & Agostini, 2015). Other economic indicators are trade, income generation effects, economic impacts, income, fits impact pricing, impact of subsidisation on electricity prices and unstable prices in the spot market, limited access to financing (Del Rio & Burguillo, 2008; Nasirov et al., 2015; Chapman, 2016; IRENA, 2016). In this study, the following indicators are used as the economic factors that are likely to influence RE policy: GDP growth, RE investment cost, and trade.
Regarding the measurement of these economic indicators, Chapman (2016) measured the “RE investment cost” as the government capital investments in dollars of the RE sector. The cost includes “capital costs,” “fuel costs,” “fixed and variable” operation and maintenance costs, financing costs, and assumed utilization rates for each plant type. IRENA (2016) has measured trade in two different ways. The first is trade balance expressed as the total net export (exports-imports of all goods and services measured in terms of constant US dollars in 2015 and expressed as a share of GDP). The second indicator is fossil fuel trade expressed in terms of constant US dollars. It has traditionally been considered energy trade. The same measure will be applied in this study but not adjusted to constant US dollars in 2015. GDP growth is measured as the annual GDP growth rate in Thailand (Al-Sahiri, 2013; IRENA, 2016).

The economic impact of RE employment has been widely reported in the literature. Al-Sahiri et al. (2015) argued that “if the domestic consumption” of energy increases “without measures to diversify” the “domestic power supply sources,” capital “losses in gas export revenues” will “grow substantially in Oman.” In 2007, Oman was reported to have been importing about “200 million cubic feet per day to meet additional requirements of natural gas” (Al-Sarihi et al., 2015). This accounted for 10 percent of the country’s total gas consumption (El-katiri, 2014). Such huge imports, when substituted by RE generated locally, will reduce imports substantially. IRENA (2016) also reported that the contribution of the energy sector to GDP was 6 percent. However, the impacts of RE on GDP will “depend on the economic structure of the country,” “the costs of alternative energy sources” (e.g. “fossil fuel prices,” “energy technology costs”), and whether the “equipment and required services” are “imported or sourced” locally.

It is reported that investments in RE “technologies can have a more significant” impact if the “technology is produced locally under the right conditions” (“RE Benefits: Measuring the Economics,” n.d.). Economies such as “China, India, and EU spend up to 7%” of their GDP on energy imports. Thus, RE can reduce imports substantially, which can have a significant economic benefit for countries with large trade benefits (IRENA, 2016).
2.12.4 Institutional Factors

Many socio-economic benefits have been linked to the deployment of RE. These include job creation, the creation of new federal and tax revenues, and more significantly, the revitalizing of struggling communities. In order to achieve all of these associated benefits, strong institutional support in the form of government policies and incentives that favor the deployment of RE is required (Sheikh et al., 2016). Thus, the deployment of RE energy is influenced greatly by the institutional and its accompanying institutional or administrative regime in a country. These institutional policies are more of an institutional decision than they are of an investment decision. Consequently, the deployment and acceptability of any form of RE will require the support of government institutions.

Many institutional factors have been identified in the literature to have some form of impact on the decision to deploy RES. These include lengthy regulatory approvals and permit procedures, policy instability, lack of subsidies, lack of institutional commitment, inadequate legal and regulatory frameworks, and land or water lease securement problems (Byrnes et al., 2013; Luthra et al., 2015; Nasirov et al., 2015). Sheikh et al. (2016) have aggregated these institutional factors to include political stability, regulation or deregulation of the market, policy and government research, and development programmes.

A regulatory policy framework can pose a large threat to RE advancement depending on how it is framed (EWEA, 2010 cited in Luthi & Prassler, 2011; Luthi & Prassler, 2011). Sheikh et al. (2016) identified RE energy policy sub-criteria as follows: energy security, support for RE in the form of Feed-in-Tariffs and Renewable Portfolio Standards (RPSs), financing options with “government backing, local sourcing,” five-year or ten-year RE plans, the integration of existing power plants, among other factors as the policy issues that can spur or stifle the development of RE technology. Generally, a major challenge to the deployment of renewable technology has to do with the absence of appropriate RE policies on the environment. Noim, Uddin, and Taplin (2009) asserted for example that the low levels of deployment of in Bangladesh are because of the lack of appropriate policy setting there.
In an analysis in Australia, “administrative hurdles, delays in project approvals” and high levels of multi-tiered regulations were identified as policy barriers to the deployment of (Martin & Rice, 2015). In Chile, it was reported that high levels of “bureaucracy in governmental bodies” make the entire process “excessively long” and “complicated.” Several “authorities and different administrative levels” within each authority are normally involved. Consequently, delays may exceed 700 days on average (Byrnes et al., 2013). Closely related to the delays and long administrative processes is the acquisition of environmental approval for RE companies. The Environmental Impact Evaluation System (EIES) is the most critical permit for RE developers in Chile. However, it is surrounded by so much uncertainty about the required time to obtain it. It is reported that the time span may “vary between 90 and 210 days, depending on nature” of the project (Byrnes et al., 2013).

Furthermore, Chalvatzis and Hooper (2009) have highlighted the importance of a favorable policy environment for the development of RES. Comparing Germany and Greece, they showed how both countries use FITs as a policy to promote RE usage. They argued that Germany has one of the highest RE penetrations in the world due to a high level of institutional support and many supporting policies, resulting in the long-term certainty required by investors. It is important to point out that the FTIs were introduced in 2000 in Germany. In 1994, Greece also introduced FITs with a combined investment subsidy of between 30 percent and 50 percent; meanwhile, capacity building in RES electricity has remained poor. These differences in the achieved results have been attributed to many factors, including the variability of potential, and interconnection availability and implementation processes, which eventually comes down to the political support given to RE technology (Chalvatzis and Hooper, 2009).

Emodi and Ebele (2016) also have cited the poor implementation of RE policies as one of the challenges of low deployment in Nigeria. They also mentioned the lack of government support in the form of price support mechanisms, funds and research, and development as other policy challenges in Nigeria. Still, regarding the general policy environment, the lack of commitment on the part of policymakers has also hindered the growth of the RE sector greatly. The potential of RE cannot be
“exploited without clear political vision with efficient scientific and technological support” (Srivastava & Sharma, 2013). Luthra et al. (2015) asserted that the issue of political commitment in India has been a matter of a political as well as a strategic challenge. “Government intervention in domestic markets, corruption and lack of civil society are major barriers” to RE adoption” (Brown, 2001).

The issue of land acquisition is also a major policy concern which continues to be a major issue when it comes to RE deployment. Indeed, the issue of land has been identified as the major “source of failure in the development of renewable” energy in Latin America. The lack of “frameworks and adequate consultation” which directly impact communities is a common challenge (Nasirov et al., 2015). As a result of these challenges, large hydro projects in Argentina and Chile were suspended in 2011 and 2014 respectively (Varas, Tironi, Rudnick, & Rodriguez, 2013).

In addition, policy instability also poses significant challenges to the development of RE sources. Frequent policy changes and abrupt discontinuation of policies undermine the growth of the RE sector (Lüthi & Prässl, 2011; Meyer, 2007; Wiser & Pickle, 1997). Byrnes et al. (2013) asserted that incompatible priority setting by political actors has tended to weaken the effectiveness of the existing policy plans. They reported that the new government in Queensland in 2012 canceled most state RE funding with only solar Feed-in-Tariffs left untouched. Such development only erodes the gains made by previous policies. Closely related to this point is the problem of short-term policy horizons, which makes long-term planning difficult and reduces confidence on the part of market participants by making it difficult for them to plan and respond more efficiently (Vine et al., 2003). Similarly, Nasirov et al. (2015) identified some of the regulatory barriers to RE deployment to include: “lack of stable energy policy, lack of confidence” in RE technology, and inadequately-equipped government policies. In India for example, there are no comprehensive policy statements for RE and there is a lack of grid access regulations. Policies are said to be “issued as and when necessary to facilitate the growth of specific” RE technology (Luthra et al., 2015).

The state of RE legal and regulatory frameworks in a country can also work to enhance or undermine the deployment of RE. Sheikh et al. (2016) have identified subsidies, energy price controls, FITs, and tax exemptions as some of the regulatory
measures that can impact either negatively or positively RE technology deployment. Some studies have categorized the provision of subsidies as an economic factor. However, it is more of an institutional factor than an economic one. When analyzed critically, the decision to provide subsidies largely resides with policymakers. Some countries subsidize RE through “production payments or rebates. Rebates are refunds of a specific share of the cost of a technology or share of total installation” costs (Sawin, 2003). Further, access to financial and tax incentives such as subsidies, low-interest loans, and tax exemptions among others may improve the viability and affordability of RE projects (Thanh Nguyen, Ha-Duong, Tran, Shrestha, & Nadaud, 2010).

In Denmark support for RE technology is given in the form of an “environmental tax.” Since 1992, the “CO2 tax” is part of “revenue generated”, and is used to pay the “generators of RE” (Fouquet & Johansson, 2005). Sweden has also been cited to have used environmental taxes to promote the growth of RE deployment (Joelsson, 2011). Similarly, Germany has one of the highest penetrations of RE technologies in the EU, partly due to an array of fiscal policies in support of RE deployment. The main RE supporting policy is the FIT, which was implemented in 2000 and revised in 2004 (Chalvatzis & Hooper, 2009).

In terms of R&D, the government has a major role to play in accelerating the development and deployment of renewable technology through the funding of research and the provision of supportive research and development (Sheikh et al., 2016; Emodi & Ebele, 2016). Most national laboratories in the US have had “some form of RE R&D in place for decades,” particularly the National RE Laboratory (NREL) (Sheikh et al., 2016: p. 106). However, it is important to point out that funding from the government may not be enough to increase R&D activities, and therefore private sector investment is vital for the realization of technological innovation and diffusion in the RE sector (Emodi & Ebele, 2016).

2.12.5 Sustainable RE Policy Development

Several indicators have represented sustainable RE policy. This study represents SRED by effective policy measures, policy stability, the rate of deployment, feed-in-tariffs, national installed capacity, and RE-installed capacity.
Effective policy measures are measured by the quality of the processes that lead to the adoption of a policy and its implementation (Emodi & Ebele, 2016), while policy stability is measured according to the extent to which policy changes over time (Emodi & Ebele, 2016). The rate of deployment is measured by RE as a proportion of total electricity (Byrnes et al., 2013). The Feed-in-Tariffs are “payments to ordinary energy users for the renewable electricity they generate.” FITs are the “electricity part of what some people call “Clean Energy Cashback,” a “scheme that pays people for creating their own” “green electricity” (http://www.fitariffs.co.uk/FITs/, n.d.). FITs can thus be measured as the annual FIT payments made to households that generate their own green electricity.

Additionally, national-installed capacity measures the total energy generated from both RE and other traditional sources of energy, especially from natural gas (Critchfield, 2015; Mann, 2014). Finally, RE-installed capacity refers to the total electricity produced per megawatt supplied to the national grid capacity. Installed capacity is generated for every megawatt-hour of renewable electricity produced and supplied to the utility grid (Critchfield, 2015). Mann (2014) in her analysis of Solar RE Certificates (SRECs) measured installed capacity based on the total energy generated and supplied to the national grid on a monthly basis. Since this study deals with RE generation as an option to other energy forms, Mann’s measurement is modified as the megawatt per ktoe generated and added to the grid over 10-year time horizons: thus, 2007-2016.

According to the literature above, the study now proceeds to develop a framework to aid in answering the research questions and achieving the research objectives. Before we proceed to present the framework, it is important to refer to some aspects of the system model, specifically, the feedback loops of the model. The dynamic nature of the system is a result of the interconnected relationships among the variables in the system. They are of two types, the positive (reinforcing) and negative (balancing). The “positive feedback loops amplify the feedback of information” and the “negative feedback loops are goal-seeking tend to resist change in the system.” In the context of this study, the variables that serve the purpose of the positive feedback loops will be designated as drivers, whilst those variables that serve the purpose of the
negative feedback loops will be designated as barriers. Figure 2.8 presents the conceptual framework for analyzing the drivers for and barriers to sustainable solar energy deployment in Thailand.

Figure 2.8 Conceptual Framework for Sustainable RE Policy Deployment

Source: Ministry of Energy, sustainable energy policy, adapted by the author.

2.13 Chapter Summary

This chapter has presented and highlighted the relevant literature and how the conceptual framework was developed to answer the research questions. The independent and dependent variables were discussed as well as their measures and indicators. The chapter also presented a significant aspect of the empirical literature and linked it to the policy models adopted for this study. The literature review highlighted the cases of South Korea’s and Japan’s RE development and the state of the policy measures of RE in these two countries. The next chapter discusses the research methodology of the study.
CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

This chapter outlines the methodology that is used to explain the factors that impact SRE (policy development, with emphasis on the rate of RE development, feed-in-tariffs, national installed capacity, RE installed capacity, effective policy measures, and policy stability in Thailand. Additionally, the determinants that are used to explain sustainable RE policy development include environmental factors (air quality and CO2), social factors (knowledge and perception), economic factors (GDP, RE investment costs and trade), and institutional factors (government subsidies, government R&D framework, regulations and administrative procedures, and stakeholder involvement). The major objective of this chapter is to explain how the data sources, sampling methods, and the measures that were used in testing and collecting the empirical study, as well as the test of the hypotheses that were derived from the conceptual model, were obtained.

The chapter is organized into four main sections. The first part focuses on the research hypotheses of the study. The second part presents the research design, which outlines the main themes of the methodology of the study. Additionally, the third section spells out the quantitative and qualitative target population, sample size, the survey instrument, and the interview protocol and how they were administered. At the same time, the third section discusses the operationalization, reliability, and validity of the survey and interview instruments, and presents the model specification of the secondary data. Then the third part articulates the statistical and analytic tools used to analyze the data for the various methodologies. The fourth part provides a summary of the chapter.
3.2 Research Hypotheses

The aim of this research is to investigate and to explain the relationships among the social, institutional, economic, and environmental factors and their effects on sustainable RE policy development: feed-in-tariffs, the rate of RE development, national installed capacity, RE installed capacity, RE policy stability, and effective policy measures. The review of the literature led to the development of a conceptual model that attempts to understand the factors impacting the implementation and development of policy measures to lead to sustainable RE deployment in the energy mix of the country. To demonstrate that the relationship between the determinants and sustainable RE policy development was not due to a “crowding effect” of the six components of the dependent variable, an initial test of the effects of the components of the four determinants on the two components of the dependent variable in the survey, which are policy stability and government subsidies to investors, was conducted.

The secondary data were examined using time multiple regression analysis for the various components of the independent variables: environmental, social and economic antecedents and sustainable RE policy development components: the rate of RE development, national installed capacity, RE installed capacity, and solar installed capacity using autocorrelations, and linear regression models. In the secondary data, time was considered the fixed or dependent variable. Using the conceptual model, five major models for testing the main hypotheses were formulated along with their sub-hypotheses. For models 1 and 5, the hypotheses were tested using the survey data administered during the fieldwork, while 2 and 4 were tested by drawing on the secondary data using multiple regression analysis. Model 3 comprised two separate approaches, social acceptance and two of its components will use the survey data while the other approach which will use multiple regression techniques to test the unemployment rate using the secondary data.

3.2.1 Model 1 and Associated Hypotheses

\[ Sus_{RE\_POD} = a + b1Soc\_Fact + b2Inst\_Fact + e \]
H1. Social factors are positively associated with sustainable RE policy development.

H2. Institutional factors have a direct and positive relationship with sustainable RE policy development.

Therefore, \( \text{Sus}_\text{RE}_{\text{POD}} = \text{time difference in sustainable RE policy development, } \text{Soc}_\text{Fact} = \text{social factors, } \text{Inst}_\text{Fact} = \text{institutional factors.} \)

### 3.2.2 Model 2 and Associated Hypotheses (Environmental Factors)

- \( \text{RO}_\text{RED} = a + b_1\text{CO}_2\text{emiss} + b_2\text{AIR}_\text{QUAL} \rightarrow \text{Model 2a} \)
- \( \text{Feed}_\text{In}_\text{Tariff} = a + b_1\text{CO}_2\text{emiss} + b_2\text{AIR}_\text{QUAL} \rightarrow \text{Model 2b} \)
- \( \text{Nat}_\text{Ins}_\text{Cap} = a + b_1\text{CO}_2\text{emiss} + b_2\text{AIR}_\text{QUAL} \rightarrow \text{Model 2c} \)
- \( \text{RE}_\text{Ins}_\text{Cap} = a + b_1\text{CO}_2\text{emiss} + b_2\text{AIR}_\text{QUAL} \rightarrow \text{Model 2d} \)

H3a. CO2 emissions have a direct and positive impact on the rate of RE development.

H3b. Air quality has a significant and positive relationship with RE development.

H3c. CO2 emissions have a positive effect on feed-in-tariffs.

H3d. Air quality has a direct and positive effect on Feed-in-Tariffs.

H3e. CO2 emissions have a positive and significant impact on national installed capacity.

H3f. Air quality has a positive and significant impact on national generation installed capacity.

H3g. CO2 emissions have a positive and significant impact on RE installed capacity.

H3h. Air quality has a positive and significant impact on RE installed capacity.

Where \( \text{RO}_\text{RED} = \text{rate of RE development, Feed}_\text{In}_\text{Tariff} = \text{feed-in-tariff, Nat}_\text{Ins}_\text{Cap} = \text{national generation installed capacity, RE}_\text{Ins}_\text{Cap} = \text{renewable installed capacity, CO}_2\text{emiss} = \text{CO2 emissions, AIR}_\text{QUAL} = \text{air quality.} \)
3.2.3 Model 3 and Associated Hypotheses (Social factors)

SusSoEPoD = a + b1Knowledge + b2Perception + e----> Model 3a

RO_RED = a + b1Unemploy_rate + e-------------------> Model 3b

Feed_In_Tariff = a + b1Unemploy_rate + e---------> Model 3c

Nat_Ins_Cap = a + b1Unemploy_rate + e--------> Model 3d

RE_Ins_Cap = a + b1Unemploy_rate + e---------> Model 3e

H1a. Knowledge of RE has a direct and positive effect on sustainable solar energy development.

H1b. Perception of RE has a significant and positive effect on sustainable solar energy policy development.

H1c. The unemployment rate has a significant positive effect on the rate of RE development.

H1d. The unemployment rate has a significant positive effect on the feed-in-tariff.

H1e. The unemployment rate has a significant positive effect on national installed capacity.

H1f. The unemployment rate has a significant positive effect on RE installed capacity.

3.2.4 Model 4 and Associated Hypotheses (Economic Factors)

RO_RED = a + b1GDP + b2Trade + b3RE_Invest_Cost + e

Feed_In_Tariff = a + b1GDP + b2Trade + b3RE_Invest_Cost + e

Nat_Ins_Cap = a + b1GDP + b2Trade + b3RE_Invest_Cost + e

RE_Ins_Cap = a + b1GDP + b2Trade + b3RE_Invest_Cost + e

H4a. GDP has a significant positive effect on the rate of RE development.

H4b. Trade has a significant and positive effect on the rate of RE development.

H4c. RE investment cost has a significant and positive effect on the rate of RE development.

H4d. GDP has a significant and positive impact on the feed-in-tariff.
H4e. Trade has a significant and direct effect on the feed-in-tariff.
H4f. RE investment cost has a significant and positive effect on the feed-in-tariff.
H4g. GDP has a positive and significant effect on national installed capacity.
H4h. Trade has a significant and direct effect on national installed capacity.
H4i. RE investment cost has a significant and direct effect on national installed capacity.
H4j. GDP has a significant and positive effect on RE installed capacity.
H4k. Trade has a significant and positive effect on RE installed capacity.
H4l. RE investment cost has a significant and positive impact on RE installed capacity.

GDP = Gross Domestic Product, Trade = trade, RE_Invest_Cost = RE investment.

3.2.5 Model 5 and Associated Hypotheses (Institutional Factors)

\[ Sus_{RE}_{Pod} = a + b1GovR&D\_FramWor + b2Reg\_Admin\_Proce + b3Stake\_Invol + b4Gov\_Sub \]

H2a. Government research and development framework have a significant and positive effect on sustainable RE policy development.
H2b. Regulatory and administrative procedures have a positive and significant effect on sustainable solar energy policy development.
H2c. Stakeholder involvement has a positive and direct effect on sustainable RE policy development.
H2d. Government subsidies have a positive and direct effect on sustainable RE policy development.

GovR&D_FramWor = government research and development framework
Reg_Admin_Proce = regulatory/administrative procedures
Stak_Invol = stakeholder involvement.
3.3 Research Design

A research design is a systematic tool for investigating and explaining a social issue by focusing on philosophical assumptions, techniques, and analyses (Myers & Avison, 2002:7). A research design is determined by several factors (Gray, 2004). These factors may include the study organization, which may be the unit of analysis, the setting of the research, and the tools to be used for collecting the data. In addition, the researcher has a responsibility to use the most effective and best-fit approaches that will help to make maximum use of resources and time (Gray, 2004). This study employs both quantitative and qualitative research methods. On the one hand, the quantitative data analysis was performed using survey responses from managers in the RE industry in Ayutthaya, Bangkok, and Rayong.

The qualitative data were analyzed using thematic and narrative analysis techniques by first organizing the data according to patterns and categories. The quantitative survey and the ten-year secondary data used SPSS version 20.0 and STATA version 13.0 to conduct descriptive statistics, a reliability test, and multiple regression to test the hypotheses.

3.3.1 Policy Evaluation Design

In evaluation research, the focus is on the purpose and method of the research. Evaluation research is the process of determining whether a program or policy is worthy and valuable in terms of its desired outcomes. Further, since there is no clear-cut definition of what constitutes an evaluation, types, and purposes of evaluation have been recommended to be used in cases where there is a confusion of what constitutes an evaluation of a policy or program (Stern, 2005). Stern (2005, p XXVII) explains that in knowledge production, evaluation attempts to increase our understanding of what works in what conditions and how different measures and interventions can be made more efficient. Additionally, institutional and community strengthening is when the study is geared towards improving and developing the capacity among stakeholders and institutions (Stern, 2005: p. XXVII). Although each of these types of evaluation has its strength and weaknesses, it is important to observe that there is no straightforward distinction in the real execution of one because
sometimes, one type may lead to another type being integrated into the final product of the evaluation.

For this study, the aim was to determine the factors that support RE policy development and to explain the impacts, successes, as well as to make practical implications and recommendations for policymakers to consider what works better for RE policy development. The study is interested in providing feedback for improvement during the lifecycle of the RE policy plan. Hence, the data collected sought to address these aspects of policy evaluation and to use the findings to guide policy implementers and formulators to address the challenges facing the RE policy process. Table 3.1 depicts the various purposes and methods of evaluation research in policy research developed by Elliot Stern (2005).

**Table 3.1 Policy Evaluation Purposes and Methods**

<table>
<thead>
<tr>
<th>Purpose</th>
<th>Methods of Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planning/Efficiency</td>
<td>Accountability</td>
</tr>
<tr>
<td>Accountability</td>
<td>Implementation</td>
</tr>
<tr>
<td>Implementation</td>
<td>Knowledge production</td>
</tr>
<tr>
<td>Resource Allocation</td>
<td>Institutional community strengthening</td>
</tr>
<tr>
<td>Allocative/economic</td>
<td>Management/performance</td>
</tr>
<tr>
<td>Standards and targets</td>
<td>Formative</td>
</tr>
<tr>
<td>Improvement/change</td>
<td>Causal/Experimental</td>
</tr>
<tr>
<td>Explanation</td>
<td></td>
</tr>
<tr>
<td>Development/participative</td>
<td>Participatory</td>
</tr>
</tbody>
</table>


Consequently, for this study, the purpose was to produce knowledge and to investigate the implementation of a sustainable RE policy development in Thailand and to provide feedback, especially because the policy on RE is on-going, and by focusing on policy feedback, the government, policymakers, implementers, and stakeholders can keep track of what policy measures work better and what barriers are hindering the achievement of the intended goals of the policy. Additionally, this study
applied the formative/change-oriented approach because the findings and recommendations of the outcome of the study may lead to changes in policy interventions and measures to re-orient the current RE policy measures to be able to meet the country’s target of 30% RE energy supply to the national grid by 2030.

3.3.2 Quantitative Method: Survey Data

3.3.2.1 Unit of Analysis

The unit of analysis in research refers to the “process of shaping and refining a research problem. The unit of analysis is a specific object or element” from which the data will be collected (Babe, 2011). According to Babbie (2013), a “unit of analysis” can be “individuals”, “organizations”, “households”, “groups” from which a study draws a sample. In this study, the “unit of analysis” is at the organizational level. In addition to responses from the organization, documents and reports of the organizations were analyzed to support the primary data. The quantitative primary data involved senior middle and line managers from ten organizations. Table 3.2 shows the composition of the institutions that were surveyed. Organizational managers were asked to respond to the survey instrument since they are involved in the day-day activities of their respective organizations. Most of the respondents were technical and management staff members that had an acceptable level of appreciation of the information that was being sought for the study.

3.3.2.2 Sampling Method/Procedure/Technique

The sampling method for this study was both probability and non-probability. The sampling procedure was in two phases involving small and big power procedures, and key stakeholders in public and private organizations. At first, the sampling was undertaken with the organization as the unit of analysis. The second included the frontline implementing organizations and key stakeholders in the energy sector. The sampling technique was both purposive and simply random. This is because the nature of the research questions required specific information that was relevant for stakeholders and informants to provide. The study used a purposive sampling technique to target 10 major stakeholders in the RE sector; that is, those organizations that are key policymakers and implementers as well as key independent power producers (IPP), small power producers (SPP), and very small power producers
These organizations are listed in Table 3.2. They are homogeneous with little heterogeneity in character, and therefore the simple random sampling technique was appropriate, as this gave each organization an equal chance of being selected. The purposive sampling technique employed helped to select top executives and key persons from the ten organizations.

3.3.2.3 Sample Size

Babbie (2011) “provides a table of population size and sample size selection.” For example, a population that ranges from “200 to 250 with a sampling error ±5%” will be “either split at 50/50” or 80/20. Further, Monette et al. (2011) maintain that if the sampling frame is unknown, the rule of thumb of the sample size should be large enough to ensure sampling accuracy and to avoid common source bias. In addition, the use of summary statistics requires that N>30 in order to ensure that inferential statistics are used for the hypothesis testing (Pallant, 2011). Additionally, the summary statistics used demanded that a large sample size is used to test the model fit and because it is difficult to obtain a good response rate with the survey method. The study purposively drew a quota sampling based on the size of the ten institutions purposely selected for the survey data. Table 3.2 displays the various quota from the ten institutions.

Table 3.2 Sample of Institutions

<table>
<thead>
<tr>
<th>No.</th>
<th>Name of Institution</th>
<th>Size of Institution</th>
<th>Quota sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>EGAT</td>
<td>Large</td>
<td>60</td>
</tr>
<tr>
<td>2</td>
<td>PEA</td>
<td>Large</td>
<td>60</td>
</tr>
<tr>
<td>3</td>
<td>MEA</td>
<td>Large</td>
<td>60</td>
</tr>
<tr>
<td>4</td>
<td>EPPO</td>
<td>medium</td>
<td>30</td>
</tr>
<tr>
<td>5</td>
<td>ERC</td>
<td>medium</td>
<td>30</td>
</tr>
<tr>
<td>6</td>
<td>DEPTAEDE</td>
<td>medium</td>
<td>30</td>
</tr>
<tr>
<td>7</td>
<td>REDSPP</td>
<td>medium</td>
<td>30</td>
</tr>
<tr>
<td>8</td>
<td>SiamSOPCL</td>
<td>small</td>
<td>20</td>
</tr>
<tr>
<td>9</td>
<td>ThaiSOPCL</td>
<td>small</td>
<td>20</td>
</tr>
<tr>
<td>10</td>
<td>BCPG</td>
<td>large</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td></td>
<td><strong>400</strong></td>
</tr>
</tbody>
</table>

**Source:** Example of energy institutions, adapted by the author.
3.3.2.4 The Questionnaire

The study used a survey instrument to collect empirical data from the field in order to answer objectives 4 and 5 of the study. The questionnaire was organized into five parts. The first section sought demographic information about the respondents, the second section gathered information on sustainable RE policy development, the third part solicited information on social factors, and the fourth section dealt with institutional factors affecting solar energy policy development. A ten-point Likert scale with 1 being “strongly disagree” to 10 being “strongly agree” was employed for the respondents to respond to. The responses were scored from 1 to 10 and were then grouped based on average scores into three main categories; thus, responses of 1, 2, 3 & 4 were considered as “disagree,” 5 being neither agree nor disagree, and 6, 7, 8, 9 & 10 being scored as “agree” with the various variables. The benefit of using a ten-point Likert scale in the study was to score the indicators related to social and institutional factors since the respondents were more likely to rate themselves low or high with a 5-point scale, which might inflate the responses. Additionally, a ten-point scale allowed the study to use advanced and robust statistical tools for the analysis of the data.

3.3.2.5 Data Collection and Survey Instrument Administration

A pilot study of 40 survey instrument was conducted in February 2018. The pilot study collected data from 5 out of the 10 institutions using the convenient sampling method. The choice of the institutions was made according to the proximity and availability of the respondents to respond to the survey instrument. After the survey, the research assistants used to collect the data presented their reports and a pre-test of the questionnaires was analyzed using SPSS software. A revision of the questionnaire was carried out before the final administration of the survey by the research field team. The team visited each of the ten institutions and administered the questionnaires.

However, due to the nature of the operations of solar and RE companies, which are mostly busy during the day, the questionnaires were self-administered, and the survey packs were picked up on a later day. The team used introductory letters that were secured from NIDA for the filed data collection for each institution and further, phone calls, and emails were used to contact these institutions before the
agreed date for the survey administration. The objectives of the research were explained to the respondents before handing over the questionnaires. In the process, a rapport was established between the research team and the institution's gatekeepers, which reduced entry and resistance on the part of the leadership of the ten institutions.

3.3.2.6 Operationalization and Measurement of Variables

The literature survey resulted in the development of a conceptual framework to support an understanding of the determinants of sustainable RE policy development. The dependent variable was “sustainable RE policy development,” with two of the six indicators: effective policy measures and policy stability, for the survey component of the study. The second component of the dependent variable—the rate of RE development, feed-in-tariff, national installed capacity, and RE-installed capacity—formed the secondary data of the conceptual framework, while the independent variables in the conceptual framework included environmental factors (air quality and CO2 emissions), social factors (knowledge and perception of solar energy), economic factors (GDP, trade, RE investment costs), and institutional factors (government subsidies to investors, regulatory and administrative procedures, government R&D framework, and stakeholder involvement). However, only social and institutional factors were analyzed using the survey data. In order to find measurements for these variables, an extensive review of the extant literature was done, and previously-used measures were identified and modified for this study. The questionnaires were adopted and modified from the literature based on their previous reliability results in the literature.

A) Dependent Variable (DV)

Sustainable RE policy development, which is the DV, had six components. The first four components—the rate of RE energy development, feed-in-tariff, national installed capacity, and RE-installed capacity—were obtained from real data from secondary sources. As a result, the focus of the survey was on the other two indicators of the dependent variable: effective policy measures and policy stability. The two components are presented below.

1. Effective Policy Measures -14 items

1) To what extent does political stability impact of RE deployment in Thailand?
2) Government policy on RE development is stable.
3) The government supports RE policy development through tax incentives and subsidies.
4) The government has provided efficient policy measures on RE technologies in the past.
5) The RE sector has relatively stable policy instruments for sustainable renewable supply.
6) The frequent policy changes and discontinuation of policies undermine the growth of the RE sector in Thailand.
7) Political priorities are directed toward ensuring the effectiveness of policy instruments in the RE sector.
8) Government commitment to funding and financing RE technology is cost-effective.
9) The government has provided intensive capital sources for SMEs that are interested in developing RE technologies at cost-effective prices.
10) There are measures put in place to ensure long-term financing options for RE power producers in the sector.
11) Government policy on RE accounts for energy price controls.
12) Government policy instruments for Feed-in-Tariffs are cost-effective and support RE deployment by both big and small energy producers.
13) The current policy instrument for RE sources can achieve the country’s target of 30% of RE supply by 2036.
14) How would you rate policy stability for RE in the country?

2. Policy Stability - 1 item

Policy stability is one of the indicator variables for the dependent variable and was developed to assess whether policy continuity and stability determine the sustainability of policies, especially with regards to solar energy policy in the Thai context. The measure was modified by Mittal et al. (2013) to suit the study. The single-term is as follows:
1) Policy stability to an exceptionally extent informs effective public policy on solar energy. Yes/No

Independent Variables

Social Factors

Social factors refer to the social acceptance of renewable sources of energy and use. They focus on the worldviews, knowledge, job creation, and perception of the people using RE sources. Two main components of the social factors were of importance to the study: social acceptance and unemployment rate. First, social acceptance included two sub-components, knowledge and perception of solar energy. The unemployment rate was a single indicator variable only available from secondary data sources for the analysis. In short, the unemployment rate was excluded from the survey and only the social acceptance indicator was used to measure the social factors. The items were modified from Sheikh et al. (2016) and Assefa and Frostell (2007) for the two sub-components of social acceptance as follows:

i. Knowledge of Solar Energy - 4 items
   1) How would you rate your knowledge of RE use in the country?
   2) How would you rate your level of knowledge of RE policies in Thailand?
   3) How would you rate your knowledge of the sources of RE in Thailand?
   4) How would you rate your knowledge of RE technology use in Thailand?

ii. Perception of Solar Energy - 11 items
   1) RE sources pose less health-related risks in communities where RE technologies are sited.
   2) The use of RE technologies is considered safer for human habitation compared with fossils fuels.
   3) How would you rate the public perception of trust in the use of RE technology deployment in the country?
   4) How would you rate your knowledge of specific issues and technologies in the RE sector?
5) The public perception of the uncertainty of RE technology use does not affect sustainable renewable deployment.

6) Is the public afraid of the effect of the use of RE technology on their health and safety issues?

7) The public perceives that the use of RE technologies produces noise and visual impairment.

8) Does the public have fear about the perceived risk of RE technology in siting plants on their farmland?

9) The public has a fear that the use of hydro-thermal as an RE source may compete with their agricultural irrigation activities.

10) How would you rate the public’s perceived fear of the danger of RE technologies to their food crops?

11) How would you rate the public support for leasehold lands for building RE technologies in communities where these plants are sited.

2) Institutional Factors

Institutional factors refer to the measures that are taken to facilitate the development of policy to support the production of solar energy in the country. These are the rules and regulations as well as the administrative procedures and behavior of key policy actors in the government sector. This variable was modified from EWEA (2010), OECD/IEA (2011), Luthi & Prassler (2011), Wiser and Pickle (1998), Meyer (2007), and Tran, Shresth, Nadaud (2010), Mittal et al. (2013), and Weis, Ilinca, and Pinard (2008):

i. Government Subsidies

This indicator was also measured using a single item, which focused on finding out how government intervention in terms of financial subsidies or incentives may help investors venture into solar energy production. The item was adopted from Luthi and Prassler (2011), Wiser and Pickle (1998), Meyer (2007), and Tran, Shresth, and Nadaud (2010). The following was asked of the respondents to indicate their level of agreement:

1) Does the state government provide investors with subsidies or financial incentives to fund their capital projects? Yes/No
ii. Government R&D Framework - 4 items
1) The government has allocated funding for R&D for future RE development.
2) The government has provided laboratories and learning centers for research on RE technology development.
3) Government support technology is transferred in the RE sector through research and innovation.
4) There is high public support for and confidence in government policy measures regarding RE technology in the country.

iii. Regulatory and Administrative Procedures - 8 items
1) Compared to other departments in the ministry or ministries in government responsible for energy are effective in issuing operating permits to power procedures.
2) The regulations on RE are easy to understand and be applied.
3) It is easy to secure an operating permit or license to produce RE in the country.
4) The agencies responsible for regulating the activities in the RE sector provide support for small and big power producers to secure land for siting plants.
5) The agencies responsible for the RE sector ensure that power producers follow environmental and local laws where plants are located.
6) The laws and regulations on RE deployment are monitored to ensure compliance by power producers.
7) The regulatory and administrative procedures are devoid of bureaucratic bottlenecks.
8) The regulatory agencies ensure compliance with environmental impact assessment before permits are issued to RE power producers.
iv. Stakeholder Involvement - 8 items

1) Government policy frameworks ensure adequate consultation with communities where RE plants and technology are located.
2) How would you rate the ministry or ministries with responsibility for RE compared to other agencies and businesses in the energy sector?
3) How would you compare the Thai ministry or ministries responsible for RE to others in the ASEAN region?
4) The regulatory agencies share information on its activities regularly with other stakeholders in the sector.
5) The government is willing to change policy directions in light of suggestions made by other energy stakeholders.
6) Policy and regulatory agencies frequently acknowledge persons in the community that have made significant contributions to RE development.
7) The regulatory agencies have considerable control over the operations of RE power producers.
8) The regulatory agencies are often forced to change policy directions because of the demands of the key stakeholder in the RE sector.

3.4 Summary of Variables Operationalization

The measurement of the variables in the quantitative survey data included the DV, policy stability and government subsidies, and two of the IVs, social and institutional, factors in the conceptual framework. The operationalization of the variables is depicted in Table 3.3 below.

Table 3.3 Summary of Variables Operationalization

<table>
<thead>
<tr>
<th>Variable type</th>
<th>Element</th>
<th>Definition</th>
<th>Variables/question Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependent Variable</td>
<td>RE Sustainable energy policy development</td>
<td>Effective policy The extent to which effective policy measures on RE is</td>
<td>Section A i. Question 1-14</td>
</tr>
<tr>
<td>Variable type</td>
<td>Element</td>
<td>Definition</td>
<td>Variables/question Number</td>
</tr>
<tr>
<td>---------------</td>
<td>---------</td>
<td>------------</td>
<td>---------------------------</td>
</tr>
<tr>
<td><strong>Independent Variable(s)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Social Factors: social acceptance</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knowledge</td>
<td>The extent to which people understand the importance of using RE</td>
<td>Section C i. Ques. 16-19</td>
<td></td>
</tr>
<tr>
<td>Perception</td>
<td>Perception deals with the extent to which people perceive renewable sources of energy as harmful to their health and their belief systems</td>
<td>Section C ii: Ques. 20-30</td>
<td></td>
</tr>
<tr>
<td><strong>Institutional factors</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Government subsidies</td>
<td>Government incentives to investors to lure them into investing in the RE sector</td>
<td>Section D i. Ques. 31</td>
<td></td>
</tr>
<tr>
<td>Government R&amp;D framework</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regulatory and administrative procedures</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stakeholder</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Giving the real results and increase in RE investments</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Policy stability</td>
<td>The extent to which policy change is relatively stable over time</td>
<td>Section A ii. Question 15</td>
<td></td>
</tr>
<tr>
<td>Variable type</td>
<td>Element</td>
<td>Definition</td>
<td>Variables/question Number</td>
</tr>
<tr>
<td>---------------</td>
<td>---------</td>
<td>------------</td>
<td>---------------------------</td>
</tr>
<tr>
<td>involvement</td>
<td>requirements needed to seek for services in the RE sector</td>
<td>Involvement and participation of key stakeholders in the process of implementing a policy on RE</td>
<td></td>
</tr>
</tbody>
</table>

**Source:** Ministry of Energy, Summary of Variables Operationalization, adapted by the author.

### 3.5 Validity and Reliability Measurement

The purpose of validity is to obtain at face value whether the research constructs measure what they are intended to measure and how sound the findings are, while reliability measures the consistency of a given set of items over time. According to Patton (2002), validity and reliability are two areas that researchers should focus on when seeking to maximize the quality of the outcome of studies. The use of triangulation is one way to test and maximize the reliability and validity of the study findings.

Validity refers to the “appropriateness of the research findings” (Maxwell, 1996, p.87). Therefore, to meet the content and criteria, previous scales were modified to suit the present study. In addition, the use of secondary data further made the data collection process valid since the researcher had less influence over these variables. The following strategies were considered:

- The use of 14 case study organizations in the energy sector in Thailand. This avoided the “weaknesses of generalizing from a single case study” (Yin, 2003 p. 46) and a sample of 5 community and local government actors in two districts.
- “[N]arrowly defining the study population to improve the robustness of the study conclusions


• [And] using multiple evidence sources to gain in-depth knowledge of the cases.”

In this study, construct validity was used during the review of the literature, which ensured a significant appreciation of previous studies through the critical review process in terms of the various variables under investigation. Additionally, the items or questions for the survey were reviewed by the National Statistics Office to ensure that they truly measured what they were intended to measure. Further, a pilot study using 40 questionnaires was conducted to test the validity and reliability of the instrument. The results of the pre-tested survey were analyzed, and the findings were used to reshape the items. The main research data were analyzed to test for the reliability and validity of the instrument to determine the consistency and accuracy of the measures.

Reliability refers to “the extent to which a method can be replicated by others under similar conditions” (Grummerson, 1991, p.80). The “research methods encompass risks associated with researcher subjectivity which may negatively impact replication” (Grummerson, 1991, p.80). This risk can be “minimized” by using a comprehensive “case study protocol” (Yin, 2003, p.67-69). The procedure “used to guide this study” included the “conceptual framework” (see Figure 2.5) and a “clear definition of the study population and the triangulation method” (Yin, 2003, p.67-69).

In addition, in order to ensure the “reliability of the data” collected, the study adopted previously-used scales that had been tested and that were found to have a Cronbach alpha greater than 0.7. However, the use of these scales was modified to suit the Thai context and the purpose of the study in order to answer the research questions and to meet the objectives. Further, a reliability test was used to run the items, except for policy stability and government stability, which were a one-item scale and hence the decision was made not to include them. The results of the reliability showed that most of the variables had a Cronbach alpha greater than 0.7. Table 3.4 displays the various reliability tests for the six sub-component variables.
Table 3.4 Reliability Test for Variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>No. Items</th>
<th>Cronbach Alpha</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effective Policy measures</td>
<td>14</td>
<td>0.82</td>
<td>165</td>
</tr>
<tr>
<td>Knowledge RE</td>
<td>4</td>
<td>0.80</td>
<td>166</td>
</tr>
<tr>
<td>Perception</td>
<td>11</td>
<td>0.80</td>
<td>164</td>
</tr>
<tr>
<td>R&amp;D</td>
<td>4</td>
<td>0.90</td>
<td>165</td>
</tr>
<tr>
<td>Admin/Regulation</td>
<td>8</td>
<td>0.73</td>
<td>164</td>
</tr>
<tr>
<td>Stakeholder Involvement</td>
<td>8</td>
<td>0.74</td>
<td>164</td>
</tr>
</tbody>
</table>

Source: Ministry of Energy Reliability Test for Variables, adapted by the author.

3.6 Factor Analysis

Factor analysis is mostly used to reduce the factors that best explain a given construct, especially when a researcher wants to determine the uni-dimensionality of the components of a given dependent or independent variable. For example, in this study, two components were used to measure the dependent variable: sustainable RE policy development, are effective policy measures and policy stability. From the literature review, it was found to be necessary to use these two dimensions to measure the dependent variable construct. The two independent variables—social and institutional factors—were measured with two components, knowledge and perception of RE use, and government subsidies, government R&D framework, regulations/administrative procedures, and stakeholder involvement. The factor analysis is presented below.

3.6.1 Factor Analysis for Sustainable RE Policy Development

Factor analysis was performed for the dependent variable, which had 15 items using PCA, which was rotated through Varimax. The correlation of the individual items showed that only item “2” had a correlation below 0.30; however, the item was retained since it was a single item that measured the component of policy stability, which required respondents to indicate a “yes” or a “no” response. Table 3.5 below displays the factor loadings for the 15 items.
**Table 3.5** Factor Analysis for Dependent Variable

<table>
<thead>
<tr>
<th>Component</th>
<th>Initial Eigenvalues</th>
<th>Extraction Sums of Squared Loadings</th>
<th>Rotation Sums of Squared Loadings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total % of Variance</td>
<td>Cumulative %</td>
<td>Total % of Variance</td>
</tr>
<tr>
<td>1</td>
<td>4.582</td>
<td>30.548</td>
<td>4.582</td>
</tr>
<tr>
<td>2</td>
<td>1.942</td>
<td>12.946</td>
<td>43.494</td>
</tr>
<tr>
<td>3</td>
<td>1.354</td>
<td>9.027</td>
<td>52.521</td>
</tr>
<tr>
<td>4</td>
<td>1.103</td>
<td>7.350</td>
<td>59.871</td>
</tr>
<tr>
<td>5</td>
<td>.998</td>
<td>6.653</td>
<td>66.525</td>
</tr>
<tr>
<td>6</td>
<td>.807</td>
<td>5.382</td>
<td>71.907</td>
</tr>
<tr>
<td>7</td>
<td>.743</td>
<td>4.951</td>
<td>76.858</td>
</tr>
<tr>
<td>8</td>
<td>.759</td>
<td>3.860</td>
<td>80.717</td>
</tr>
<tr>
<td>9</td>
<td>.550</td>
<td>3.668</td>
<td>84.385</td>
</tr>
<tr>
<td>10</td>
<td>.508</td>
<td>3.389</td>
<td>87.775</td>
</tr>
<tr>
<td>11</td>
<td>.474</td>
<td>3.160</td>
<td>90.934</td>
</tr>
<tr>
<td>12</td>
<td>.441</td>
<td>2.940</td>
<td>93.874</td>
</tr>
<tr>
<td>13</td>
<td>.344</td>
<td>2.290</td>
<td>96.165</td>
</tr>
<tr>
<td>14</td>
<td>.333</td>
<td>2.217</td>
<td>98.381</td>
</tr>
<tr>
<td>15</td>
<td>.243</td>
<td>1.619</td>
<td>100.000</td>
</tr>
</tbody>
</table>

Note: KMO= 0.80, Eigenvalue= 7.35, Variance = 59.87, p<0.001, Extraction Method: Principal Component Analysis.

**Source:** Factor Analysis for Dependent Variable, adapted by the author.

The results in Table 3.6 above indicate that the factor loading provided a 7.35 eigenvalue, which explained a total variance of 59.87%. This result provided a strong point for including all of the items since most of them were loaded on one factor because the recommended eigenvalue is 1 with an expected 30% variation in the social sciences (Pallant, 2011). Additionally, the Kaiser-Meyer-Olkin measure of sampling adequacy was 0.80 and the chi-square or Bartlett's test of sphericity was statistically significant. Therefore, all fifteen items were retained for further analysis. The scree plot below in Figure 3.1 further validates the items.
3.6.2 Factor Analysis for Social Factors

Factor analysis was performed to consider the uni-dimensionality of the two components that measured the social variable. The two components were made up of fifteen items. The items were assessed for their suitability for factor analysis before further analysis of the items was performed. The method typically used for factor analysis is principal component analysis, where the interest is to extract the factors that best fit the definition of the construct under investigation. After the initial checks, the results of the factor loadings indicated that one factor was extracted, and the inter-item correlation was above 0.2, as recommended by Pallant (2011). Table 3.6 shows the various factor loadings.
Table 3.6 Factor Analysis for Social Factors

<table>
<thead>
<tr>
<th>Component</th>
<th>Initial Eigenvalues</th>
<th>Extraction Sums of Squared Loadings</th>
<th>Rotation Sums of Squared Loadings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>% of Variance</td>
<td>Cumulative %</td>
</tr>
<tr>
<td>2</td>
<td>2.716</td>
<td>18.106</td>
<td>46.761</td>
</tr>
<tr>
<td>3</td>
<td>1.808</td>
<td>12.053</td>
<td>58.814</td>
</tr>
<tr>
<td>4</td>
<td>.974</td>
<td>6.493</td>
<td>65.307</td>
</tr>
<tr>
<td>5</td>
<td>.895</td>
<td>5.965</td>
<td>71.272</td>
</tr>
<tr>
<td>6</td>
<td>.708</td>
<td>4.722</td>
<td>75.994</td>
</tr>
<tr>
<td>7</td>
<td>.654</td>
<td>4.360</td>
<td>80.354</td>
</tr>
<tr>
<td>8</td>
<td>.598</td>
<td>3.986</td>
<td>84.340</td>
</tr>
<tr>
<td>9</td>
<td>.481</td>
<td>3.203</td>
<td>87.543</td>
</tr>
<tr>
<td>10</td>
<td>.412</td>
<td>2.745</td>
<td>90.288</td>
</tr>
<tr>
<td>11</td>
<td>.392</td>
<td>2.615</td>
<td>92.903</td>
</tr>
<tr>
<td>12</td>
<td>.354</td>
<td>2.363</td>
<td>95.266</td>
</tr>
<tr>
<td>13</td>
<td>.306</td>
<td>2.043</td>
<td>97.309</td>
</tr>
<tr>
<td>14</td>
<td>.235</td>
<td>1.568</td>
<td>98.877</td>
</tr>
<tr>
<td>15</td>
<td>.168</td>
<td>1.123</td>
<td>100.000</td>
</tr>
</tbody>
</table>

Note: KMO = 0.789, Eigenvalue = 12.05, Variance = 58.81, p<0.001, Extraction Method: Principal Component Analysis.

Principal component analysis (PCA) with a varimax rotation was performed for the fifteen items on the two social factor components, which were responded to by the respondents. The factor loading showed that only two factors, “14” and “15,” had correlations below 0.3.; however, the decision was made to retain all of the factors since each of the items measured various aspects of the social variable. The factor loading showed that the first three factors had an eigenvalue of 12.05 greater than 1 as recommended in the factor analysis (Pallant, 2011), and the three factors explained a total variance of 58.81%, which was higher than the 30% variance in most studies (Pallant, 2011). The Kaiser-Meyer-Olkin measure of sampling adequacy showed that a value of 0.79 was greater than 0.6 recommendation for social sciences. Also, Bartlett’s test of sphericity showed a statistical significance, which supported the
functionality of the construct under investigation. This evidence is further shown in Figure 3.2 in the scree plot for all of the items. All 15 items were retained for further analysis.

![Scree Plot](image)

**Figure 3.2 Scree Plot for Social Factors**


### 3.6.3 Circumstance for Institutional Factors

The principal component analysis for the institutional factors was rotated through the varimax method of extraction factors. In all 21 items were used for the analysis and most of the items had a correlation higher than 0.30. However, some of the items had correlations lower than 0.30 yet the decision to retain them was necessary because a critical observation of the items showed that each item measured an important aspect of the institutional variable which forms the key determinants of the sustainable policy development in the solar energy sector. Hence all 21 items were retained for further analysis. Table 3.7 depicts the various factors and their eigenvalues.
Table 3.7 Factor Analysis for Institutional Factors

<table>
<thead>
<tr>
<th>Component</th>
<th>Initial Eigenvalues</th>
<th>Extraction Sums of Squared Loadings</th>
<th>Rotation Sums of Squared Loadings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total % of Variance</td>
<td>Cumulative %</td>
<td>Total % of Variance</td>
</tr>
<tr>
<td>2</td>
<td>1.721</td>
<td>8.196</td>
<td>40.484</td>
</tr>
<tr>
<td>3</td>
<td>1.604</td>
<td>7.636</td>
<td>48.120</td>
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<tr>
<td>4</td>
<td>1.449</td>
<td>6.902</td>
<td>55.022</td>
</tr>
<tr>
<td>5</td>
<td>1.175</td>
<td>5.593</td>
<td>60.616</td>
</tr>
<tr>
<td>6</td>
<td>1.006</td>
<td>4.788</td>
<td>65.404</td>
</tr>
<tr>
<td>7</td>
<td>.909</td>
<td>4.328</td>
<td>69.732</td>
</tr>
<tr>
<td>8</td>
<td>.852</td>
<td>4.060</td>
<td>73.791</td>
</tr>
<tr>
<td>9</td>
<td>.756</td>
<td>3.601</td>
<td>77.392</td>
</tr>
<tr>
<td>10</td>
<td>.680</td>
<td>3.240</td>
<td>80.632</td>
</tr>
<tr>
<td>11</td>
<td>.618</td>
<td>2.940</td>
<td>83.573</td>
</tr>
<tr>
<td>12</td>
<td>.599</td>
<td>2.852</td>
<td>86.425</td>
</tr>
<tr>
<td>13</td>
<td>.497</td>
<td>2.367</td>
<td>88.792</td>
</tr>
<tr>
<td>14</td>
<td>.439</td>
<td>2.088</td>
<td>90.880</td>
</tr>
<tr>
<td>15</td>
<td>.419</td>
<td>1.997</td>
<td>92.877</td>
</tr>
<tr>
<td>16</td>
<td>.370</td>
<td>1.760</td>
<td>94.637</td>
</tr>
<tr>
<td>17</td>
<td>.311</td>
<td>1.483</td>
<td>96.119</td>
</tr>
<tr>
<td>18</td>
<td>.251</td>
<td>1.196</td>
<td>97.315</td>
</tr>
<tr>
<td>19</td>
<td>.221</td>
<td>1.053</td>
<td>98.368</td>
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<tr>
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<td>.175</td>
<td>.831</td>
<td>99.199</td>
</tr>
<tr>
<td>21</td>
<td>.168</td>
<td>.801</td>
<td>100.000</td>
</tr>
</tbody>
</table>

Note: KMO = 0.789, Eigenvalue = 4.79, Variance = 65.40, p<0.001, Extraction Method: Principal Component Analysis.

Most of the correlations exceeded 0.30 and using the Kaiser-Meyer-Olkin measure of sampling adequacy and the scree plot test, the uni-dimensional of institutional factors showed that the KMO was positive with 0.82 greater than the recommended value of 0.6, while Bartlett’s test of sphericity was statistically significant and confirmed the functionality of the items that measured the institutional factor. The eigenvalue was 4.79, which was greater than 1 and provided a variance of
65.30%. The scree plot below further shows the uni-dimensionality of the items in Figure 3.3.

![Scree Plot](image)

**Figure 3.3** Screen Plot for Institutional Factors  

### 3.7 Sample Selection and Secondary Data Sources

For the secondary data, the unit of analysis was at the national and sectoral level of the variables. For example, GDP growth was calculated from annual GDP growth. Because of the focus of the study’s interest in the sustainability of RE policy, sustainability was defined by Campbell (1996) as a conflict among economic development, environmental protection, and social equity. Therefore, there should be a balance between the three factors, which forms the core of sustainability (Wheeler, 2002). Hence, this study focused on these three factors to explain and analyze the sustainability of RE policies in the Thai context. Although the literature projected that the RE drive in Thailand appears to be on course in reducing the country’s dependency on electricity imports and to become an energy-secure nation by 2036, there are serious challenges that have the potential to affect the government’s policy goals. Similarly, if the challenges are not addressed the country’s effort and target to reduce greenhouse gas emissions by 25% may be affected.
According to the projections of the new Alternative Energy Development Plan (AEDP), it is expected that the country will generate 40,000 megawatts (MW) in 2036 from the previous projections of 19,600MW under the old AEDP in 2015. Further, Thailand is a leader in solar energy in Southeast Asia; however, the contributions of solar energy to the national grid is relatively small and hence, policy measures are underway to give equal opportunities and priorities to the wind, biomass, biogas, and waste management to support solar energy (GTZ, 2016).

This study focused on RE policy deployment, the processes that underpin policy development, and the holistic evaluation of RE policy sustainability performance. This includes both the quantitative and qualitative appraisal of the economic, environmental, institutional, and social factors that can induce effective RE policy implementation in Thailand. There is a clear the lack of the quantitative and qualitative assessment of the economic, environmental, and social aspects of RE policy sustainability analysis in the Thai context. Most studies focus on only the economic, risk, and financial analysis of RE sources (Jue, Johnson, & Vanamali, 2012; Keyuraphan, Thanarak, Ketjoy, & Rakwichian, 2012; Rennkamp, Haunss, Wongsa, Ortega, & Casamadrid, 2017; Tongsopit & Greacen, 2013), while little attention has been given to the impacts of the social, economic, institutional, and environmental aspects of RE policy development. To fill this gap, the study focused on explaining and describing how these four factors enhance and improve the sustainable deployment of RE in Thailand.

To address the research questions of the study, the sample of secondary data on the environmental and economic variables, as well as one of the social variables, used a 10-year baseline comparison to understand the RE deployment and policies that have been implemented from 2007-2016 using multiple regression technique. The reason for choosing a 10-year baseline comparison was to observe the extent to which RE has contributed to the national grid and what measures the country can implement to ensure energy self-sufficiency. The goal is to reduce the overreliance on electricity imports and the traditional sources of energy, i.e. natural gas which constitutes about 67% of total grid capacity. To provide a clearer picture, the measures of the dependent were revised to include the rate of RE development, feed-in-tariffs, national installed capacity, and RE-installed capacity.
Another reason for selecting a 10-year baseline comparison was to analyze again the extent to which greenhouse gas (GHG) emissions (CO2) and air quality can be reduced through RE use. Additionally, the 10 years allowed the study to measure the economic impacts, such as GDP growth (energy use per capita and unit of GDP - increase in GDP), trade, and investment costs of RE. Lastly, the 10-year baseline comparison helped the study to predict the social factors of the use of RE in terms of the reduction in the unemployment rate, knowledge, and the perception of RE. Although the study intended to use 10 years of data for the analysis, some variables were dropped due to the unavailability of the data and some missing data.

Because of the limited sample size, and missing data problem, the proposed time series analysis could not be used to analyze the data since time series data are sensitive to small sample sizes and missing values. Additionally, the time series could not be used because most of the variables violated the non-stationarity of time series assumptions, thereby making the use of time series models difficult. At the same time, the secondary data were annual aggregates and since time series techniques are more suitable when they are quarterly positioned. Consequently, the decision to use multiple regression technique to analyze the secondary data was made.

The secondary datasets were collected from the World Bank (WB), the International Energy Agency (IEA), the Ministry of Energy (MOE), the National Alternative Energy Authority (NAEA), the Energy Policy and Planning Office (EPPO), the National Energy Policy Office (NEPO), the Development Office (BBEDO), and the Ministry of Finance (MOF). The reason for choosing these organizations for the secondary sources was due to the reliability and availability of the data sources since they were the primary sources of information for research. In addition to these sources, the secondary data utilized annual energy reports from both international and domestic organizations’ published journal articles, regional and country reports, and status updates of major leading producers of RE at the global level. However, the difficulty in finding specific information was a challenging task and affected the data-collection process.
3.7.1 Variable Specification and Operationalization

This section of the methodology provides the specification and operationalization of the variables of the study. Details of the variables and their definitions have been provided to ensure that the data to be collected represented the concepts being studied. For the variables, social, environmental, economic and institutional factors were adapted from studies such as those of Al-Sahiri et al. (2015), Chapman (2016), IRENA (2016), Gupta (2008), and Mittal et al. (2013) and others. Table 3.2 below shows the variables and their definitions as well as their sources.

1) Dependent Variables

The dependent variable for the secondary data consists of four components: the rate of RE development (RO_RED), feed-in-tariff (Feed_In_Tariff), national installed capacity (Nat_Ins_Cap), and RE-installed capacity (RE_Ins_Cap). These measures have been used in the study of the sustainability of RE policies in previous work (Al-Sahiri et al.2015). Table 3.8 shows the variables, measures, and their definitions.

2) Independent Variables

The independent variables (IVs) consisted of three main dimensions: environmental factors which comprised two indicators or components: air quality (AIR_QUAL) and GHG emissions (CO2_emiss); the second dimension was social factors, which comprised the unemployment rate (Unemploy_rate); and the third dimension was economic factors, which included GDP growth rate (GDP), trade, and RE investment cost (RE_Invest_Cost). These variables were adopted and modified from previous studies, as indicated in Table 3.8 below. Table 3.9 shows the raw data obtained from the Alternative Energy Department and the National Energy Commission.
### Table 3.8 Variable Specification and Operationalization for Secondary Data

<table>
<thead>
<tr>
<th>Variables</th>
<th>Indicators</th>
<th>Measurement</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dependent Variable (s)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sustainable Solar Policy Development</td>
<td>Rate of deployment</td>
<td>Rate of deployment is measured as RE as a proportion of total electricity</td>
<td>Byrnes et al. (2013)</td>
</tr>
<tr>
<td></td>
<td>Feed-in-tariff</td>
<td>Refers to the fixed pay for RE power over a fixed period of time</td>
<td>Chapman (2016)</td>
</tr>
<tr>
<td></td>
<td>National Installed Capacity RE</td>
<td>Refers to total grid capacity in a period</td>
<td>Mann (2014)</td>
</tr>
<tr>
<td></td>
<td>National Installed Capacity</td>
<td>The total RE supply to national grid over a time</td>
<td>Al-Sahiri et al. (2015)</td>
</tr>
<tr>
<td><strong>Independent Variables</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental factors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air quality</td>
<td>Annual reduction in GHG emissions or CO$_2$e</td>
<td>Al-Sahiri et al. (2015)</td>
<td></td>
</tr>
<tr>
<td>GHG/CO$_2$e</td>
<td>Annual GHG emissions or tones of CO$_2$e</td>
<td>Al-Sahiri et al. (2015)</td>
<td></td>
</tr>
<tr>
<td>Social factors</td>
<td>Unemployment Rate</td>
<td>The rate of reduction in the unemployment rate as the proportion of total</td>
<td>Chapman (2016)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Sheikh et al. (2016); Assefa &amp; Frostell (2007);</td>
</tr>
<tr>
<td>Variables</td>
<td>Indicators</td>
<td>Measurement</td>
<td>Source</td>
</tr>
<tr>
<td>----------------</td>
<td>------------</td>
<td>------------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Economic factors</td>
<td>GDP growth</td>
<td>Annual GDP growth rate</td>
<td>Al-Sahiri (2015); IRENA (2016)</td>
</tr>
<tr>
<td>Trade</td>
<td></td>
<td>Fossil fuel trade (energy trade) or the proportion of imports to exports expressed (Bahts)</td>
<td>IRENA (2016); Mwakasonda (2014)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Investments cost made in RE by government</td>
<td>Del Rio and Burguillo (2008); Chapman (2016); Chapman (2016); Linder (2017)</td>
</tr>
</tbody>
</table>

**Source:** Variable Specification and Operationalization for Secondary Data 2013-2017, adapted by the author.
<table>
<thead>
<tr>
<th>Year</th>
<th>RO_RED (%)</th>
<th>Nat_Ins_Cap (Ktoe)</th>
<th>RE_Ins_Cap (Ktoe)</th>
<th>SolarInsCap (ktoe)</th>
<th>AIRQUAL</th>
<th>CO2 emissions (%)</th>
<th>UnEMPLOYRATE (%)</th>
<th>GDP (at 2002 prices) million bahts</th>
<th>Trade million bahts</th>
<th>RE_Invest_Cost(million bahts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>7.1</td>
<td>28285</td>
<td>18233</td>
<td>32.51</td>
<td>75.97</td>
<td>195847</td>
<td>4.7</td>
<td>7579558.00</td>
<td>-5268</td>
<td>0.00</td>
</tr>
<tr>
<td>2008</td>
<td>7.1</td>
<td>147427.0</td>
<td>19314</td>
<td>33.39</td>
<td>77.84</td>
<td>198146</td>
<td>5.1</td>
<td>7710356.00</td>
<td>-1745</td>
<td>0.00</td>
</tr>
<tr>
<td>2009</td>
<td>12.9</td>
<td>148390.0</td>
<td>19542</td>
<td>43.17</td>
<td>73.24</td>
<td>197657</td>
<td>5.9</td>
<td>7657098.00</td>
<td>442</td>
<td>16053.00</td>
</tr>
<tr>
<td>2010</td>
<td>13.9</td>
<td>159518.00</td>
<td>1879.8</td>
<td>49.22</td>
<td>81.9</td>
<td>216363</td>
<td>4.0</td>
<td>8232421.00</td>
<td>-4070</td>
<td>49998.83</td>
</tr>
<tr>
<td>2011</td>
<td>14.7</td>
<td>155986.00</td>
<td>5063</td>
<td>243.00</td>
<td>80.81</td>
<td>206408</td>
<td>2.9</td>
<td>8301570.00</td>
<td>-8839</td>
<td>44747.17</td>
</tr>
<tr>
<td>2012</td>
<td>29.2</td>
<td>156899.00</td>
<td>5692.6</td>
<td>388.00</td>
<td>77.55</td>
<td>215013</td>
<td>3.1</td>
<td>8902850.00</td>
<td>-8892</td>
<td>76248.84</td>
</tr>
<tr>
<td>2013</td>
<td>39.9</td>
<td>169593.00</td>
<td>6694.9</td>
<td>829</td>
<td>88.42</td>
<td>214468</td>
<td>3.6</td>
<td>9146118.00</td>
<td>-12556</td>
<td>12690.00</td>
</tr>
<tr>
<td>2014</td>
<td>58.5</td>
<td>174467.00</td>
<td>7400.4</td>
<td>1299.00</td>
<td>86.51</td>
<td>217876</td>
<td>4.5</td>
<td>9229761.00</td>
<td>-11969</td>
<td>38376.00</td>
</tr>
<tr>
<td>2015</td>
<td>60.9</td>
<td>184350.00</td>
<td>7962.8</td>
<td>2021.00</td>
<td>85.08</td>
<td>219052</td>
<td>4.7</td>
<td>9501230.00</td>
<td>-15557</td>
<td>131038.00</td>
</tr>
<tr>
<td>2016</td>
<td>90.1</td>
<td>187640.00</td>
<td>8332.9</td>
<td>2753.00</td>
<td>85.59</td>
<td>233211</td>
<td>4.6</td>
<td>9808878.00</td>
<td>-30089</td>
<td>8014.50</td>
</tr>
</tbody>
</table>

3.8 Data and Management Analysis for Quantitative Data

The study used quantitative analysis technique to manage both the survey data and the secondary data. First, SPSS version 20 and STATA version 13.0 were used for the survey data in order to screen and clean the datasets for further analysis. Second, the results used multiple regression technique and descriptive statistics to examine the relationship between the dependent variable: sustainable RE policy development with two sub-components, effective policy measures and policy stability for the survey data and the independent variables: social factors (knowledge and perception of RE), and the institutional factors (government R&D framework, regulatory and administrative procedures, stakeholder involvement, and government subsidies) to test the multiple effects. Also, STATA software was also used for the secondary data to prepare the data for further analysis using the multiple regression technique to test the relationships among the continuous dependent variables and the continuous independent variables (Pallant, 2011).

3.8.1 The Assumption of Multiple Assumption and Data Screening

First, the study checked for the assumptions of the multiple regression technique to ensure that the datasets were suitable to perform the regression analysis. For example, a test of normality, the independence of the sample datasets, as well as the homoskedasticity of the sample datasets was performed. The results for the normality test showed that the datasets were normality distributed. See Figures 3.4 and 3.5 below for details of some of the variables.
Secondly, a test for the presence of outliers was performed; however, the datasets had cases of outliers and thus extreme and low values. They were not substantial enough however to affect the regression models. Therefore, a decision was made to include all cases since the sample size made it difficult to drop cases that were extremely high or low. Another data cleaning and screening were performed for missing values and those that were not sufficient to be included in the regression
analysis were dropped. However, for the regression analysis, pairwise correlation and listwise methods were used in the correlation matrix and the multiple regression technique.

The “Enter” method was used to estimate the coefficient and the predicted values of the rate of RE development, feed-in-tariff national installed capacity, and RE-installed capacity. This involved regressing the dependent variables against the set of independent variables by including the constant in the question. Based on the results of the regression, the estimates were used to predict and test the hypotheses for both the survey data and the secondary data. Each variable had a given set of the regression equation and the hypotheses were tested based on these assumptions.

3.9 Qualitative Method

The study employed a case study approach as a method of triangulating data sources. The purpose of the qualitative method is to answer parts of the research questions of the conceptual framework, especially institutional factors. Therefore, a case study allowed the study to gather detailed information that was used to provide a thick description of the research findings. The advantage of using the case study approach was to allow the participants to explain the issue according to their own context and how important they saw the issue under investigation (Hollweck, 2016; Yin, 2014). In addition, the case study approach was used to investigate the two factors—social and institutional—that drive solar policy development by asking major stakeholders in both the traditional and alternative energy sectors to discuss their understanding of the factors that can impede the country’s efforts in achieving the RE policy target of 30% by 2036.

Firstly, the case needed information from the policymaker's perspective in order to understand the policy goals and objectives, the rationale, and the values and alternative courses of action that have been taken to ensure that the RE policy being implemented achieves the desired goals. Secondly, the study focused on implementing agencies to seek information on what strategies have been used to achieve the goals and objectives of the RE policy since its adoption. Additionally, the implementing agencies had a deep understanding of the challenges and prospects of
the RE policy in general and what measures are suitable to address the bottlenecks that currently interfere with the RE policy implementation. Hence, contact with these agencies supported and enriched the data collection process, which helped with the analysis and policy implications of the study.

Thirdly, the case approached used in this study underscores the idea that in the policymaking process, there are various constituents that may be affected by the outcomes of a proposed policy, either as gainers or losers of the policy action. Consequently, in doing sensitivity analysis of public policies it is imperative for researchers to involve other key stakeholders in order to obtain their input in the policy formulation process. Hence, the study included industry actors that were actively involved in the RE sector, either as producers of the technology or suppliers of RE, as well as the end-users of RE in Thailand. Additionally, individuals in the communities where RE plants are located were interviewed, and community leaders or opinion leaders or village heads were included to ensure that a complete stakeholder framework was achieved.

### 3.9.1 Unit of Analysis and Case Study Sample Selection

For the qualitative data, the unit of analysis was at the organization level, where managers and senior executives were interviewed. The study conducted 19 interviews in all. The participants were purposively selected to be part of the in-depth interviews. Four main criteria were used to select the 19 participants:

- Role in RE policy development – organizations performing key roles and responsibilities at each stage of the policy cycle
- Proposal development, priority setting, implementation
- Major regulators that monitor and appraise RE production
- Stakeholders engaged in the RE production or solar rooftop owners that are commercial or residential consumers of RE
- Community leaders and local heads were part of the sample of the study

### 3.9.2 Data Collection Method for Qualitative Data

The qualitative interviews were collected from three sources: policymakers, implementers, and the stakeholders in the RE sector. The interviews were comprised
of an in-depth discussion of the interview protocol that was developed regarding the
determinants of RE policy development. The interviews lasted 30-60 minutes. First of
all, the qualitative interviews involved key policymaking and implementing
institutions: The National Alternative Energy Authority, National Energy Policy
Planning Office, Energy Policy and Planning Office, etc. The sample for this first
group was selected based on the knowledge and depth of information that the officers
in these organizations had on solar energy policies in the country.

Secondly, key employees of energy companies who produce RE; senior and
line managers who had in-depth and first-hand information were selected for the
interviews. The interviews were conducted in Bangkok and Ayutthaya because the
major independent power producers and small power producers are in these
provinces, even though the plants are in different districts. However, their business
transactions take place in Bangkok and nearby provinces. In addition, the higher
concentrations of RE partnership companies in the country have seemingly been in
Bangkok since 2006. Therefore, the choice of the setting of the study was justified.
They were made up of both manufacturers of RE technology, materials and
production, and the distribution of RE power for both industrial and domestic uses.
Thirdly, the interviews involved end-users of RE, and especially residential rooftop
solar owners were selected for the interviews. Lastly, community members and local
heads and authorities in areas where the RE plants are located (Kanong-Phra,
Pakchong, Sumrong-Nua, and Samutprakarn districts) were included in the study. In
all, 23 interviews were conducted.

3.9.3 Data Management and Analysis for Qualitative Data

The study used qualitative data management technique to handle the in-depth
interviews. First, the interviews were played several times before being transcribed
onto 4A sheets. After the transcripts were read and necessary corrections were made
by a replay of the tapes, the transcripts were sent to a qualified translator to translate
the transcribed interviews from Thai to English. This was important since language
was crucial in understanding the content of the interviews; hence, the decision to use a
certified translator for the English version. Further, the translated version was then
coded and organized into themes, patterns, and these were grouped into different
categories for easy understanding of the data. The final stage of the data management was through the thematic and narrative analysis of the results of the interviews. The themes were the dominant views of the participants and the content analysis of the secondary sources of the data from the reports from the key institutions responsible for policy development in the RE sector.

3.10 Chapter Summary

This chapter outlined the content of the research methodology of the study and explained the details of the techniques, tools, instruments, and analytical approaches used in analyzing the primary data from the survey, secondary data, and interviews. The main analytic tool for analyzing the quantitative data was multiple regression, while multiple regression analysis tools were used for the secondary data due to the limitations of the data for a time series model. The qualitative section used a thematic and narrative approach for the analysis of the interviews. Further, the chapter discussed the operationalization of the measurements used to collect the data. The next chapter presents the analysis of the qualitative data.
CHAPTER 4

DATA ANALYSIS AND DISCUSSION OF QUALITATIVE FINDINGS

4.1 Introduction

This chapter discusses the findings of the qualitative interviews. The chapter is organized into sub-headings to ensure a systematic presentation of the results of the study. This section of the thesis focuses mainly on the first research question and first objective of the study, which sought to investigate the determinants of sustainable RE development in Thailand. Hence, efforts are made to use a thematic analysis to address this purpose. The chapter is divided into three (3) sections. The first part presents the biographic information of participants, the second part presents the nature and structure of the RE policy under the flagship of the Alternative Energy Development Plan (AEDP). The third part presents the major themes of the in-depth interviews and a discussion of the findings of the interviews as well as a summary of the main findings. In all, 23 interviews were conducted and organized into major themes for further analysis.

4.2 Demographic Description of Participants

This section deals with the demographic information of the participants who were selected for the interviews. The participants who were mostly key actors drawn across the RE sector with most them being SPP and IPP as well as government agencies and policy institutions. The results show that four (4) were females and nineteen (19) males. Also, the minimum age is 24 and the maximum age is 69. The age distribution of the participants shows a relatively middle-aged population where ten of them ages were between 43-59, five were between 24-38, while six were between the ages of 61-69. While two did not indicate their ages (table 4.1).
### Table 4.1 Summary of Demographic Information of Participants

<table>
<thead>
<tr>
<th>ID</th>
<th>Age</th>
<th>Sex</th>
<th>Highest Level of Education</th>
<th>Position</th>
<th>Sectors</th>
</tr>
</thead>
<tbody>
<tr>
<td>RE01</td>
<td>65</td>
<td>Male</td>
<td>MSC</td>
<td>Licensing Consultant</td>
<td>Regulatory agency</td>
</tr>
<tr>
<td>RE02</td>
<td>61</td>
<td>Male</td>
<td>-</td>
<td>MD</td>
<td>Solar</td>
</tr>
<tr>
<td>RE03</td>
<td>45</td>
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<td>MBA</td>
<td>MD</td>
<td>Biofuels</td>
</tr>
<tr>
<td>RE04</td>
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<td>BSC</td>
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<td>Ethanol</td>
</tr>
<tr>
<td>RE05</td>
<td>46</td>
<td>Male</td>
<td>MBA</td>
<td>CEO</td>
<td>Biogas &amp; Solar</td>
</tr>
<tr>
<td>RE06</td>
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<td>Engineer</td>
<td>Solar</td>
</tr>
<tr>
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<td>Biofuels/Solar</td>
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<tr>
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<td>MSC</td>
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<tr>
<td>RE09</td>
<td>38</td>
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<td>BSC</td>
<td>Factory Manager</td>
<td>Biofuels</td>
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<td>RE11</td>
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<tr>
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<td>RE13</td>
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<td>-</td>
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<td>Deputy Director</td>
<td>Regulatory Agency</td>
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<td>RE15</td>
<td>69</td>
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<td>Multiple RE</td>
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<tr>
<td>*RE16</td>
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<td>CEO</td>
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<td>MSC</td>
<td>Deputy Governor</td>
<td>Distribution</td>
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<tr>
<td>RE19</td>
<td>64</td>
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<td>Sub-Prime</td>
<td>Sumrong-Nua, Samutprakarn</td>
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<tr>
<td>RE20</td>
<td>47</td>
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<td>Sumrong-Nua, Samutprakarn</td>
</tr>
<tr>
<td>RE21</td>
<td>61</td>
<td>Male</td>
<td>BA</td>
<td>Sub-Prime</td>
<td>Kanong-Phra, Pakchong</td>
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<tr>
<td>RE22</td>
<td>58</td>
<td>Male</td>
<td>BA</td>
<td>Community member</td>
<td>Kanong-Phra, Pakchong</td>
</tr>
<tr>
<td>R23</td>
<td>45</td>
<td>Female</td>
<td>Secondary</td>
<td>Community member</td>
<td>Sumrong-Nua, Samutprakarn</td>
</tr>
</tbody>
</table>

With reference to the highest level of education of participants, twelve (12) had a master’s degree representing 52.1 %, four (4) had Bachelor Science degree (BSC) constituting 17.4%, two (2) had Bachelor of Arts (7.7%, with one (1) being a
medical doctor (4.3%) and three (3) of them did not indicate their level of education. One participant had secondary education representing 4.3%. Further, the biographic details suggest that four (4) of the interviewees were engineers, two (2) were factor managers, two (2) were managing directors, and one (1) division manager. Additionally, one (1) of them was a licensing consultant, four (4) deputy directors, two (2) CEOs and one (1) board chairman. Two were village heads (Sub-Prime), one (1) mayor, two (2) community members.

For the type of RE that participants were working, six (6) of them were from biofuels companies, four (4) of them were from solar companies, three (3) were from hybrid RE companies, three (3) were from electricity distribution company, and two (2) were from regulatory agencies. One (1) participant was from the Residential Solar Rooftop model, and two (2) were community members, from Sumrong-Nua, Samutprakarn and Kanong-Phra, Pakchong districts. While one (1) was a mayor from Sumrong-Nua, Samutprakarn and two Sub-Prime from Sumrong-Nua, Samutprakarn and Kanong-Phra, Pakchong districts.

4.3 Policy Development in Thailand

Figure 4.1 Timeline of Governmental Regimes and RE Policy

RE policy dates back 30 years in Thailand. However, the most significant policy invention started with the Adder rate policy in 2007, under the military government of General Surayud Chulanont, as shown in Figure 4.1. The plan was called the “RE Development Plan,” or REDP, from year 2007-2022. It was later adjusted by the government of the People Power Party, decreasing the sum of Adder which will be later discuss in the next section. The policy for the Power Development Planning was formulated 2009 and implemented in 2010, under the government of the Democrat Party. On the 7th of October 2009, the Ministry of Energy announced the “Green PDP” policy for PDP2010, systematic public participation process, to reduce GHG emission from PDP 2007. This introduces the “end-use” approach for demand forecast. This is adjusted from the targets in the RE Development Plan 2007-2022 by the Ministry of Energy to suit different PDP options and performing impact assessment.

In 2010, the Thailand Power Development Plan 2010 – 2030, the PDP2010, was formulated by the Nation Energy Policy Council (NEPC) and was implemented on the 23rd March 2011. The themes of PDP2010 focused on security and adequacy of power system along with the policies of the Ministry of Energy on the aspects of environmental concern. This promoted energy efficiency of RE to be in line with the 15-Year RE Development Plan, REDP 2008 - 2022. The new government policies and the variation of current economic situation were made in attempt to encourage changes and fluctuation in both power demand and power supply. In order to have a clear vision on power supply acquiring, Thailand Power Development Plan 2010–2030 (PDP2010: Revision 3) is developed with crucial issues as the following:

1) Forecasted power demand results approved by the Thailand Load Forecast Subcommittee (TLFS) on 30 May 2012 are adopted within frameworks as the following. Refer to the projected Thai Gross Domestic Products (GDP) and projected Gross Regional Products (GRP) estimated by the Office of National Economic and Social Development Board (NESDB), and issued on 29 November 2011, covering the economic stimulation policies and flooding effects at the end of 2011. Refer to the approved 20-Year Energy Efficiency
Development Plan 2011 –2030 (EE Plan 2011 – 2030) proposed by the MoEN
2) Alternative Energy Development is regarded according to Alternative Energy Development Plan: AEDP 2012-2021 to use RE and alternative energy by 25 percent instead of fossil fuels within the next 10 years.
3) Energy supply security is taken into consideration of fuel diversification and suitable power reserve margin level

The revised PDP or “Thailand Power Development Plan 2010 – 2030 (PDP2010: Revision 3)” suggested the following scope:
1) The 20-Year Energy Efficiency Development Plan 2011 – 2030 (EE Plan 2011 – 2030): this policy is targeting on 25 percent reduction of energy intensity (ratio of energy consumption to GDP) of the country within 20 years (2011 – 2030), resulting in the decrease of country’s power demand projection on account of energy saving programs and energy efficiency promotions.
2) The 10-Year Alternative Energy Development Plan 2012 - 2021 (AEDP 2012 –2021): this policy is targeting on increasing the share of RE and alternative energy uses by 25 percent instead of fossil fuels within the next 10 years, resulting in replacement of some planned conventional (fossil fuels as coal-fired or gas-fired based) power plants by renewable power plants. (SUMMARY of THAILAND POWER DEVELOPMENT PLAN 2012 – 2030, Ministry of Energy)

In 2011, at the 29th ASEAN Energy Ministers Meeting, Thailand and ASEAN member countries saw high potentials for RE, including solar, wind, energy, biomass energy, and biofuels. The joint strategy was created to maximize these potentials. In 2012, under the government of the Pheu Thai Party, the Ministry of Energy, Thailand later set up a 25% alternative energy and alternative energy development plan in 10 years (2012-2064) or the Alternative Energy Development Plan (AEDP). Based on the newly made Alternative Energy Development Plan (AEDP) for 10 years (2012-2021), as shown in diagram 17.4, the AEDP 2012-2021 will replace the existing 15-year RE development plan, of 7,413 thousand tons of crude oil equivalent (ktoe) in
2012 to 25,000 ktoe in 2021, or 25% of total energy consumption. The AEDP 2012-2021 paved a roadmap to promote alternative energy and renewable development of 25% in 10 years (2012-2021) or AEDP (2012-2021) (figure 4.2). AEDP plans to promote alternative energy development in 6 areas as follows:

1) Encourage the community to participate in the production and use of RE widely
2) Adjustment of incentive measures for private investment to suit the situation
3) Amendment of the law and regulations are not conducive to the development of alternative energy
4) Infrastructure improvements, such as power transmission lines, and Smart Grid development
5) Public relations and knowledge generation
6) The promotion of research as a tool for the development of a comprehensive alternative energy industry
Figure 4.2 Alternative Energy Development Plan (AEDP 2012)

Source: Alternative Energy Development Plan (AEDP 2012), adapted by the author.
In 2015, the SD Goals was formulated by the United Nations. The SDGs are 17 global goals set under Resolution 70/1 of the United Nations General Assembly. They are a collection of 17 broad global goals set; each has a separate list of targets to achieve, 169 targets total. The SDGs cover social and economic development issues including poverty, hunger, health, education, global warming, gender equality, water, sanitation, energy, urbanization, environment and social justice. Goal 7, “Affordable and Clean Energy” have these following underlying principles and goals:

- 13% of the global population still lacks access to modern electricity.
- 3 billion people rely on wood, coal, charcoal or animal waste for cooking and heating.
- Energy is the dominant contributor to climate change, accounting for around 60 per cent of total global greenhouse gas emissions.
- Indoor air pollution from using combustible fuels for household energy caused 4.3 million deaths in 2012, with women and girls accounting for 6 out of every 10 of these.
- The share of RE in final energy consumption has reached 17.5% in 2015.
- By 2030, ensure universal access to affordable, reliable and modern energy services.
- By 2030, increase substantially the share of RE in the global energy mix.
- By 2030, double the global rate of improvement in energy efficiency.
- By 2030, enhance international cooperation to facilitate access to clean energy research and technology, including RE, energy efficiency and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology.
- By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, Small Island developing States, and land-locked developing countries, in accordance with their respective programs of support” (https://www.un.org/sustainabledevelopment/energy).
In 2015, Thailand came up with the new Thailand Integrated Energy Blueprint, as shown in Figure 4.3, adding the Energy Efficiency Development plan to the “security” based on the model. The explanations of the model are as follow:

1) Security – to create stability for national energy need/demand and support the National Economic and Social Development Plan by distributing fuel to reduce risk on depending too much on a fuel’s kind

2) Economy – to create reasonable energy cost for both people and business, which will not be hurdle for long-term national development, including to promote energy efficiency

3) Ecology – to reduce effects on environment and community

The Energy Efficiency Development Plan (EEDP 2015) was created to conform to the Thailand Power Development Plan (PDP 2015) and achieve the National Agenda. In 2010, from the Agreement reached by APEC Leaders in 2007, a target has been set to reduce energy intensity by 25% in 2030, with the benchmark of 2005. In 2011, another target was set to reduce energy intensity by 25% in 2030, with the benchmark of 2010. In 2014, another new target was set to reduce Energy Intensity by 30% in 2036, with the same bench mark of 2010. The EEDP 2015 saving target aimed to reduce energy intensity (EI) by 30% in 2036. This is done to accomplish the APEC agreed target aiming, reducing EI by 25% in 2030, with 2005
benchmark. Moreover, the plan aimed to achieve the GHG emission reduction target according to the pledge submitted to UNFCCC in COP20, which aimed to reduce 7% from transport and energy sector in 2020, with 2005 benchmark.

In the past, the Energy Policy Committee was in place. The first policy promotion was known as the SPP Project, which refers to the small power plant. The SPP is into two groups. First, using waste energy generate electricity such as sugar plant project where steam is used to generate electricity. The results of the interviews suggest that Thai governments have been supporting RE development since 2007 with the introduction of ‘Adder rate’ pricing system by the Ministry of Energy (MOE) which was the major policy measure to induce investors in all types of RE. Again, the responses from the informants indicate that the government policy provides only 10 megawatts and below of electric power for all types of RE types under the ‘Adder demonstrated a clear indication of incentives to potential small power producers to invest more in the RE sector. Table 4.2 displays the historical development of RE policy in Thailand.

Table 4.2 RE Policies Framework in Thailand

<table>
<thead>
<tr>
<th>RE Type</th>
<th>REDP 2008-2022</th>
<th>AEDP 2012-2021</th>
<th>PDP 2010-2030</th>
<th>AEDP 2015-2036</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar</td>
<td>500</td>
<td>2000</td>
<td>923</td>
<td>6000</td>
</tr>
<tr>
<td>Wind</td>
<td>800</td>
<td>1200</td>
<td>798</td>
<td>3000</td>
</tr>
<tr>
<td>Biomass</td>
<td>3,700</td>
<td>3,630</td>
<td>2,340</td>
<td>5,500</td>
</tr>
<tr>
<td>Biogas</td>
<td>120</td>
<td>600</td>
<td>121</td>
<td>3,000</td>
</tr>
<tr>
<td>Mini Hydro</td>
<td>324</td>
<td>1,608</td>
<td>263</td>
<td>3000</td>
</tr>
<tr>
<td>MSW(Waste)</td>
<td>160</td>
<td>160</td>
<td>173</td>
<td>550</td>
</tr>
<tr>
<td>Others</td>
<td>3.5</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>5,608 (by 2022)</td>
<td>9,201 (by 2021)</td>
<td>4,617 (by 2030)</td>
<td>21050 (by 2036)</td>
</tr>
<tr>
<td>% of installed Capacity</td>
<td>11% of installed capacity by 2022</td>
<td>19.3% of installed capacity by 2021</td>
<td>6% of installed capacity by 2030</td>
<td>30% of installed capacity by 2030</td>
</tr>
</tbody>
</table>

*=Hydrogen, Tidal & geothermal source

**Source:** REDP2008-2022, AEDP 2012-2021, PDP 2010-2030, AEDP 2015-2036, adapted by the author.
Table 4.2 shows the various policy interventions since 2008 towards the development of RE in the country. This suggests that the governments’ targets on RE have been changing due to the significant gains and investments made in the six RE types, namely, solar, wind, biomass, biogas, and MSW as well as other RE. Although over the years, the government have made attempts to invest in these areas, it appears that the priority areas by the government are in solar, wind, biomass since 2007 with little attention given to biogas and MSW (Waste). This finding was revealed in the interviews when some participants in the waste management sector, explained that they are being offered lower prices for electric power generated from this source.

The system Adder and FIT were created to attract businessmen are interested to invest in RE. The Government has a policy of buying RE (under the Adder system, which the RE power generation will be increased from the normal purchasing power, in addition to Ft. The Adder has developed in three phases, all decreasing in financial incentives due to the improved technology. The purpose of Adder was to sufficiently motivate investment in RE, reducing the amount of greenhouse gas emissions, and reducing dependence on fossil fuel price volatility, and limited quantities. The system FIT, on the other hand, first issued by the energy policy and Planning Office (EPPO) the fixed rate throughout the contract period and unchanged over the power base and Ft purpose, but still want to give reasonable compensation to producers to encourage investment in this segment continues.

Adder system clearly stimulated investments in the RE because business benefit from the uptrend purchase cost and production costs that are likely to decrease. Under the system of Adder formulated since the late 2006, and implemented in 2007, the government purchase electricity at a rate equal to the sum Adder according to the type of RE power purchase rates normally vary with the cost of electricity as the country is increasing steadily. The compensation system under Adder is in an uptrend because the cost of RE production is declining from innovation and technological advancement, raising the production standard of electricity up steadily all over the world. Reduction of the cost of energy conversion devices, for example, solar panels, enables higher energy conversion efficiency. The power supply increases, and production increases, with these factors, it’s causes Adder to attract businesses to invest in RE during the first years of the adoption system Adder, 2007 to
2009. However, the system Adder power purchase cost add a burden to the government. This is why the policy has been changed to FIT mid-year 2010.

Since the rise of the FIT system, the overall investment in RE slowed down. The government initially set Fit for solar energy at 5.94 baht per unit. The rate is lower than the purchase of electricity under Adder significantly because only the minimum Adder lone is 6.50 baht per unit for solar energy. The rates did not include regular electricity purchase. However, the period of the contract is longer, extending from the original 10 years to 20 years. This helped the concern among the business value of investment in RE that may lower yield and longer power supply contracts. The FIT of other RE, with the exception of Solar Energy, has a less clear remuneration policy. This affected the confidence in investments in RE and cause the vulnerable hesitation in the group of investors.

The government set the feed-in tariff to be balanced in terms of reducing the cost of government and maintain the attractiveness of investment in RE, without carrying and burden, and still having a significant impact towards the business sector and consumers. The results of the interviews revealed that there have been policy changes since 2008 and the government have had to set new targets from previous policy goals. One such policy that is presently been implemented is the Alternative Energy Development Plan 2015 which targets 30% RE by 2036 from the 2012-2021 target of 19.3% by 2021.

4.3.1 AEDP 2015 Plan

Alternative Energy Development Plan (AEDP2015), as shown in figure 4.4, is a crucial plan to promote the production of energy from a renewable material which domestically available at full capacity. Because of the potentials developing renewables through research and other promotion activities, the AEDP in 2015 set the target of 30% by the year 2036 which will translate into about 20000 megawatts of electric power of the 40000 megawatts of electricity required for the country to be self-sufficient. However, the focus of the ADEP within the first 5 years is to support all RE types not limited to solar alone. Nevertheless, solar generation is the largest in the 30% target of 2036 which is presented in Table 4.3 depicts the share of each of the six RE types.
Table 4.3 Summary of RE and Policy Targets for AEDP 2015-2036

<table>
<thead>
<tr>
<th>Type of RE</th>
<th>Installed Capacity MW.</th>
<th>Percentage of total Installed capacity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar</td>
<td>6000</td>
<td>28.5</td>
</tr>
<tr>
<td>Wind</td>
<td>3000</td>
<td>14.3</td>
</tr>
<tr>
<td>Mini Hydro</td>
<td>3000</td>
<td>14.3</td>
</tr>
<tr>
<td>Biomass</td>
<td>5,500</td>
<td>26.0</td>
</tr>
<tr>
<td>Biogas</td>
<td>3000</td>
<td>14.3</td>
</tr>
<tr>
<td>Waste</td>
<td>550</td>
<td>2.6</td>
</tr>
<tr>
<td>Total</td>
<td>21050</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Source: Alternative Energy Development Plan (AEDP 2012), adapted by the author.
Figure 4.4 Alternative Energy Development Plan (AEDP 2015)

Source: Alternative Energy Development Plan (AEDP 2015), adapted by the author.
4.3.2 Adder Rate Price Policy

Adder rate is the top up payment of base electricity buying price, where the base electricity price is given by EGAT, the top up amount is added to aid producers for the high cost RE has, as compared to traditional source of energy. Hence ‘Adder rate’ is the top up of the retail price of electricity to producers. Under the previous policy target and framework, the pricing mechanism which supported the Adder price in the year 2007 was at 8 THB for Solar Energy and decreased to 6.50 THB in 2010. However, full change from Adder to Feed-in-tariff was in 2014 – 2015. Clearly, Adder rate started with 8THB for solar and then decreased to 6.50THB in 2009. Adder rate ended in 2012, with Feed-in-tariff being ushered in 2013-2014 year (Table 4.4 and 4.5).

Table 4.4 Adder Rate Policy for RE Types

<table>
<thead>
<tr>
<th>Type of Energy</th>
<th>Adder 2007 (Baht/kWh)</th>
<th>Adder 2009 (Baht/kWh)</th>
<th>Adder 2010 (Baht/kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Biomass</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Installed Production Capacity ≤ 1 MW</td>
<td>0.30</td>
<td>0.50</td>
<td>0.50</td>
</tr>
<tr>
<td>Installed Production Capacity &gt; 1 MW</td>
<td>0.30</td>
<td>0.30</td>
<td>0.30</td>
</tr>
<tr>
<td>2. Biomass (From all sources of production)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Installed Production Capacity ≤ 1 MW</td>
<td>0.30</td>
<td>0.50</td>
<td>0.50</td>
</tr>
<tr>
<td>Installed Production Capacity &gt; 1 MW</td>
<td>0.30</td>
<td>0.30</td>
<td>0.30</td>
</tr>
<tr>
<td>3. Waste</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fermentation of landfill</td>
<td>2.50</td>
<td>2.50</td>
<td>2.50</td>
</tr>
<tr>
<td>Thermal Process</td>
<td>2.50</td>
<td>3.50</td>
<td>3.50</td>
</tr>
<tr>
<td>4. Wind</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Installed Production Capacity ≤ 50 kW</td>
<td>3.50</td>
<td>4.50</td>
<td>4.50</td>
</tr>
<tr>
<td>Installed Production Capacity &gt; 50 kW</td>
<td>3.50</td>
<td>3.50</td>
<td>3.50</td>
</tr>
<tr>
<td>5. Small Tidal Energy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50 kW ≤ Installed Production Capacity ≤ 200 kW</td>
<td>0.40</td>
<td>0.80</td>
<td>0.80</td>
</tr>
<tr>
<td>Installed Production Capacity &lt; 50 kW</td>
<td>0.80</td>
<td>1.50</td>
<td>1.50</td>
</tr>
<tr>
<td>6. Solar Energy</td>
<td>8.00</td>
<td>8.00</td>
<td>6.5</td>
</tr>
</tbody>
</table>

Table 4.5 Special Adder Rate Policy for Renewable Energy Types

<table>
<thead>
<tr>
<th>Type of Energy</th>
<th>Special Adder for Diesel replacement (Baht/kWh)</th>
<th>Special Adder for 3 Southern Provinces (Baht/kWh)</th>
<th>Support Period (Year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Biomass</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Installed Production Capacity ≤ 1 MW</td>
<td>1.00</td>
<td>1.00</td>
<td>7</td>
</tr>
<tr>
<td>Installed Production Capacity &gt; 1 MW</td>
<td>1.00</td>
<td>1.00</td>
<td>7</td>
</tr>
<tr>
<td>2. Biomass (From all sources of production)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Installed Production Capacity ≤ 1 MW</td>
<td>1.00</td>
<td>1.00</td>
<td>7</td>
</tr>
<tr>
<td>Installed Production Capacity &gt; 1 MW</td>
<td>1.00</td>
<td>1.00</td>
<td>7</td>
</tr>
<tr>
<td>3. Waste</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fermentation of landfill</td>
<td>1.00</td>
<td>1.00</td>
<td>7</td>
</tr>
<tr>
<td>Thermal Process</td>
<td>1.00</td>
<td>1.00</td>
<td>7</td>
</tr>
<tr>
<td>4. Wind</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Installed Production Capacity ≤ 50 kW</td>
<td>1.50</td>
<td>1.50</td>
<td>10</td>
</tr>
<tr>
<td>Installed Production Capacity &gt; 50 kW</td>
<td>1.50</td>
<td>1.50</td>
<td>10</td>
</tr>
<tr>
<td>5. Small Tidal Energy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50 kW ≤ Installed Production Capacity ≤ 200 kW</td>
<td>1.00</td>
<td>1.00</td>
<td>7</td>
</tr>
<tr>
<td>Installed Production Capacity &lt; 50 kW</td>
<td>1.00</td>
<td>1.00</td>
<td>7</td>
</tr>
<tr>
<td>6. Solar Energy</td>
<td>1.50</td>
<td>1.50</td>
<td>10</td>
</tr>
</tbody>
</table>

Remark: * 4 district in Songkhla Province such as Chana, Thaepha, Sabayoi and Nathanwee

Source: Ministry of Energy, Special Adder Rate Policy 2007-2010, adapted by the author.

During the Adder rate policy, solar generation capacity had increased from 7.22 MW in 2009 to 189.0 MW in 2012 which added about 96.31% growth of solar energy to the total installed capacity of solar energy for the 4 years’ timeline. Also, it appears that the Adder rate depicts an upward trend in RE production, especially in solar since the policy prioritized solar energy over other RE under the Adder pricing policy (Table 4.6). Further observation of Table 4.6 indicates that solar and biomass have seen a consistent upward trend after the Adder was revised to the FiT policy.
Table 4.6 Actual Supply of RE Types to the National Grid from 2007-2016

<table>
<thead>
<tr>
<th>Year</th>
<th>Biomass (Mw)</th>
<th>Biogas</th>
<th>Waste</th>
<th>Solar</th>
<th>Wind</th>
<th>Hydro</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td></td>
<td></td>
<td></td>
<td>32.51</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2008</td>
<td></td>
<td></td>
<td></td>
<td>33.39</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2009</td>
<td>1,071.41</td>
<td>79.18</td>
<td>3.60</td>
<td>7.22</td>
<td>5.1</td>
<td>3,596.25</td>
</tr>
<tr>
<td>2010</td>
<td>254.66</td>
<td>81.81</td>
<td>6.50</td>
<td>21.42</td>
<td>5.6</td>
<td>12.40</td>
</tr>
<tr>
<td>2011</td>
<td>199.83</td>
<td>17.81</td>
<td>60.00</td>
<td>192.39</td>
<td>165.70</td>
<td>696</td>
</tr>
<tr>
<td>2012</td>
<td>332.80</td>
<td>40.60</td>
<td>15.80</td>
<td>188.63</td>
<td>103.50</td>
<td>8.23</td>
</tr>
<tr>
<td>2013</td>
<td>401.91</td>
<td>13.57</td>
<td>0.90</td>
<td>510.15</td>
<td>7.50</td>
<td>22.67</td>
</tr>
<tr>
<td>2014</td>
<td>355.10</td>
<td>35.47</td>
<td>6.78</td>
<td>390.49</td>
<td>34.00</td>
<td>7.32</td>
</tr>
<tr>
<td>2015</td>
<td>470.52</td>
<td>61.30</td>
<td>61.00</td>
<td>700.51</td>
<td>10.00</td>
<td>30.00</td>
</tr>
<tr>
<td>2016</td>
<td>529.52</td>
<td>83.76</td>
<td>20.43</td>
<td>787.25</td>
<td>326.00</td>
<td>33.92</td>
</tr>
<tr>
<td>Total</td>
<td>3615.75</td>
<td>413.50</td>
<td>175.01</td>
<td>2798.06</td>
<td>612.7</td>
<td>3710.79</td>
</tr>
</tbody>
</table>

Source: Ministry of Energy, Actual Supply of RE Types to the National Grid from 2007-2016, adapted by the author.

However, the respondents interviewed explained that although the Adder rate was a better pricing mechanism, the payback period was short which was between 7 years for other REs and 10 years for solar and wind. The findings of this study suggest that the Adder rate was depended on the type of technology used for production.

4.3.3 Feed-In-Tariff (FiT) Policy

Feed-in Tariff or FiT is one of the financial incentives to promote the purchase of RE which was widely used abroad to attract the private entrepreneurs in the business of RE power plants. This is due to the fact that production of electricity from RE consume relatively high-cost. The FiT rate was fixed at constant buying rate through lifetime of project. However, there was adjustment to raise the rate for fuel users. The FiT rate varied by electricity fee base and Ft change to create clear price and fairness. The purchasing power in the form FiT that can be divided into 2 main sections.
1) The power purchase rate constant (FiT fixed: FiTF) calculated from a power plant construction costs and operation and maintenance (O & M) throughout the project life for all types of RE.

2) The power purchase rate variability (FiT variable: FiTV) based on the cost of the raw materials used for electricity production, which change over time in RE and bio-energy sector.

In addition, purchasing electricity rate was defined in the model FiT (FiT Premium) which added from purchase rate for electricity in a regular pattern FiT for certain type of technology to create the motivation to invest in the project according to government policies such as waste, biomass and biogas projects and in the southern border provinces to enhance energy stability in the area. (See Table 4.7) The structure of the FiT consists of three parts:

(1) The purchasing power of fixed (FiTF) which are fixed throughout the life of the project. (See Table 4.23)

(2) The purchasing power of variation (FiTV) will increase value of basic inflation (Core inflation) the average of previous years, According to the Ministry of Commerce

(3) Power Purchase special rate (FiT Premium) policies of the Government's wish to create incentives for investment in certain types of fuel. The structure FiT rate is as follows. (Table 4.7, figure 4.5, and figure 4.6)
### Table 4.7 FiT for RE Types

<table>
<thead>
<tr>
<th>Installed Production Capacity</th>
<th>FIT (Baht/Unit)</th>
<th>Support</th>
<th>FIT Premium (Baht/Unit)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FIT</td>
<td>FIT V1 2017</td>
<td>FIT (1) Period</td>
</tr>
<tr>
<td></td>
<td>Year</td>
<td>First 8 years</td>
<td>Life</td>
</tr>
<tr>
<td>1) Waste (Mixed Waste Management)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Installed Production Capacity ≤ 1 M</td>
<td>3.13</td>
<td>6.34</td>
<td>20</td>
</tr>
<tr>
<td>Installed Production Capacity &gt; 1 - 3 M</td>
<td>2.61</td>
<td>5.82</td>
<td>20</td>
</tr>
<tr>
<td>Installed Production Capacity &gt; 3 M</td>
<td>2.39</td>
<td>5.08</td>
<td>20</td>
</tr>
<tr>
<td>2) Waste (Landfill)</td>
<td>All Size</td>
<td>5.60</td>
<td>5.60</td>
</tr>
<tr>
<td>3) Biomass</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Installed Production Capacity ≤ 1 M</td>
<td>3.13</td>
<td>5.34</td>
<td>20</td>
</tr>
<tr>
<td>Installed Production Capacity &gt; 1 - 3 M</td>
<td>2.61</td>
<td>4.82</td>
<td>20</td>
</tr>
<tr>
<td>Installed Production Capacity &gt; 3 M</td>
<td>2.39</td>
<td>4.24</td>
<td>20</td>
</tr>
<tr>
<td>4) Biogas (Waste Water/Waste)</td>
<td>All Size</td>
<td>3.76</td>
<td>3.76</td>
</tr>
<tr>
<td>4) Biogas (Waste Water/Waste)</td>
<td>All Size</td>
<td>2.79</td>
<td>2.55</td>
</tr>
</tbody>
</table>

**Source:** Ministry of Energy, Feed-in Tariffs Policy 2015-2017, adapted by the author.

**Figure 4.5** FIT Equation for Fit + Core Inflation + Fit Premium

**Source:** Ministry of Energy, Feed-in Tariffs Formula 2015 & 2017, adapted by the author.

**Figure 4.6** Fit Premium

**Source:** Ministry of Energy, Feed-in Tariffs Premium 2015 & 2017, adapted by the author.
Feed-In-Tariff (FiT) is a fixed cost in a fixed period, unlike Adder rate which is paid on top of the retail price. Feed-In-Tariff has a payback period for solar at 20 years where the price for solar electricity is fixed within two bands, the upper limit (5.66baht) and lower limit (4baht). Under the FiT policy, EGAT and PEA are more profitable by buying electricity from producers. FiT is based on a premium criterion using the core inflation formula to set the fixed price for each RE-type. Further, with FiT, EGAT and PEA are getting electricity at stable prices regardless of electricity price increases. For example, if FiT is 4THB, it remains this way for the period of 20 years even though, electricity base price may increase at the distribution end. With this, the government can benefit stable and profitable electricity at 6-7THB although producers are paid 4THB per unit of RE produced. However, it was revealed that other REs types unlike solar have a different formula for arriving at the fixed price. Table 4.8 below further elaborates on the pricing formula for FiT.

Despite the price stabilization mechanism introduced by government under the FiT, it appears that investors are more likely to suffer loses and their return on investment (ROI) may diminish gradually as they turn to get lower prices for their power under the components of FiT: bidding and drawing which the government uses to get the best lower prices of energy purchased from producers. However, some of the government agencies interviewed were of the view that before the price is fixed, there is usually cost-benefit analysis (CBA) conducted for each set of RE types and the process ensures that the investor is not made worse-off under the FiT policy. According to some of the interviewees, the policy ensures that the cost of electricity issued for final users enhance the pricing of REs because it takes every possible alternative in evaluating the RE type production.

The government considers a balance between investors’ profits and the benefits that will benefit the people. For investors, they are seeking higher profits and they maintained that the price given by the government is low, but the government is focusing on people first. Also, the government allowed a stable investment and returns in the energy sector by controlling the price of electricity. Although high electricity prices will mean that higher profits for investors and wealth in the short-run, the stable returns should compensate for the lower prices given by government since sustainable price stabilization is needed for the constant supply of electric
power. The shift from the Adder rate to FiT was because the estimated base electricity price was likely to increase every 5 years, and hence, if the price increase for electricity, investors were also more likely to increase the unit price of electricity purchased by EGAT and PEA. For example, if Adder is for 7-10 years, the base electricity fee will increase, unlike FiT which is a fixed price throughout the contract lifecycle. Also, unlike the Adder rate which short payback period for investors about 7-10 years, the new FiT policy ensures a long payback period of investments of about 20 years.

In 2017, under the government of General Prayut Chan-o-cha, the Twelfth National Economic and Social Development Plan 2017-2021 was imposed. According to the Office of the Thai NESDB, since the Ninth Plan, the principles of the “Sufficiency Economy Philosophy” “have been and continue to be a vital element of development strategy as they underpin the promotion of moderation, reasonableness, and resilience. These principles have significantly contributed to balanced and SD in Thailand.” Explaining the “Sufficiency Economy Philosophy” of the Tenth Plan, “King Rama 9, King Bhumibol Adulyadej, had proposed solutions that would bring about sustainable national development to Thailand. The goal of this philosophy is aimed at enhancing the quality of life of people and local communities, making them become “self-reliant, thus achieving SD.” Moreover, although the “Thai people in rural areas fundamentally depend on and utilize natural resources and the environment, the economic sector has deteriorated natural resources and the environment faster than the capacity to rehabilitate them.” Therefore, “His Majesty initiated natural resource management which includes water resource management, reforestation, and soil conservation as these three factors form the essential food chain of every single life. Hence, it is necessary that natural resources be conserved and developed in conjunction with appropriate utilization.”

According to the Twelfth Plan (table 4.8), “Thailand will face an array of fundamental strategic development factor limitations which will provide an obvious obstacle to the country’s future development.” Additionally, according to the report, “natural resources and the environment have rapidly deteriorated in both quantity and quality, resulting in higher economic costs and devastating negative impacts on people’s quality of life. In addition, public administration has been inefficient, lacking
in transparency, and highly corrupted. All of these factors will be constraints to national development and will leave some parts of society behind.” In relations to RE, the Twelfth Plan can be summarized under 5 themes as follows:

1) In the future, new technology and innovation will cause a critical transformation of economic and social development, and people’s lifestyles.

2) Intensified international agreements relating to climate change caused countries to intensify the mitigation of greenhouse gas emissions creating pressure for the nations to transform towards more sustainable forms of consumption and production, and to use more RE and bio-fuel.

3) The plan is to prescribe measures and mechanisms to support greenhouse gas reduction in all sectors, with an emphasis on the following sectors: electricity generation, transport, industry, households, and buildings. Thailand has to reduce the use of fossil fuels in generating power while at the same time promoting the use of RE, energy saving, and waste-to-energy. The country has to build the capacity of manpower to excel in various forms of RE.

4) The goal of the NAMA Roadmap is to reduce greenhouse gases by 7 percent compared to the business as usual (BAU) emissions in 2020. The implementation of NAMA is based on the voluntary actions of the energy and transport sectors. Important measures include electricity generation from RE, efficiency improvement in production and energy use, biofuel utilization, and other sustainable transport measures.

5) The Twelfth Plan calls for enhancing RE production in the Central and Lower Northeastern provincial clusters of Thailand by: balancing food and energy crop plantations, suggesting suitable areas for farmers to grow energy crops, and encouraging manufacturers, local communities, and local authorities to generate RE from solar energy, wind power, biomass, and solid waste.”

The twelfth edition has been developed the 11th edition from 2012-2016, where the plan called for the creation of energy security by promoting “the use of
alternative clean sources of energy.” (table 4.9) The Plan advocated for the “effective incentives should be established to encourage greater use of RE for both electricity and transport needs” to “stimulate the use of biofuels such as gasohol and biodiesel from biomass and solid waste.” The plan also called for the “restructure production sectors toward an environmentally sound low-carbon economy: Upgrade industries that have emitted high levels of greenhouse gases toward environmentally safe technology by providing low-interest loans and tax incentives to retrofit machinery, increase efficiency, and switch from fossil fuels to RE.” Additionally the “RE Development Plan also aimed to increase the level of ethanol in benzene by at least 9 million liters per day by 2022, and by at least 4.5 million liters per day in biodiesel”, comparing this to the 2011 ethanol and biodiesel consumption of approximately 1.2 and 1.7 million liters per day.”

The 10th edition NESDP in contrast, from 2007-2011, announced that the “Leapfrog advances in technologies including communications technology, biotechnology, materials technology, and nanotechnology, presented both opportunities and threats to economy and society.” Additionally, the Tenth Plan read that the” international agreements and treaties have been concluded governing various aspects of the world’s environment and natural resources.” Thus, Thailand had to “upgrade its standards of environmental management in order to protect the resource base and maintain a sustainable balance in the natural environment, by developing more efficient systems for administering and managing natural resources with participatory processes.” The report also called for Thailand to “adjust processes of producing goods and services to become more environment-friendly and must increase efficiency in energy usage and develop alternative energy sources to meet the domestic demand for energy” (NESDB 2018) (table 4.10).
Table 4.8 The National Economic and Social Development Plan (NESDP), 12th Edition

<table>
<thead>
<tr>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Access to safe food</strong></td>
<td><strong>Provide social protection and increase income for the poor</strong></td>
<td><strong>Promote comprehensive and sustainable economic growth</strong></td>
<td><strong>Sustainable agriculture Access to safe drinking water</strong></td>
<td><strong>End human trafficking and violence against children</strong></td>
<td><strong>Reduce corruption</strong></td>
<td><strong>Mobilization of state resources to support sustainable development</strong></td>
<td><strong>Increasing energy efficiency</strong></td>
<td><strong>Increase the share of exports of developing countries</strong></td>
<td></td>
</tr>
<tr>
<td><strong>End the spread and death from communicable diseases and non-communicable diseases.</strong></td>
<td><strong>Reduce stress on women and children.</strong></td>
<td><strong>Increase resource efficiency</strong></td>
<td><strong>Green industry</strong></td>
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</tr>
</tbody>
</table>

*Source: National Economic and Social Development Plan 2017, adapted by the author.*
<table>
<thead>
<tr>
<th>Table 4.9 The National Economic and Social Development Plan (NESDP), 11th Edition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Eleventh plan strategies 2012-2016</strong></td>
</tr>
</tbody>
</table>
| **1. Creating fairness in society** | - Increasing the potential and capacity of the community  
- Development of consumer protection system standards |
| **2. People development to a learning society** | - Development of quality Thai people to be immune to change  
- Labor force development with knowledge and competency |
| **3. Agricultural sector strength, Food and energy security** | - Promoting Thailand to be a center of privatization to increase value of agricultural and food products  
- The promotion of international cooperation at both the multilateral and bilateral levels |
| **4. Adjusting the economic structure to quality growth** | - Enhancing marketing efficiency and product distribution to potential new markets  
- Increasing the role of Asian currencies in foreign markets |
| **5. Building links with countries in the region** | - ASEAN Economic Community  
- ASEAN Social and Cultural Community  
- ASEAN Political and Security Community |
| **6. Sustainable natural resource and environmental management** | - Raising the ability to cope and adapt to climate change  
- Increasing the role of Thailand in the international community arena regarding the international environmental framework  
- Pollution control and reduction |

**Source:** National Economic and Social Development Plan 2012, adapted by the author
Table 4.10 The National Economic and Social Development Plan (NESDP), 10th Edition

Tenth plan strategies 2007-2011

<table>
<thead>
<tr>
<th>Development of quality of people</th>
<th>Enhancement of community strength</th>
<th>Adjustment of economic structure</th>
<th>Biodiversity-based development</th>
<th>Enhancement of good governance</th>
</tr>
</thead>
</table>

- **Public sector**
  - National administration plan

- **Private sector/Institutions/mediation**
  - Plans of organizations/institutes

- **Community**
  - Community plans

- **Family**
  - Way of living of a person/family

Create participation process of development partners

- **Monitoring and evaluation**
  - Indicate major investment strategies according to 10th plan
  - Revise, amend, and draft the necessary laws
  - Study and research to create in-depth bodies of knowledge to enhance and drive the strategies

Source: National Economic and Social Development Plan 2012, adapted by the author.
4.4 Thailand’s Electricity Corporate Structure

The corporate structure of RE in Thailand is a multilayered system and with a stream of responsibilities distributed along the value chain in electricity production. For example, there are components of the corporate structure, generation (% installed capacity), transmission, and distribution. For the first component, SPP has 7% of generation capacity, EGAT has 47%, IPP has 38%, import is 5%, and VSPP is 3% providing a 100% generation capacity of electricity (Figure 4.1 below). The second component includes a transmission system performed by EGAT giving a total of 100% power transmission.

The third component is distribution where, in 2015, EGAT is responsible to distribute electricity through the system in which the following allocations are done: MEA (32%) and PEA (66%) to distributed electricity to final customers in VSPP format. For the VSPP they transmit electricity directly to PEA and MEA. Also, SPP can transmit directly to users under PEA and MEA. Within the corporate structure is the Energy Regulatory Commission (ERC) who regulates the activities of plants and the distribution channel (figure 4.7).

**Figure 4.7** RE Corporate Structure in Thailand

**Source:** PEA 2016, adapted by the author.
It should be noted the selling of electricity and signing of contracts are done on behalf of the government by PEA and the VSPP. In case of SPP and IPP, they are allowed to sell electricity directly to EGAT’s main system because the VSPP system is the smaller generation line in the electricity line. However, in terms of policy and oversight responsibilities, EGAT is regulated by NEPC, EPPO, and DEDE.

4.4.1 Types of Private Power Producer of RE

There is three main type of private producers of RE in Thailand, the independent power producer (IPP), the small power producer (SPP), and very small power producer (VSPP). The details of these three different types are discussed below.

1) Independent Power Producer (IPP)

IPP is a power plant with capacity more than 90 megawatts, using mainly natural gas and coal. This group is at risk for low-income recognition due to classification as a base power plant with a long-term power purchase agreement with EGAT. There are two main sources of income for these types of producers: 1) Total electricity distributed into the system according to the use of consumers and, 2) Maximum revenue received under EGAT’s long-term contract agreement.

2) Small Power Producer (SPP)

SPP is a power plant with a capacity of 10 – 90 megawatts. The period of contract with EGAT is about 20 – 25 years and they sell electricity directly to industrial customers in the neighbourhood that they are located. However, this group may be at risk in terms of uncertainty of income, especially in part because they sell electricity directly to industrial sector which may be easily affected by the fluctuation of economic conditions and industry-specific risks.

3) Very Small Power Producer (VSPP)

VSPP is a power plant with a capacity of fewer than 10 megawatts. Usually, these plants are produced from residues of the plant in agricultural processes for internal use, an example is rice husk or sugar cane. However, the surplus of electricity produced from this source is sold to MEA and PEA at the current Feed-in-Tariff rate. However, the type of RE production determines the project lifecycle since some are
offered more payback period than others. For example, solar energy is purged at 20 years under the FiT policy.

4.5 Presentation of Interviews and Findings

This section of the report presents the results of the interviews by focusing on the research question one of this study: ‘What are the determinants of sustainable RE development? And how do major actors influence RE policy development cycle?’, and part of question five (5) which sought to examine the policy goals and objectives to ensure sustainability: ‘How do policy goals and objectives influence sustainable RE deployment?’. Because of these two questions, there were several themes that emerged from the interviews. However, to be able to manage the data and ensure a clear understanding of the topic under investigation, only major and key themes are selected for further analysis and subsequent analysis. Table 4.11 shows the major themes and subthemes for the qualitative interviews. In all 23 interviews were conducted. Below is a presentation of the findings on the determinants of RE policy sustainability and their effect in the Thai context.
### Table 4.11 Summary of Major Themes and Findings

<table>
<thead>
<tr>
<th>No.</th>
<th>Major Theme</th>
<th>Sub-themes</th>
<th>Findings</th>
<th>No. Count in interviews</th>
</tr>
</thead>
</table>
| 1   | Financial Incentives         | Three Phases: Adder rate, Feed-In-Tariff and cooperative (PPP)                                                                            | Adder rate paid on top of retail prices of electricity for REs  
FiT- (Bidding)  
Cooperative/PPP (uses Drawing)  
competitivepricing/- bidding-(the price war)  
SPP is not happy with the new pricing because the government is interested in offering lower prices which are a disincentive to the real-time investors. | 19 out of 23             |
| 2   | Clarity of Policy goals      |                                                                                                                                              | Lack of clarity of the goals and objectives of the RE policies  
And there is a lack of direction and definition of the RE policy targets and goals                                                                                                                      | 13 out of 23             |
|     | Legal framework/ regulations| Rules governing firms' contracts  
Administrative Procedures                                                                                                                  | Lack of legal or regulatory framework  
Certificates are obtained without real production of RE by many firms and there are no stricter sanctions for non-compliance. The potential of the absence of a legal framework to hold investors to account for their license is likely to affect the target of 30% by 2036 Complex administrative process is | 11 out of 23             |
<table>
<thead>
<tr>
<th>No.</th>
<th>Major Theme</th>
<th>Sub-themes</th>
<th>Findings</th>
<th>No. Count in interviews</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>involved in obtaining a license to operate Red tape</td>
<td>11 out of 23</td>
</tr>
<tr>
<td></td>
<td>Transparency and Corrupt practices</td>
<td>Openness in the pricing system Licenses and regulations/Restriction on RE Certification/contracts Ghost investors</td>
<td>-Corrupt practices especially the queueing process where investors are provided with a license to operate -The contractual process is bedevilled with bureaucratic bottlenecks and red tape -Lack of effective Monitoring</td>
<td>10 out of 23</td>
</tr>
<tr>
<td></td>
<td>Cheating and Gaming the System</td>
<td>Gaming the bidding system</td>
<td>Some bidders never run a power plant, but they can bid and win Some investors bid for lower prices to increase their stock prices, but they cheat the system by not producing any energy from their license</td>
<td>11 out of 23</td>
</tr>
<tr>
<td></td>
<td>Stakeholder Consultation</td>
<td>Lack of dialogue between power plant producers and agencies in the RE sector</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Political Interference</td>
<td>Military takeover Low commitment</td>
<td>There are times politicians incite communities to protest investors because they perceive the owner to be politically inclined to a party they do not support Frequent government takeover is affecting policy stability There is a low commitment from regulatory agencies to</td>
<td>9 of 23</td>
</tr>
<tr>
<td>No.</td>
<td>Major Theme</td>
<td>Sub-themes</td>
<td>Findings</td>
<td>No. Count in interviews</td>
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<td>-----</td>
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<td>------------------------</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>make the process of obtaining operating permits transparent. However, there is a general impression that government is supporting the growth of RE.</td>
<td>8 out of 23</td>
</tr>
<tr>
<td></td>
<td>Subsidies</td>
<td>1. Financial support 2. tax incentives 3. Credit assistance for SMEs</td>
<td>The government does not provide any financial support for startup companies, but they support investors in the pricing system since investors have good returns on their investments through stable prices of electricity fixed to 20 years under the FIT and 7 years under the ‘Adder rate’ policy</td>
<td>8 out of 23</td>
</tr>
<tr>
<td></td>
<td>Cost of Investment</td>
<td>High technological investment costs Limited market opportunities High attrition rate Price stability Competitive pricing/ bidding-the price war</td>
<td>The investment cost for some RE types are high however, there are cheaper construction costs of power plants in Thailand. The RE sector experienced a fall in stock prices in the Financial Market. Limited market opportunities Solar cell plants are high because they have non-toxic gas Technology is expensive since some of the technical issues are imported into the country</td>
<td>10 out of 23</td>
</tr>
<tr>
<td>No.</td>
<td>Major Theme</td>
<td>Sub-themes</td>
<td>Findings</td>
<td>No. Count in interviews</td>
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<td>-----</td>
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<td>-------------------------</td>
</tr>
<tr>
<td></td>
<td>The current price under FiT is believed not to be sustainable</td>
<td></td>
<td>The high attrition rate of producers because of low bidding prices</td>
<td></td>
</tr>
<tr>
<td></td>
<td>R&amp;D Support</td>
<td>There are little support and investment in R&amp;D by the government. And the content of the R&amp;D is of lower quality and mostly, it is incomplete</td>
<td>7 out of 23</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Benefits of Solar</td>
<td>Environmental friendliness Electricity prices are cheaper because of the RE production Electricity Subsidies for Households Community acceptance</td>
<td>16 out of 23</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Challenges facing RE</td>
<td>The results showed that there are several challenges facing RE development: Corruption and transparency Technical competencies Investments costs Bureaucratic bottlenecks</td>
<td>18 out of 23</td>
<td></td>
</tr>
</tbody>
</table>

**Source:** ministry of energy, Summary of Major Themes and Findings, adaptor by the author.

The major themes in Table 4.11 above are further analysed according to the content of the interviews by using narrative and content analysis techniques to provide a clear understanding of the potential effect that these themes may support or impede the policy targets of the government in the long-run.
4.5.1 Financial Incentives: The AEDP policy: Three Phases Overview

The first Phase was Adder rate that was paid in addition to the base price of electricity, thus solar, for 7 to 10 years over the Lifecycle of the plant. However, this policy had limitations since producers were overproducing and putting the burden on EGAT since it had to pay more. However, the regional producers who were assigned to PEA were not getting adding payment made to them since PEA put the ceiling at the requested megawatt of electricity that the plant installed capacity was assessed. Similarly, under phase, Adder was designed to be revised, with the example of solar, from 8 to 6.5 baht within the 7 year-duration of the policy. There are two groups of buyers under the AEDP. For example, if the production is less than ten megawatts of solar electric power, the main buyer, especially at the provincial level, is PEA while plants with a capacity of ten or more megawatts of electricity generated by SPP and IPP must contact EGAT. If the policy for Adder required that those firms that produce a megawatt of electricity of REs should sell to PEA while 10 or more megawatt be sold to EGAT, this is was also followed by a set of rules which restricts the number of megawatts of electricity to be produced by SPP and IPPs.

It must be noted the two phases involved two pricing mechanism adopted by the government under the Adder rate (phase 1) which sought to attract more investments in the area from 2007-2012 to achieve a rapid production share of RE in the country. The resultant effect was a mad rush for solar energy investments with some companies’ stock prices being increased due to the high turns on solar investments in this period. A respondent captured this theme in the following quote:

“In phase 1, they promoted a lot through the extra 8 bath Adder. Everyone in the industry during the time wants a part of this. Everyone wants to make RE, want to create and use clean energy that does not emit carbon dioxide, and also want to make a lot of profit.”

The drawback of the Adder policy is that the mass production witnessed an increasing number of firms in the sector and this placed a huge burden on government since solar electricity was paid after the electricity base price to investors. The indication was that government was paying more while investors were cashing out with this policy. As the ‘Tom yum’ crisis peaked in 2009, the government perhaps tried to ensure price stability of electricity prices through a new policy change under
FiT. Phase two is the Fee-in-tariffs. The Fit expected to last for 20 years. One significant finding on Feed-in-tariff is that the policy had no pre-project goals but rather it was meant to look at existing projects that can be turned in use after the lifecycle. FiT has a longer payback period than the Adder rate and it may support steady investments in the RE sector since investors will not take decisions in the short-term to recover their investments.

The feed-in-tariffs is limited by price and the price is lower than Adder. However, the number of years has added to the previous 7 years up to 20 years to compensate for the fall in price. Most of the RE producers agreed that although the FiT offers a long payback period of 20 years for bank loans, however, they prefer the Adder which was 7 years. An interesting finding revealed in the interviews indicates that the Banks preferred the FiT because of the long contractual agreement that the banks are likely to gain more through interest expense than the Adder rate with shorter payback period. This is means that the FiT provides a stable price for 20 years, which they can recoup, their loan. One significant observation in this finding is that although the price has been reduced for FiT unlike Adder, the Banks are willing to commit and partner with investors to start RE plants. Some of the participants agreed that the price under FIT is lower than Adder, it was not misplaced for businesses to support the government to provide a regular source of energy to the public at low cost.

However, some of the participants interviewed was of the view that the FiT places limitation on their profitability since regardless of the changes in the base price of electricity will not affect the amount government will pay for RE electric power added to the grid. Also, the FiT has introduced two new pricing methods for renewable electricity, 1) bidding and 2) drawing where producers are expected to bid for the price of electricity that they will sell to EGAT or PEA before license are given to them. These two processes of acquiring certificates for RE are termed as the evolution of purchasing. The data reveals that the bidding and drawing introduced by the government to the RE pricing to set prices low and regulate the number of REs firms, investors are not in agreement with the process. The bidding price is 3-baht 8 satang instead of 5 baht for waste and different REs except for solar. According to some waste plant owners, the price is too low. For the current FiT formula, the solar rooftop is given more advantage with 12baht per unit kilowatt of electricity produced.
for residential producers while ground solar producers are offered 5.66 baht to about 4.0 baht. However, other forms of REs are given lower prices such as waste, biomass, and biogas. (See Diagram 28-35)

Conceptually, from various Adders, feed-in tariffs, and bidding, the incremental policy changes showed the solution of what the government believed to be beneficial to both parties, government and producers. The Adder is more burden to the government, adding on top of the electricity price, no matter how much the electricity price rises. It is a big burden for the government. The Fit, on the other hand, is less, with fixed buying price, but helped producers for a longer period of time. The bidding is for whoever can bid below the feed-in tariffs (figure 4.8-4.19). Former president and current chairman of a large producer explained that the government had a limit of 5 years to start the operation once the first Adder came out. His company was one of the lucky companies to have started operated near year 5. This was because, by that time, the cost was so low, due to technology, mainly from China. This resulted in high profit margin for his company, and many other companies who received Adder and started to operate late.
Figure 4.8 Incremental Financial Incentives Policy Model Representing Adder Policy, FiT Policy, and Bidding Policy, for Solar Energy, with The Assumption of Electricity Price Remaining Constant


Figure 4.9 Incremental Financial Incentives Policy Model Representing Adder Policy, FiT Policy, and Bidding Policy, for Solar Energy, with The Assumption of Electricity Price Increasing at an Average of 3.25%

Figure 4.10 Incremental Financial Incentives Policy Model Representing Adder Policy, FiT Policy, and Bidding Policy, for Energy from Waste, with The Assumption of Electricity Price Remaining Constant


Figure 4.11 Incremental Financial Incentives Policy Model Representing Adder Policy, FiT Policy, and Bidding Policy, for Energy from Waste, with The Assumption of Electricity Price Increasing at an Average of 3.25%

Figure 4.12 Incremental Financial Incentives Policy Model Representing Adder Policy, FiT Policy, and Bidding Policy, for Biomass Energy, with The Assumption of Electricity Price Remaining Constant

Source: Ministry of Energy, Adder, Feed-in Tariffs, and Bidding Policy, 2007-2017, adapted by the author

Figure 4.13 Incremental Financial Incentives Policy Model Representing Adder Policy, FiT Policy, and Bidding Policy, for Biomass Energy, with The Assumption of Electricity Price Increasing at an Average of 3.25%

Figure 4.14 Incremental Financial Incentives Policy Model Representing Adder Policy, FiT Policy, and Bidding Policy, for Biogas Energy, with The Assumption of Electricity Price Remaining Constant

Source: Ministry of Energy, Adder, Feed-in Tariffs, and Bidding Policy, 2007-2017, adapted by the author

Figure 4.15 Incremental Financial Incentives Policy Model Representing Adder Policy, FiT Policy, and Bidding Policy, for Biogas Energy, with The Assumption of Electricity Price Increasing at an Average of 3.25%

Source: Ministry of Energy, Adder, Feed-in Tariffs, and Bidding Policy, 2007-2017, adapted by the author
Figure 4.16 Incremental Financial Incentives Policy Model Representing Adder Policy, FiT Policy, and Bidding Policy, for Hydro Power Energy, with The Assumption of Electricity Price Remaining Constant


Figure 4.17 Incremental Financial Incentives Policy Model Representing Adder Policy, FiT Policy, and Bidding Policy, for Hydro Power Energy, with The Assumption of Electricity Price Increasing at an Average of 3.25%

**Figure 4.18** Incremental Financial Incentives Policy Model Representing Adder Policy, FiT Policy, and Bidding Policy, for Wind Energy, with The Assumption of Electricity Price Remaining Constant

**Source:** Ministry of Energy, Adder, Feed-in Tariffs, and Bidding Policy, 2007-2017, adapted by the author.

**Figure 4.19** Incremental Financial Incentives Policy Model Representing Adder Policy, FiT Policy, and Bidding Policy, for Wind Energy, with The Assumption of Electricity Price Increasing at an Average of 3.25%

**Source:** Ministry of Energy, Adder, Feed-in Tariffs, and Bidding Policy, 2007-2017, adapted by the author.
The cooperative or private-public partnership (PPP) which is introduced alongside with the other policies where RE firms are supposed to partner with local partners or local governments (LGs) to acquire a license to produce RE power. The contract is usually between the investor and the region or district to build a plant of not more ten megawatts of electricity from RE sources. This type of project is meant for small plants, as a result, the government uses drawing pricing method because of the huge numbers that requested for Re licenses in this category. The purpose of this type of policy is to foster collaborations with bigger companies to enable the government to coordinate the RE sector. The requests are mostly performed in the name of the cooperative and not individual investors. The cooperative under the RE is a form of interorganizational relationships which seeks to build a network of investors in the RE sector through collaborative mechanisms. They pull their resources together and partner with the district or region to produce electricity.

4.5.2 Clarity of Policy Goals

In terms of policy success, many policy analysts interviewed during the fieldwork who formed part of the sample size indicated that goal clarity to some large extent has an impact on the sustainability of RE energy policies. However, the results of the interviews revealed a somewhat gloomy picture of the clear definition and direction of the RE policies in general. According to thirteen (13) out of the twenty-three (23) interviewed, policy on the development and production of solar energy and different REs is unclear. They explain that even though it is an important factor, however, how to analyze the source of the raw materials from power plants to farmers which is equally important is not being given attention in the policy framework since this ensure regular supply of the RE power to the national grid. For example, the source of raw materials for biofuel is palm and it is mostly obtained from the Southern part of Thailand, however, this is not considered in pricing formula of the FiT for biomass production.

Another finding on policy goals is that majority of the respondents expressed the view that there are unstable policy guidelines which leads to frequent changes in policy objectives. The policy changes and frequency changes in the governance system in the country affect their operations. They explained that sometimes their
operations are halted, or their licenses are suspended because of the unstable situation in the country. Similarly, the frequent revision of policy and new policies are introduced at a faster rate than they can assimilate to reflect their current operational lines. Furthermore, the targets on RE keep changing while a target is under implementation, a new directive is given for policy change. For example, the target for RE was 25% for 2007 now it has been increased to 30% within 36 years. In tune with this is that this new policy seems to be an unrealistic target. In the next 18 years, it is expected that RE will triple jump from the current 6% to 30%. There is no clear-cut policy or goal-clarity in the RE policy intervention. Besides, the targets are unrealistic. The finding above, the original target assumed that 19,000 or 20000 megawatts of electricity will be added from REs in 2015. Two thousand and then it is expected to be about 30,000 megawatts of electricity by 2036. This unrealistic setting of targets is captured by one respondent as follows:

“I think it is possible in my opinion, but not probable. When the financial incentives decreases throughout the year, it speeded up fast only in the beginning. It has been increasing at a deteriorating rate. Nevertheless overall, I think it is still possible. They have a clear direction. They are going to review the GDP 2015 in 2018. Review in order to see the given of price limited or the limitation of unstableness that is still the weak point. This may slow down the acceleration of the increase a little bit, but I still believe that the end of the plan, the deployment can be 30%. The limitation, whether about pricing for a while it can be fought with fossil condition. In short, if you look at the price, it went down”

The inference from the above is that the current target of 30% of RE is likely not to be achieved to meet the electricity demand of 40000 megawatts. The 30% target will result in 24000 megawatts of electric power added to the grid. However, the government must set realistic targets. For example, 10,000 megawatts may be possible on an incremental policy goals basis.
4.5.3 Legal Framework and Regulations/Administrative Procedures

The results revealed that 11 out of the 23 people interviewed, expressed their view that the laws and regulations governing the operations of the RE sector are weak and inconsistent mainly due to changes in institutional rules. For example, half of them (11), which constitute about 50%, explained that since some investors bid for operating licenses and failed to deliver their commitment in the long run. However, the regulations for punishing or sanctioning these firms are not very clear and appear to be less deterrent. In the case where an investor fails to deliver on the license, the investor is made to obtain a letter from the agencies, which gives them a guarantee to protect their investment. This shows poor regulatory laws on RE.

Additionally, the finding on this theme suggests that producers are maximizing their production to the limit of their contracts with the goal of making more energy and returns. Producers want to get more out of operations to make more electricity. However, the interviews revealed that some provincial buyers have cut off points for how much a plant can produce and sell to them. EGAT limited the peak megawatt after few producers have already installed the plant. For example, there was an agreement with 24 Hours times Capacity of 38 MW. The producer installed 45MW due to the fact that solar can only be generated daytime, about 8 hours (figure 4.20). Once multiplied, the total MWH is still much less than the agreement. The producer has requested to give whatever is over the peak for free, but EGAT has refused. The producer explained that the reason behind the refusal was that produce still has Adder. This means high cost for EGAT. The producer explained that EGAT wants to buy as less as possible. Many other companies have been reported to absorb the cost in removing the excess MW in this additional policy, made later by EGAT.

PEA, on the other hand, with the agreement of smaller MW, (figure 4.21) accepts the model if whatever is over the peak is given without charges. The same producer mentioned above installed a 16 MW on the actual 9 MW solar plant agreements. They did not have to unplug and remove their excess plant. They made more during the day and gave whatever that was over the peak to PEA for free. PEA accepted because they did not have the burden of the policy “Adder,” the producer explained. While EGAT demand all plants to unplug all, PEA insisted on the megawatt that the plant is supposed to add to the grid beyond this threshold, they
score it as free megawatt and no payment is made for it. Many participants explained that there should be stricter and more consistent rules on plant capacity because investors are losing their investments and absorbing the cost.

**Figure 4.20** PEA Accepting 16 Installed Megawatt to 9 Actual Megawatt Contract Agreement

**Source:** ministry of energy, PEA Accepting 16 Installed Megawatt to 9 Actual Megawatt Contract Agreement, adaptor by the author.

**Figure 4.21** EGAT Rejecting 45 Installed Megawatt to 38 Actual Megawatt Contract Agreement

**Source:** ministry of energy, 21 EGAT Rejecting 45 Installed Megawatt to 38 Actual Megawatt Contract Agreement, adaptor by the author.
Another finding related to this theme is that administrative procedures are characterized by bureaucratic bottlenecks and red tape. For example, residential users must go through the complex process before they sell electricity to EGAT. Under the current power purchase agreements, rooftop and SPP can sell electricity to EGAT. Notwithstanding this procedure, households are producing lots of RE yet due to the complexity and inconvenience of the sale of electric power to EGAT owners are not selling but using it for agricultural purposes. However, some of the participants were of the view that there were two only processes both at the regional and the Provincial levels and two places that EGAT uses to buy electric power from residential rooftop and SPP. The two mandatory processes by EGAT and PEA involved the following:

- Evaluation of rooftop projects and installed plants
- Public clearing from nearby communities.

The above processes are used to buy power from SPP and VSPP by EGAT. Yet owners of plants view these processes to be demanding especially residential producers or solar rooftop producers since according to them, they have made several visits to the offices of EGAT and PEA before, they are offered the power purchased agreements (PPA).

The results if the interviews revealed that there is the absence of cost-effectiveness of the administrative set up responsible for the activities of RE producers. Most of the respondents were of the view that, they sometimes must pass through several channels and provide monetary incentives for officers before services are rented to them. This finding suggests that individuals who have oversight responsibilities to ensure that power producers have cost-effective services are not doing so. Hence the current administrative set up leads to bureaucratic bottlenecks and red tape on the side of public officers. Moreover, the participants expressed the view that the present policy measures do not protect investors against local partners power-play behavior. To a large extent, a careful analysis of the AEDP indicates there is no clear-cut legal framework for addressing grievances and non-compliance of regulations in the sector.

Further, there is a disconnection between what government does and what the regulations governing industry players. For example, some of the participants stated
that the government is giving out licenses to newcomers who are not interested in developing RE but increasing their stocks without investment in the renewables. The only penalty is a guarantee letter after three years. The price is that these companies usually bid for cheaper prices and win the bits without producing the RE. For example, in Germany, the government provides quotas for the bidding process while in Thailand it is not so. For instance, in Germany, the government provides scores for existing power plant owners and the score will determine how well a producer is performing before adding or lowering the price. Also, newcomers are not giving new investors more than previously owned power producers. However, the priority is given to stable firms in the RE.

4.5.4 Transparency and Corrupt Practices

Transparency in transacting business and obtaining contracts is characterized by lack of openness and fair play. The central government agency is responsible for transparency of the RE sector. However, the participants explained that there is no openness in the process of obtaining operating licenses and the bidding process. According to 11 of the participants, Local Authorities (LG) are engaged in corrupt practices where one company pay 5% of their contract to them and then they request for more like 10% from another company in profit sharing since the contractual agreement is based on either private-public partnership (PPP) or joint venture (JV).
Element can happen at every stage of the process and the view that there is a ‘first come and first bases’ for receiving and processing requests. However, this information was only made known by other investors who had insider information and the majority of investors were not aware of it. A quote below describes the assertion that the RE is characterized with corrupt practices and lack openness.

“I think there is massive lack of transparency because the authorities are corrupt. Corruption can happen at every stage of the process (Figure 4.22). The bidding announcement is closed for certain few. We need connection to know about announcements and regulations. One time, we have turned in all papers, but were rejected due to “missing paper.” All documents were submitted, we have photocopies. It was pulled out because we did not pay money. Money is like oil that keeps the machine running until the end, when the plant is finally built. The other ministries involved are no exception, like getting the 334 (Agreement in building the plant). The administrators want

Figure 4.22 Process Flow of Obtaining License

money. Even public hearings, we need to lobby the head of communities to prevent their greediness, and also public riots. Not riots because of public interest, but personal interest, such as those who want to mark up their land and sell to us to build plants, and from those hired by our competitors to bring us down.”

Similarly, the results revealed that the present structure of RE is a PPP system where local authorities partner with firms to produce RE electric power. However, the interviews suggest that local partners are exploiting the system by demanding higher profit sharing from firms. They use power play dynamics to limit the number of bids given to companies who are not willing to pay more percentage of their profits with them. Some of the respondents were of the view that the structure of PPP is creating problems for investors. Also, the company have three years of guarantee to be able to transfer their shares if they are having low returns on their investments. However, companies that are under PPP can be sold at premium prices.

Likewise, the government has introduced a new regulatory process on RE contracts and certification. However, the interviews revealed that this information is not communicated to existing firms and potential entrants. It was revealed that the Thai Government is controlling the number of contracts signed for REs. However, in the beginning, most people were not interested in the RE, and according to respondents, the government had to encourage more investments by signing more contractors. At the same time, the government provided some funding subsidies to individuals to invest in the sector; however, with time the government has introduced limited quotas to regulate the sector.

4.5.5 Cheating and Gaming the System

Ten (10) of the participants revealed that investors engage in gaming the system due to lower prices offered through the bidding process. The low prices lead investors to bid for the price and to increase their stocks while they are not building power plants. The only thing they do is to take a letter of guarantee to protect their investment while no power plant is built while their stock increases. Interestingly,
there are some investors who want to go into real biogas or solar cell energy production, but the bidding process does not favor since they are not able to win bids.

In the view of the 10 participants, the government does not have very adequate measures and sanctions system to punish offenders who violate the contract agreement especially companies who win bids without building power plants while the stock prices increase. According to them, the government only takes a guarantee letter from bidders that are very negligible for investors who fault the contract. Some of the respondents were of the view that the government should measure in place that will blacklist offenders as well as name and shame investors cheating system to be able to achieve the 30% target by 2036. Also, some individuals establish companies to bid for the price and use that to increase their stock prices and sell the license they obtain and sell it to other potential investors. About 70% of companies sell their franchise to other firms. However, bidding has been introduced for the past 1-2 years, which makes license holders, start and build a plant within 2 years after obtaining their licenses. The interviews revealed that some investors bid for lower prices to increase their stock prices, but they cheat the system by not producing any energy from their license. Previously, starting an RE firm was free and firms obtain licenses and they could forfeit them without producing a single unit of electricity to the grid.

4.5.6 Stakeholder Consultation

One significant observation made in the interviews indicates that most of government’s decision and policy change is not informed by stakeholder collaboration and input. Eleven (11) of the participants’ expressed the view that most of the policy changes that government introduces, they are not consulted, and their suggestions do not reflect the output on the policymaking process. Another finding revealed in relation to stakeholder participation is the issue of PPP with local partners and LGs exhort money from investors in demanding high for-profit sharing. According to the participants, the local partners are creating problems in the issuance of operating licenses to investors and sometimes they demand 5% bribe from them.

Similarly, there is a lack of information sharing with stakeholders in most cases especially when new regulations are introduced. One important observation during the interviews that were expressed by informants is the non-transparency
nature of the processes for acquiring operating licenses and signing of contracts. They explained that the bureaucratic processes affect their businesses especially when the processes are being delayed unnecessarily. They are not able to determine the queuing time and some investors are able to jump the line to obtain their licenses. Also, stakeholders were of the view that politicians interfere in the public clearing process. This they explain that the public clearing requires a consensus building and dialogue between community members and key stakeholders to seek for their opinion and views to agree with the community whether to establish the plant or not. If the community accepts, the cycle of public clearing is deemed as passed. The final stage is to submit the documentary evidence to Electricity Authority to consider whether to issue the license or not. However, politicians often organize the community members to protest the sitting of plants because a potential plant owner may not have allegiance with the local politician.

However, the community members and leaders explained that there is little participation of communities in the public hearing process and information about the effects and environmental hazards of Municipal Solid Waste (MSW) plants are readily available to communities located around. The implication is that there is not enough consultation and participation is absent and community members are not aware of the benefits and fallouts of sitting RE plants in their communities.

4.5.7 Political Interference

Nine (9) of the interviewees explained that in the issuance of a license, some politicians demand money for a license before investors are provided with permission to operate. At the same time, 4 out of the 9 participants who link RE policy sustainability to non-interference of politicians in the contractual agreement, said that some investors perceived to be loyal to some politicians have been favoured than others who are perceived to owe allegiance to previous politicians. This situation has often led to political vindictiveness.

Moreover, the interviewees explained the political machinations through protests by communities. There is intimidation by politicians. Public clearing refers to where would-be investors go through a process with the Ministry of Energy to announce the opening of the power plant. The proposed plant site is surveyed, and the
MOE will have assessed and see if the area meets the standard requirements. Also, in the decision-making process, EGAT would determine the terms and see the basics are in place before the government regulators will accept it.

There is also powerplay evident in the process of the PPP. According to participants, LGs started using other means of negotiations. The LGs demand for higher profit sharing from companies and sometimes, bids are given to companies that agreed on the high profiting sharing terms. In the long-run, investors market shares are affected since the cost production is mostly bare by them and operational expenses are deducted and leaving fewer profits to be shared with local partners.

1) Military Interventions

The military coup in 2014 affected policy measures on RE. Most of the decisions taken by the military government, the National Council for Peace and Order (NCPO) lack adequate consultation with RE stakeholders and the informants were of the view that the military regime has failed to take their concerns in the process of making policies on the RE sector. For example, the NCPO changed the Adder rate immediately after taking the realms of power within a year of governance of the country. Further, there is a lack of consensus between stakeholders and the new military government. The RE power producers were aggrieved because plant owners wanted the government to continue with the Adder while the new government insisted on FiT. For instance, solar cells producers requested for solar cells to be maintained at 8baht while the government offered less (6.50 baht).

One applicant complimented the military government for formulating and implementing policy on the Ministry of Industry for issuing the agreement to build plant (13 4) within 30 days once the PPA has been issued. In this applicant’s view, it eliminated the administrator in the ministry to delay or ask for corruption money to speed up the process. However, two applicants expressed that though this is true, it made the corruption more effective and convenient for them. The closed bidding in the beginning, not giving fair chances to all interested parties, gave military allies the ease in every stage of the process.
2) Low Commitment Level of Government

Similarly, the commitment on the part of government is lacking since the price competition for bidding is lower for non-solar Res which is not motivating other RE types to increase their investments. In words of an interviewee, “the targets look gorgeous” because the government is confident but lacks the commitment to put measures in place to achieve the set targets. According to some of the participants, a 25% increase in RE set by government means more commitment in terms of policy stability and sustainable pricing system to be achieved. However, they explain that the present target of 30% is likely not to achieve because the government has not placed a restriction on the number of requests and contracts to produce RE electricity.

4.5.8 Government Subsidies

According to of the majority of the participant’s government subsidies constitute about 50% at the beginning of the first RE policy in 2007 and at the same time, the government provided the budget and the investor is requested to invest 100% in the choice of RE type. Additionally, some of the respondents were of the view that government used price mechanism as a way of subsidizing RE through the power generated in the form of base electricity price plus ‘Adder rate’ from 2007-2012. The subsidies for the electricity were in the form of the Adder and the price was subject to the RE type. For example, the participants stated that Solar cells attracted 8 Baht per kilowatts while Biogas was awarded 35 Satang, which was later increased, to 50 Satang. Adder gave Solar cell 8 baht from 2007; however, many people did not want to invest in solar at the time. However, the prices were cut down for some RE types like solar from 8Baht to 6.50Baht.

However, an important finding on the pricing was that government was subsiding the prices for households at 4 baht. The question of how the government will be able to use its reserves to pay for the shortfall is of concern for some participants’ even though they tend to benefit at the expense of the state. The government helped the RE investors to acquire loans from the banks which takes up to 7 years which was a tie to the 7 year-Adder rates. The essence is for investors to meet the payback period of the Bank credit. After 7 years, the price per kilowatt is
reverse to normal pricing. Also, the government gives basic prices on the unit of electricity produced in 2007, at the first implementation phase of the Adder policy.

It was revealed in the interviews that government is not providing incentives in the form of tax exemption and tax holidays to attract investors to the RE sector. However, most of the participants agreed that for government to ensure environmental sustainability and reduce the cost to the environment by fossil flues, there must be some incentives in this sector to motivate investors to produce and add to the national grid. Also, apart from solar, the rest of the RE types uses bidding and drawing to set the price for a unit of electricity produced. Therefore, these two processes provide cheap prices for electricity for the government while investors are paying higher for raw materials. According to some of the VSPP interviewed this is a disincentive since the lower prices are affecting their return on investment. They maintained that the prices for biogas and waste should be purge with the cost of the raw of materials. The results show that the government does not provide any financial support for startup companies, but they support investors in the pricing system since investors have good returns on their investments through stable prices of electricity fixed to 20 years under the FiT and 7 years under the ‘Adder rate’ policies respectively.

4.5.9 Cost of Investment

Most of the participants were of the view that the initial investments incurred in setting up a plant are high. Ten (10) of the participants interviewed explained that solar has a high investment cost for Startups Solar plants. The investment in solar is very high at the beginning as a result; many potential investors are not attracted to the sector. Yet, the government has encouraged some individual investors and companies to build solar plants at the beginning of 2007. One participant described the situation in the following quote:

“Many of the executives persuaded us and invited us to do and asked to invest in it because the government wanted us to do RE. It was successful, and it worked well but of course at that time investment in solar cells was high investment 1 megawatt 100 million – 120 million
per MW but Adder was also high at 8 baht per unit included electricity base fee it’s about 11 Baht 12 Baht per unit”

However, this trend has changed since in the view of one of the participants the cost has improved: “There were many unseen costs but, in this age, we found those costs and we improve it’s then there was some success”. Generally, the interviews suggest that the cost of investment in Re technology is high in Thailand. For example, 1 megawatt of electricity is about 45million baht. One panel cost is 45million for solar rooftop and installation is double of the 45*2 million or 90 million. One panel of solar can only store sunlight for 4-5 hours and electric power can be generated until 5 pm in the evening, which is what solar energy can be produced, the rest of night nothing can be done. Therefore, there is the need for more investment in panel storage, which is highly expensive, and this affects the electricity price. Also, the investment in biogas is very expensive. The raw material for biogas, for example, waste used to be 200 baht per ton, however, with time, the prices increased from 200 baht to 1, 200 baht. The high cost of technology used in processing other forms of REs, example rice husk is sold for the crystal to produce chips, which are way more profitable than being used to generate electricity.

Similarly, because of the high investment cost in the waste sector, most investors are not willing to venture into biogas plants. This affects their operations and many biogas producers went bankrupt. Previously there was a free waste but now the waste is sold to them at higher prices. Waste owners decided to produce biogas when the RE sector in this area had made progress, however, with time, these companies have folded up because biogas production was not their main business lines but because it was considered as a cash cow at the beginning of RE policy framework. The high attrition rate among RE investors is found to be affecting the stability of the RE market. In the RE sector especially garbage or biomass; companies are folding up due to lower prices offered for electricity generated from these sources. According to participants the bidding price for these types is lower than solar rooftops and solar cell farms. The Bidding price for waste is 2.80 to 2.90 baht, which is lower than the price offered to solar, and others.
Moreover, garbage, Biomass, and biogas are using bidding and drawing. The owners of biogas and biomass plants were dissatisfied that they are being offered lower electricity prices compared to solar cells. They expressed the view that many investors shy away from investing in this area. Also, the production cost is expensive because the wages paid to workers in this sector is high. They further expressed the opinion that the government is supporting sugar plant production, which produces high pollution especially the residuals of the sugar which releases molasses. Another finding related to investments in RE sector is the fall in the stock prices in the financial market had an impact on investors’ shares. For example, the declining rate in stock prices in some of the REs affected investors’ equity, especially in the solar cell business. However, the distinctive feature of the business is that the electricity contract in the RE does not look for customers since it is a concession; owners of plants do not have to attract their own customers which provides security of initial capital invested in plants. However, there were several factors that affected the stock market price fluctuations, like the general economic meltdown and the possibly the 2009 Tom Yum Crisis or Hamburger Crisis. One participant observed the situation in the statement below:

“The fall in stock price(stock price fell because they told people that they will not buy. And if you ask me in the contract no commitment that they will purchase. But they said that they will purchase but you cannot see in the contract”.

Notwithstanding, the effect of the fall in the stock market had an impact on the solar cell market because solar was the leader in the RE. This is because the large market size of the solar cells provided low operation made the market to boom and the stock prices for the solar increase and this attracted many investors to the solar energy sector. However, after the fall in the stocks, many companies are folding up and diversifying into other sectors of the economy.

4.5.10 Government R&D Support

The interviews revealed that there are little support and investment in R&D by the government. And the content of the R&D is of lower quality and mostly, it is incomplete. According to one respondent, the research and development activities
of government is not effective, and the quality of personnel trained outside the country is below average according to the three (3) out of the five participants who asserted that government has invested little in R&D since 2007. However, in contrast to the above view, some of the participants were of the view that government support for the RE in research has been successful and some few centres have been set up for research into solar technology and other RE sources. However, this finding should be treated with caution since more studies are required to draw a conclusion on whether the government’s R&D programs have an impact on the technology that is used for RE generation.

4.6 RE Types and Contribution to the National Grid

The RE sector can only be a supplementary power source for the country but it may not be able to replace natural gas sources of energy. Electricity consumption is high in the country and the RE sector cannot provide that if fully implemented as an alternative source of energy for the country. The respondents were of the view that RE can only serve as a supplementary energy source to the traditional energy sources like natural gas, coal and crude oil. According to some of the interviewees wind is not efficient for RE investment and at the same time, the solar cell is not suitable because Thailand does not have high temperature, but it depends on the seasons unlike Europe which has higher temperatures and the potentials of solar is better comparatively since Thailand started at the same time with major countries in the Eurozone was investing in solar cells. These countries have performed better with solar cell production than Thailand. However, they explain that since Thailand is an agricultural country the potentials of agricultural waste should be explored. This is because, in their opinion, wind and sunlight in Thailand are not the same as Europe. The intensity of these two sources is lesser in the country. Also, the cost of storage of wind and sunlight is quite expensive as well.

In the view of some of the informants, Thailand is an agricultural country and the best sources of RE according to some respondents will be biomass and biogas since the country generate a lot of waste from the food sector and agricultural produce. However, these two areas are not adequately supported because the
government uses lower prices. According to most of the participants, garbage is another source of RE and it has a generation capacity of 400 megawatts, yet the government cannot rely on this source because of sustainability of the raw materials for continuous production. Also, those of biogas and biomass are not enough to support the target if the government decides to invest heavily in these areas. Biomass is wood scrap or fuelwood, weed, rice husk etc. Thailand needs about electric power plant of 40,000 megawatts. And waste only provides 400 megawatts. Also, Biomass has a generation capacity of about 2,000 to 2,500 megawatts of electric power while biogas comes from food waste which is not enough to sustain the energy needs of the country. Biogas sector has been neglected and the government must focus on this area since the waste generated in the country can be used for RE to reduce pollution.

Another finding some power plant producers are using a hybrid system where they produce different fuel types. Despite these concerns by the government agencies, investors in this type of RE explained that the process of generating electricity from these types can be sustained especially waste since the country is an agricultural enclave where a large amount of waste is generated which can be used to produce electricity (See Figure 4.23 below for each of the RE types contributions to national grid).

Figure 4.23 Expected targets and Contributions of RE Types by 2022
4.7 Benefits of RE

Participants identified several benefits that the use of RE is useful to the country’s energy mix. Most of them explain that is cheaper and sustainable. Also, the RE sector offers both cheaper prices for the electricity and construction cost of power plants to households and power producers respectively. The perceived benefits of RE in Thailand are presented in Table 4.12 below.

Table 4.12 Benefits of RE in Thailand

<table>
<thead>
<tr>
<th>No.</th>
<th>Benefit</th>
<th>Dimension of Sustainability</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Clean energy</td>
<td>environment</td>
</tr>
<tr>
<td>2</td>
<td>Solar plants create non-noise, odour, non-pollutants and non-smoking equipment</td>
<td>environment</td>
</tr>
<tr>
<td>3</td>
<td>RE power plants create jobs for communities where they are located.</td>
<td>Social</td>
</tr>
<tr>
<td>4</td>
<td>Profits/breakeven of investments. According to this participant, there are higher returns on investment and the breakeven point of installation is 8 years and the profits start to realize which may be equal to 3000THB per month</td>
<td>Economic</td>
</tr>
<tr>
<td>5</td>
<td>Security of investments. Warranty is 25 years and some companies provide inverters and different equipment for solar rooftop installation.</td>
<td>Economic</td>
</tr>
<tr>
<td>6</td>
<td>Reduction of electricity cost because each unit of electricity consumed is 6THB per unit. However, with this installation residential solar rooftop are paid 132THB per unit of electricity</td>
<td>Economic</td>
</tr>
<tr>
<td>7</td>
<td>Competitive pricing for producing electricity</td>
<td>Economic</td>
</tr>
<tr>
<td>8</td>
<td>Cost-effectiveness of energy production through hybrid models by investors</td>
<td>Economic</td>
</tr>
<tr>
<td>9</td>
<td>The payback period is relatively flexible between 7-8 and 10-20 years for credit facilities provided by banks to SMEs</td>
<td>Economic</td>
</tr>
</tbody>
</table>
4.8 Challenges of RE Policy Development

There are several challenges facing the RE sector as revealed by the interviews. Most of the participants were either SPP or IPP power plant organizations. Of the 18 interviewed, most of them express their views that the current policy target on RE which is 30% is achievable while others expressed mixed opinions. This in part is attributed to some of the challenges facing the sector. One of the significant challenges of the RE policy in terms of sustainability is unclear policy goals and lack of coordination of the various policies on RE since 2007. Similarly, participants expressed their views that powerplay and political interference is likely to affect their operations if these challenges persist.

Further, lack of clear legal and regulatory framework may affect the government’s target in the sector. And the pricing mechanism that is used to discriminate between the RE types is creating dissatisfaction among producers. However, these challenges can be under the following: institutional, political, economic, social, and environmental. The challenges have been identified in the content of the interviews and are presented in Table 4.13 below.

Table 4.13 Summary of challenges Facing RE Policy Sustainability in Thailand

<table>
<thead>
<tr>
<th>No.</th>
<th>Dimension of Challenge</th>
<th>Description</th>
</tr>
</thead>
</table>
|     | Institutional          | 1. Lack of definition and direction of the AEDP policy framework  
2. There is lack of dialogue between power plant producers and the government and its agencies responsible for RE sector  
3. new investors or ghost investors come into the sector without generating electricity to the grid even they bid for lower prices  
4. Some companies also bid for cheaper prices to increase their stock prices without real production of RE  
5. There is a lack of clear laws and regulations on the conduct of investors whom the government enter into contractual agreement with  
6. Generally, there are a lot of corrupt activities ongoing in the RE sector. However, there are no regulations or legislation to protect investors. |
<table>
<thead>
<tr>
<th>No.</th>
<th>Dimension of Challenge</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>7. There are bureaucratic bottlenecks and red tape in the process of acquiring licenses and sometimes, the guidelines for queuing is not followed since some investors are able to acquire their licenses without following the laydown procedures</td>
</tr>
<tr>
<td></td>
<td>Institutional</td>
<td>1. Local governments and local partners request for high profit sharing under the current structure of the PPP</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. LG and politicians extort money from firms for sitting plants</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Politicians organize protestors against some RE owners in some regions because of perceived allegiance to previous politicians</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. The government is not collaborating effectively with stakeholders in the RE for their input in policy changes. For example, some of the respondents explained the policy change from the Adder to FiT was done without adequate consultation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5. The regulations and rules associated with RE production especially the long approval processing time for power purchase agreement is affecting the development of the RE sector</td>
</tr>
<tr>
<td></td>
<td>Economic</td>
<td>1. There is the uncertainty of RE supply and feedstock price especially for biomass, MSW etc</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. There is the high cost of investments in waste energy production, biogas, and biomass RE types, but lower prices are offered to them</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. the technology used for solar cells are imported from either China or Germany making the cost of investment very in this sector</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. Lack of storage facilities in the solar energy production sector</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5. Solar plants produce fewer problems than other forms of REs, yet some problems related to the storage of the solar energy during the off-peak period</td>
</tr>
<tr>
<td></td>
<td>Social</td>
<td>1. Low public awareness of the importance of RE plants</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Community protests RE plant owners</td>
</tr>
<tr>
<td>No.</td>
<td>Dimension of Challenge</td>
<td>Description</td>
</tr>
<tr>
<td>-----</td>
<td>------------------------</td>
<td>-------------</td>
</tr>
<tr>
<td></td>
<td>Environmental</td>
<td>Some sugarcane factors produce waste and pollutants into the environment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The high potential RE supply resources outside the energy high demand areas.</td>
</tr>
</tbody>
</table>

In Table 4.13, the trend shows that the challenges are more related to institutional and political dimensions. Subsequently, the following chapter would discuss the findings of the qualitative data in the light of these challenges and the key findings for the first objective of the study.

### 4.9 Discussion of Findings

The purpose of this chapter was to explain the factors that determine sustainable RE policy development in the Thai context. The findings revealed several themes that emerged from the analysis of the interviews that answered objective one of the study: What are the determinants of sustainable RE policy development in Thailand? However, the discussion will provide a brief appreciation of the findings in line with this objective. In tune with this understanding, the study also discusses some key trends in the findings which are related to the challenges confronting the sustainability of RE policy in the long-run (Pongsiri, 2009). These key issues identified include clear policy goals of the AEDP, the legal framework and regulations, cost of investment, political support and commitment, effective stakeholder consultation, transparency processes and certainty in the administrative procedures. These trends are discussed further in the subsequent paragraphs.

Firstly, the findings showed that clear definition and direction of policy goals have a significant effect on policy sustainability. However, the trend revealed in the data suggests that there are unclear policy goals and lack of coordination of the existing policies since 2008. The results as indicated give the impression that the policymakers are not harmonizing the various policies on RE to ensure that the targets
are measured in line with the available evidence. This finding is consistent with previous studies (Al-Sarihi, Contestabile, & Cherni, 2015; IEA, 2012; Kettle, 2002).

Secondly, the findings show that there is no clear legal framework for addressing grievances in the RE. The participants explained that the current policy framework does not provide protection for investors through the PPP structure with local partners who tend to demand high profit sharing with firms although firms are responsible for providing 100% of the cost of starting an RE plant. Also, there are no regulations on the conduct of local governments role in the RE sectors since these institutions are using powerplay and other means to affect the ease of doing the RE business. This finding has been found in other studies that there is the tendency for public officers to engage in corrupt practices during contract requests in which unnecessary delays are characterised with the administrative procedures (Buckley & Nicholas, 2017; Emodi & Ebele, 2016; Square & Tongsopit, 2016; Tongspit & Greacen, 2013).

Similarly, the findings showed that government has begun a policy on restricting the number of contracts or licenses to companies to produce provided few licenses and regulations. However, during the first years, the target of government on RE licenses was not met because few people made requests to for licenses. According to the informants, in the past, the procedures for obtaining licenses was extremely easy and there were no guarantees at the beginning of RE policy and its operationalization in 2007. However, later measures were put in place and hence, the procedures are not the same as of today since there are many people willing to venture into the RE sector unlike in the past where few people were willing to invest in the sector. The findings indicate, there are so many bottlenecks in the process of acquiring licenses is characterized by red tape and corrupt practices where some individuals can cross the queue. This finding is tune with studies such as (Buckley & Nicholas, 2017; IEA, 2016 a).

Thirdly, the findings of the interviews suggest that there is the cost of investment in RE setup and technology. According to the participants, the cost of setting up power plants especially getting land for leaseholds is very expensive. For example, the local landowners lease the land to investors at very high prices, which is increasing the initial setup costs. At the same time, the findings indicate that the technology used in generating electricity is expensive since most of these
technologies are imported from either China or Germany. Fourthly, there is liberate attempts by local politicians to demand huge kickbacks from investors and incite local communities against some investors especially setting power plants in these communities. Similarly, the findings showed that local governments demand 5% from investors during the initial phases of the project and later demand 10% in profit sharing from RE companies. Similarly, the political climate in the country does not foster a good relationship especially some collaboration between key stakeholders and the government in passing legislation that affects the sector. Sometimes, in the view of the participants, political actors engage in political vindictiveness because they perceive that some investors have loyal to different politicians.

Furthermore, political support and commitment on the part of politicians are affecting the RE business. The findings revealed that for some time now, the government has stopped purchasing RE and the reason given by the major government institutions responsible for buying is that purchasing from the government is now higher than the target and that is why buying of RE from producers have been halted. Also, the government is using bidding pricing system to lower the cost of electricity from producers. The findings indicate that government’s commitment to exploring different REs type is insignificant. According to the findings, Thailand potentials in solar is little compared with EU countries, yet government is much more interested in supporting the growth of solar farms and solar rooftops than waste which Thailand generates more waste from agriculture and the food industry. However, government agencies interviewed suggested that sunlight in Thailand is far higher than in Europe, however, the technology and technical competencies might be lacking in the country. Nonetheless, the potentials of using solar energy as a main source of RE is feasible since it produces less effect on the environment unlike the waste and other forms of REs.

Fifthly the findings indicate that there is no effective stakeholder consultation is inadequate. Some of the participants expressed the view that collaboration between government and investors in the RE sector is non-existent and to a large extent, they are not consulted for a major policy shift. And in some cases, even when they are consulted, their inputs do not reflect the outcome of the policymaking process. However, studies have shown that RE policy sustainability is affected by industry
players and their inputs into the policy-making and implementation process. For example, when the government decided to change from the Adder policy to FiT, there was little or no dialogue between investors and the government. Similarly, communities are not consulted effectively during the public clearing process and there is an information gap between power plant siting and community leaders.

Last but not least, transparency issues are impacting negatively on the RE sector. The interviews revealed that local partners under the PPP are deliberating delaying the signing of contracts because, they most often negotiate behind the formal process for higher profit sharing and if an investor refuses, they contact the second firm and give the contract to. Also, the government agencies give out licenses to ghost companies who are not able to add a megawatt of electricity to the national grid. Similarly, there is an absence of information flow in the bureaucratic chain, especially how long it takes for investors to obtain licenses.

4.10 Summary of Chapter

The analysis of the results of the interviews and the findings revealed that the government has implemented the AEDP in 2015 to ensure that the new target of 30% is achieved by 2036. The purpose of this chapter was to investigate the determinants of sustainable RE policy development in the context of Thailand. The findings show that clear definition of policy goals and objectives, effective legal and regulatory framework, transparency, government subsidies in the form of tax incentives, pricing and credit support for SMEs are key to a sustainable supply of RE in Thailand. Also, factors such as political commitment and support, stakeholder consultation and lower cost of investment all affect the policy target. However, these factors are being challenged since the current policy goals lack clarity, a weak regulatory framework to protect investors and little investments in R&D activities. Moreover, the cases presented evidence of gaming and cheating by investors who acquire licenses without generating any unit of RE power. The chapter also discusses the benefits and the contributions of the RE types. The next chapter presents the findings on survey and secondary data.
CHAPTER 5

RESEARCH FINDINGS FOR SECONDARY DATA AND DISCUSSIONS

5.1 Introduction

The previous chapter outlined the findings from the qualitative interviews. This chapter discusses the results of the survey and the secondary datasets. The aim of this chapter is to present the descriptive results using measures of central tendencies to show the clustering and the dispersion of the variables. At the same time, the chapter focuses on the correlation matrix and regression results for the quantitative data sets to determine the relationship between the dependent variable: sustainable RE policy development (effective policy measures and policy stability) and the independent variables: social factors (social acceptance: knowledge & perception of RE), and institutional factors (government subsidies, government R&D framework, regulatory/administrative procedures, & stakeholder involvement ). The chapter is divided into three main sections. The first section has five sub-sections where the demographic information on the respondents is presented, followed by the descriptive results from the main variables, the correlation matrix, and the multiple regression analysis. Additionally, the second section is devoted to a presentation of the time series analysis of the secondary data.

Among other things, the series will focus on trends using graphs, and will run an autoregression correlation for the variables: the rate of RE development, national installed capacity, and RE-installed capacity measuring the dependent variable (sustainable RE policy development), the air quality index, and CO2 emissions (environmental factors), GDP, trade, and the investment cost of RE (economic factors), and unemployment rate (social factors) constituting the independent variables.
The third major section is used for testing the hypotheses of the study. The main models and sub-models were tested using the multiple regression results from the ordinary least squares techniques. A summary of the discussion is presented thereafter.

5.2 Presentation of the Survey Data Response Rate

In all, 250 answered questionnaires were returned out of the 400-survey pack distributed to the respondents, representing a response rate of 62.5%. However, after screening and cleaning the data, only 166 questionnaires were usable, giving a response rate of 66.4% out of the 250 questionnaires received. The answered questionnaires were checked for completeness and accuracy before the final decision so that all of the questionnaires could be used for the analysis since only two out of the 166 had few missing data; hence the decision to use them.

5.2.1 Descriptive Statistics on the Respondents

The answers to the survey instrument were collected from engineers, CEOs, MDs, and senior government officers from key government institutions and solar energy producing companies. The variables for section included sex, age, size of the organization, position, education, role, and type of producer. The minimum age was 23 and the maximum age was 60. The rest of the data are presented in table 5.1.

Table 5.1 Demographic Distribution of Respondents

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>Frequency(f)</th>
<th>Percentage (%)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>Male</td>
<td>120</td>
<td>72.3</td>
<td>100.0</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>46</td>
<td>27.7</td>
<td></td>
</tr>
<tr>
<td>Size</td>
<td>Small</td>
<td>56</td>
<td>33.7</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Large</td>
<td>91</td>
<td>54.9</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>19</td>
<td>11.4</td>
<td>100.0</td>
</tr>
<tr>
<td>Variable</td>
<td>Description</td>
<td>Frequency(f)</td>
<td>Percentage (%)</td>
<td>Total</td>
</tr>
<tr>
<td>----------</td>
<td>-------------</td>
<td>--------------</td>
<td>----------------</td>
<td>-------</td>
</tr>
<tr>
<td>Producer</td>
<td>VSPP</td>
<td>26</td>
<td>15.7</td>
<td></td>
</tr>
<tr>
<td></td>
<td>IPP</td>
<td>53</td>
<td>31.9</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Seller</td>
<td>87</td>
<td>52.4</td>
<td>100.0</td>
</tr>
<tr>
<td>Role</td>
<td>Regulator</td>
<td>30</td>
<td>18.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Producer</td>
<td>28</td>
<td>16.9</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Buyer</td>
<td>108</td>
<td>65.1</td>
<td>100.0</td>
</tr>
<tr>
<td>Position</td>
<td>Sen.Gov Officer</td>
<td>14</td>
<td>8.4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>HOD/MD</td>
<td>17</td>
<td>10.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Admin /Manager</td>
<td>25</td>
<td>15.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Engineer</td>
<td>55</td>
<td>33.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Policy Analyst</td>
<td>11</td>
<td>6.6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Others</td>
<td>44</td>
<td>26.5</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Note: Mean= 37.09, S.D= 8.11, Min= 23, Max= 62

The results show that 72.3% were males while 27.7% were females. The size of the organization showed that 33.7% of the respondents worked in small organizations, 11.4% worked in medium organizations, and 54.9% worked in large firms. To determine the type of producer, the results showed that 15.7% of the respondents’ firms were VSPP, 31.9% were IPP, and 52.4% were main distributor and sellers of RE energy in the electricity supply sector. In terms of “role” in the RE sector, 18.1% of the sample were from regulatory agencies, 16.9% from RE producing firms. In terms of the positions of the respondents, 8.4% were senior government officers, 10.2% were MD/HODs, and 15.1%, 6.6% were policy analysts. Most of the respondents were engineers, presenting 33.1%, and 26.5% were from other categories of ranks that fell outside the four categories. Regarding the age
distribution of the respondents, the results revealed an average age of 37.09 years, with a majority being 40 years with a minimum age of 23 and a maximum of 62 years old.

5.2.2 Descriptive Statistics for Sustainable Solar Policy Development Indicators

This section presents the results of the two components of the dependent variable: sustainable RE policy development. The results are presented below.

5.2.2.1 Effective Policy Measures

Fourteen items were used to measure the aspects of effective policy measures in this study. The overall results of the variable indicated that 45.2% of the respondents neither agreed nor disagreed that effective policy measures influenced sustainable RE policy development, while 14.4% disagreed that there was an influence of policy effectiveness on solar policy development. Forty point four percent of the respondents agreed that effective policy measures were indicative of sustainable RE policy. The mean score for the data was 5.31, and the standard deviation was 1.40, showing that the data had not deviated from the means. The minimum score was 2 and the maximum was 10 (table 5.2).

Table 5.2 Effective Policy Measures

<table>
<thead>
<tr>
<th>Description</th>
<th>Disagree</th>
<th>Neither agree nor disagree</th>
<th>Agree</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>To what extent does political stability impacts on RE deployment in Thailand?</td>
<td>11.0</td>
<td>35.7</td>
<td>53.3</td>
<td>100.00</td>
</tr>
<tr>
<td>Government policy on RE development is stable</td>
<td>25.3</td>
<td>29.5</td>
<td>45.2</td>
<td>100.00</td>
</tr>
</tbody>
</table>
## Description

<table>
<thead>
<tr>
<th>Description</th>
<th>Disagree</th>
<th>Neither agree nor disagree</th>
<th>Agree</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Government support RE policy development through tax incentives and subsidies</td>
<td>13.9</td>
<td>29.1</td>
<td>57.0</td>
<td>100.0</td>
</tr>
<tr>
<td>The government has provided efficient policy measures on RE technologies in the past</td>
<td>30.3</td>
<td>46.1</td>
<td>23.6</td>
<td>100.0</td>
</tr>
<tr>
<td>The RE sector has relatively stable policy instruments for sustainable renewable supply</td>
<td>23.1</td>
<td>44.2</td>
<td>37.7</td>
<td>100.0</td>
</tr>
<tr>
<td>The frequent policy changes and discontinuation of policies undermine the growth of the RE sector in Thailand</td>
<td>10.3</td>
<td>30.3</td>
<td>59.4</td>
<td>100.0</td>
</tr>
<tr>
<td>Political priorities are directed to ensuring that the effectiveness of policy instruments in the RE sector</td>
<td>9.1</td>
<td>37.0</td>
<td>53.9</td>
<td>100.0</td>
</tr>
<tr>
<td>Government commitment to funding and</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Description</td>
<td>Disagree</td>
<td>Neither agree nor disagree</td>
<td>Agree</td>
<td>Total</td>
</tr>
<tr>
<td>----------------------------------------------------------------------------</td>
<td>----------</td>
<td>----------------------------</td>
<td>-------</td>
<td>--------</td>
</tr>
<tr>
<td>financing RE technology is cost-effective</td>
<td>27.7</td>
<td>37.3</td>
<td>35.0</td>
<td>100.00</td>
</tr>
<tr>
<td>The government has provided intensive capital sources for SMEs that are interested in developing RE technologies at cost-effective prices</td>
<td>27.8</td>
<td>38.2</td>
<td>34.0</td>
<td>100.00</td>
</tr>
<tr>
<td>There are measures put in place to ensure long-term financing options for RE power producers in the sector</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Government policy on solar energy accounts for energy price controls</td>
<td>16.3</td>
<td>35.2</td>
<td>48.5</td>
<td>100.00</td>
</tr>
<tr>
<td>Government policy instrument on feed-in-tariffs is cost-effective and supports RE deployment by both big and small energy producers</td>
<td>15.1</td>
<td>29.7</td>
<td>55.2</td>
<td>100.00</td>
</tr>
<tr>
<td></td>
<td>19.4</td>
<td>28.5</td>
<td>52.1</td>
<td>100.00</td>
</tr>
<tr>
<td>The current policy instrument on RE sources can achieve the country’s target of 30% of RE supply by 2036</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Description</td>
<td>Disagree</td>
<td>Neither agree nor disagree</td>
<td>Agree</td>
<td>Total</td>
</tr>
<tr>
<td>-----------------------------------------</td>
<td>----------</td>
<td>---------------------------</td>
<td>-------</td>
<td>-------</td>
</tr>
<tr>
<td>How would you rate policy stability on</td>
<td>22.4</td>
<td>30.9</td>
<td>46.6</td>
<td>100.00</td>
</tr>
<tr>
<td>RE in the country?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>21.8</td>
<td>35.2</td>
<td>43.0</td>
<td>100.00</td>
</tr>
<tr>
<td>Effective Policy Measures of RE:</td>
<td>14.4</td>
<td>40.4</td>
<td>45.2</td>
<td>100.00</td>
</tr>
<tr>
<td>Overall</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: $X=5.31, SD=1.40, \text{Min}=2, \text{Max}=10, N=165$

It should be noted that most of the responses for this variable were quite difficult for the respondents to rate because of the present political atmosphere in the country. However, careful observation of the results showed that most (53.3%) of them agreed that political stability has positive outcomes on the existing policies to support RE production. Yet, 45.2% of them agreed that there was stability regarding the RE policy in the country, 25.3% disagreed, and 29.5% neither agreed nor disagreed with the statement on policy stability. For example, 59.4% further agreed that the frequent changes in RE and discontinuation of policies affected the SD of the first item when asked about respondents’ level of agreement on the statement of ‘political stability’. Additionally, 30.3% neither agreed nor disagreed that political stability affected policy outcomes in terms of RE production while 10.3% of them disagreed that political stability had an influence.

Further, the responses showed that in terms of policy measures and effectiveness, 46.1 neither agreed nor disagreed that the government was providing efficient policy measures, 30.3% disagreed that the government had effective and
efficient policies in place, while 23.6% of them believed that indeed the government has provided effective and efficient policy measures to support the RE energy sector. Similarly, the results suggested that government commitment and support for funding SMEs were on course, where 35.0 agreed that the government has supported investors with funds to develop their SME businesses in the solar sector, 38.2% neither agreed nor disagreed, while 27.8 disagreed. With regards to tax holidays, subsidies and financial incentives, 57% agreed that the government supports RE investment, 29.1% neither agreed nor disagreed, and 13.9% disagreed. More so, the results showed that 48.5% agreed that there were long-term financing options for investors in the RE sector, 35.2% neither agreed nor disagreed, while 16.3% disagreed.

Concerning the feed-in-tariff policy by the government, the respondents agreed (52.1%) that the policy was a cost-effective measure to support RE production, 28.5% neither agreed nor disagreed, with 19.4% of them disagreeing with the FIT being cost-effective in supporting RE production. In addition, most (53.9%) of the respondents agreed that the government priority area was solar energy and other REs to support the country’s energy needs, 37.0 neither agreed nor disagreed, while 9.1% disagreed. The question of whether the government’s target of 30% REs will be achieved by 2036 with the current policy measures, most of the respondents (46.6%) agreed, which suggests that the policy goal is likely to be achieved, 30.9% expressed indecisiveness by neither agreeing nor disagreeing, with 22.4% of them being optimistic that the current policy target may be achieved by 2036.

5.2.2.2 Policy Stability

The results showed that in terms of the policy stability as outcome variable: 87.3% of the respondents agreed that policy stability to a large extent had an influence on policy outcomes, while 12.7% said that the stability of policy had no effect on the outcomes of policy goals (see Table 5.3 and Figure 5.1 below).
Table 5.3 Descriptive Results of Policy Stability Scale

<table>
<thead>
<tr>
<th>Description</th>
<th>Response</th>
<th>Frequency</th>
<th>Percentage (%)</th>
<th>Total</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Policy stability</td>
<td>Yes</td>
<td>145</td>
<td>87.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>to a very large extent</td>
<td>No</td>
<td>21</td>
<td>12.7</td>
<td>100.00</td>
<td>166</td>
</tr>
<tr>
<td>effective public policy outcomes on RE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note $\bar{X}=1.13, \ SD=0.33, \ Min=1, \ Max=2, \ N=166$

Figure 5.1 Pie for Policy Stability

5.2.3 Descriptive Statistics of Social Factors

There is one dimension (social acceptance) of the social factors where the data were collected to measure the social variable. However, two components were developed to measure social acceptance: knowledge and perception of RE.

5.2.3.1 Knowledge of RE Use

The results showed that there was a wide distribution of the knowledge of solar energy on the part of the respondents (table 5.4).
Table 5.4 Descriptive Results of Knowledge of RE Use

<table>
<thead>
<tr>
<th>Description</th>
<th>Among the Worst</th>
<th>Average</th>
<th>Among the Best</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>How would you rate your knowledge of RE use in the country</td>
<td>19.3</td>
<td>62.7</td>
<td>18.0</td>
<td>100.00</td>
</tr>
<tr>
<td>How would you rate your level of knowledge on RE policies in Thailand</td>
<td>29.0</td>
<td>60.8</td>
<td>10.2</td>
<td>100.00</td>
</tr>
<tr>
<td>How would you rate your knowledge on the sources of RE in Thailand</td>
<td>24.7</td>
<td>59.6</td>
<td>15.7</td>
<td>100.00</td>
</tr>
<tr>
<td>How would you rate your knowledge of RE technologies use in Thailand</td>
<td>24.1</td>
<td>62.7</td>
<td>13.2</td>
<td>100.00</td>
</tr>
<tr>
<td><strong>Knowledge of RE: Overall</strong></td>
<td><strong>18.1</strong></td>
<td><strong>68.1</strong></td>
<td><strong>13.8</strong></td>
<td><strong>100.00</strong></td>
</tr>
</tbody>
</table>

Note: X̄=2.98,SD=0.63, Min=2, Max=5, N=166

The results above indicate that the overall responses to the survey suggest that the sampled respondents on the average had an appreciable level of knowledge of 68.1% concerning the use of RE and its potential to add to the clean green energy use in the country since 68.1% of the respondents assessed their knowledge as average. The minimum score was 2 and the maximum had a mean score of 2.98, and the standard deviation was 0.63, as displayed in Table 5.4 above.

The responses to the four items varied in the rating their knowledge of RE from the worst scoring at least 18.1%, while 13.8% of them said that their knowledge of RE use in the country was among the best. For example, the respondents were asked to rate their knowledge of RE use in Thailand and about 62.7% rated their knowledge as average, and 19.3% observed that their knowledge of RE use was...
among the worst, while 18.0% rated their knowledge level as among the best. However, from Table 5.4 above, it can be seen that the respondents rated their knowledge of RE policy as average (60.8%), among the best (10.2%), and among the worst at 29.0%. Additionally, it appears that the respondents’ knowledge of RE technology was average (62.7%), among the worst at 24.1%, and among the best at 13.2%. In general, the results for this variable indicated an average knowledge of the existence of RE use, policy, and technologies in the country. However, the knowledge of RE policy seems to be good, yet the number of people in the country that have taken advantage of the rooftop solar PV installation is not known.

5.2.3.2 Perception of RE Use

The respondents were asked to rate their perceptions regarding their fear and the perceived harmfulness of RE use in the country. Forty-two point two percent of them believed that RE use was not harmful or injurious to their health, 46.4% rated it as average, while 11.4% indicated that to some extent their perceptions on RE use had health-related concerns (table 5.5).

**Table 5.5** Descriptive Results of Perception of Solar Energy Use

<table>
<thead>
<tr>
<th>Description</th>
<th>Disagree</th>
<th>Neither agree nor disagree</th>
<th>Agree</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>RE sources pose less health-related risks in communities where RE technologies are sited</td>
<td>19.9</td>
<td>28.9</td>
<td>51.2</td>
<td>100.00</td>
</tr>
<tr>
<td>The use of RE technologies is considered safer for human habitation compared with fossils fuels</td>
<td>8.4</td>
<td>27.1</td>
<td>64.5</td>
<td>100.00</td>
</tr>
<tr>
<td>How you rate the public perception of trust of the use</td>
<td>23.0</td>
<td>40.9</td>
<td>36.1</td>
<td>100.00</td>
</tr>
<tr>
<td>Description</td>
<td>Disagree</td>
<td>Neither agree nor disagree</td>
<td>Agree</td>
<td>Total</td>
</tr>
<tr>
<td>-------------</td>
<td>----------</td>
<td>---------------------------</td>
<td>-------</td>
<td>-------</td>
</tr>
<tr>
<td>of RE technology deployment in the country</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How you rate your knowledge about specific issues and technologies in the RE sector</td>
<td>17.0</td>
<td>42.4</td>
<td>40.6</td>
<td>100.00</td>
</tr>
<tr>
<td>The public perception of the uncertainty of RE technology use does not affect sustainable RE deployment</td>
<td>24.7</td>
<td>30.1</td>
<td>45.2</td>
<td>100.00</td>
</tr>
<tr>
<td>Is the public afraid of the effect of the use of RE technology on their health and safety issues</td>
<td>20.5</td>
<td>30.1</td>
<td>49.4</td>
<td>100.00</td>
</tr>
<tr>
<td>The public perceived that the use of RE technologies produces noise and visual impairment</td>
<td>26.0</td>
<td>35.5</td>
<td>38.5</td>
<td>100.00</td>
</tr>
<tr>
<td>Do the public has fears on the consequences of the perceived risk of RE technology on the siting of plants on their farmlands</td>
<td>19.4</td>
<td>38.2</td>
<td>42.4</td>
<td>100.00</td>
</tr>
</tbody>
</table>
The public has the fear that the use of RE as renewable sources of energy may compete with their irrigation agricultural activities.

<table>
<thead>
<tr>
<th>Description</th>
<th>Disagree</th>
<th>Neither agree nor disagree</th>
<th>Agree</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>The public has the fear that the use of RE as renewable sources of energy may compete with their irrigation agricultural activities</td>
<td>30.3</td>
<td>36.4</td>
<td>33.3</td>
<td>100.0</td>
</tr>
<tr>
<td>How would you rate the public perceived fear of danger on the siting of renewable energy technologies on their food crops</td>
<td>22.0</td>
<td>42.1</td>
<td>35.9</td>
<td>100.0</td>
</tr>
<tr>
<td>How would you rate the public support for leasehold lands for building RE technologies in communities that these plants are sited</td>
<td>15.2</td>
<td>30.9</td>
<td>53.9</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Perception of RE: Overall

<table>
<thead>
<tr>
<th></th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Note: $\bar{X}=5.61, SD=1.55, \text{Min}=0, \text{Max}=10, \text{N}=165$

The results revealed that the mean score for the overall perception of the respondents was 5.61, and the standard deviation was 1.55, which indicates that the data were not widely dispersed from the mean. The minimum score was 0, while the maximum score was 10. Also, the responses to each of the 11 items showed some marked variations. For instance, 51.2% of the respondents agreed that RE technologies posed less risk to communities, for example, where plants are located, 28.9% neither agreed nor disagreed whether RE posed less to communities where they were sited, while 19.9% of them disagreed that solar cells, solar farms or waste, and biogas plants posed less risk to communities where they are found.
According to the results, the respondents believed that communities are willing to lease land for RE plants and that they do not view RE technologies as competing with agricultural production on their farmland (53.9%). However, 30.9% of them were indecisive as to the effect of RE technology on farmlands and agricultural production in communities where they are sited, while 15.2% of them indicated their disagreement, suggesting that RE plants may have an impact on the farmlands and agricultural activities.

5.2.4 Descriptive Statistics for Institutional Factors

The institutional factors were represented by four components: government subsidies, government R&D framework, regulatory/administrative procedures, and stakeholder involvement. The results of the four components are presented in the subsections below.

5.2.4.1 Government Subsidies

This component sought to find out whether government support for solar energy production in terms of subsidies or financial incentives increased grid capacity of RE energy in general. The results suggest that 65.7% of the respondents said government did not provide financial subsidies to solar energy investors in the form of their capital projects, while 31.3% said that the government provides support in the form of subsidies and financial incentives to investors through the form of the base price of the electricity and Adder rate between 2007-2012. This was also confirmed in the interviews with some of the participants. However, the results for the survey indicated that the government does not provide subsidies to investors, especially for startups. Table 5.6 and Figure 5.2 below depict the results of the survey.
Table 5.6 Government Subsidies

<table>
<thead>
<tr>
<th>Description</th>
<th>Response</th>
<th>Frequency</th>
<th>Percentage (%)</th>
<th>Total</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Does the state government provide investors with subsidies or financial incentives to investors?</td>
<td>Yes</td>
<td>52</td>
<td>31.3</td>
<td>100.00</td>
<td>166</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>114</td>
<td>68.7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: X=1.69, SD=0.47, Min=1, Max=2, N=166

Figure 5.2 Pie Chart for Government Subsidies

5.2.4.2 Government Research and Development Framework

In order to examine if the component of government investment in R&D has an impact on sustainable RE policy development, the respondents were asked to state their level of agreement on four sets of items that measured R&D in the RE sub-sector and RE in general. The results indicated that the mean score for the overall scale was 6.01, and the standard deviation was 2.06, indicating little dispersion of the sample
data. The minimum score was 0 and the maximum was 10. Table 5.7 displays the variations in the responses to the four items.

**Table 5.7** Descriptive Results for Government R&D Framework

<table>
<thead>
<tr>
<th>Description</th>
<th>Disagree</th>
<th>Neither agree nor disagree</th>
<th>Agree</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>The government has allocated funding for R&amp;D for future RE development</td>
<td>14.5</td>
<td>29.1</td>
<td>56.4</td>
<td>100.0</td>
</tr>
<tr>
<td>The government has provided laboratories and learning centers for research on RE technology development</td>
<td>27.9</td>
<td>29.1</td>
<td>43.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Government support technology transfer in the RE sector through research and innovation</td>
<td>21.8</td>
<td>29.1</td>
<td>49.1</td>
<td>100.0</td>
</tr>
<tr>
<td>There is high public support and confidence of government policy measures on RE technology in the country</td>
<td>18.8</td>
<td>37.6</td>
<td>43.6</td>
<td>100.0</td>
</tr>
</tbody>
</table>

**R&D: Overall**

|               | 18.8 | 28.5 | 52.7 | 100.0 |

Note: $\bar{X} = 6.01$, SD = 2.06, Min=0, Max=10, N=165

The results from the above table show that for the overall government R&D framework, most of the respondents agreed (52.7%) that the government R&D framework is effective in supporting RE deployment, 28.5% neither agreed nor disagreed, while 18.8% of them disagreed that the government R&D framework will
support RE technology development. According to the data in Table 5.7 above, the responses to the four items that measured R&D showed variation. For example, 56.4% of the respondents agreed that the government has released funding for research and development on RE technologies, 14.5% disagreed, and 29.1 neither agreed nor disagreed. The implication is that the government is investing in the development of technologies that will further support RE technologies.

Furthermore, most of the respondents, 43.0%, indicated that the government has established laboratories and learning centers for RE technology, 29.1 did not know if these learning centers and laboratories existed, while 27.9% disagreed that there were any existence of such facilities. This finding is perhaps inconclusive and must be interpreted with caution since a follow-up study in the feature could visit and attain the level of the operational functionality of these labs and learning centers if any. The results suggest that most of the respondents, 49.1% of them, believed that the government supports technology transfer in the RE sector by strengthening research and innovation in the R&D framework. Further, 29.1% of them said that they neither agreed nor disagreed, with 21.8% disagreeing that the government supports technology transfer through research and innovation. Finally, most of the respondents (43.6%) expressed that there is high public support for and confidence in government policy measures on RE technology; 18.8% expressed dissatisfaction, and 37.6% neither agreed nor disagreed that the public supports and places confidence in government policy measures.

5.2.4.3 Regulations and Administrative Procedures

Eight items were used to measure the regulation and administrative procedures scale. The aim of this component was to access the nature of the administrative support services and bureaucratic procedures that are required before potential investors can process and obtain licenses to start their RE plants. The results showed a mean score of 5.73, a standard deviation of 1.65, the minimum score was 0, and the maximum score was 10. The overall score for how effective and efficient the administrative procedures are indicated that 40.6% agreed that they were efficient, 45.0% of them indicated that they neither agreed nor disagreed, while 14.4% disagreed (table 5.8).
Table 5.8 Descriptive Results for Regulations/Administration Procedures

<table>
<thead>
<tr>
<th>Description</th>
<th>Disagree</th>
<th>Neither agree nor disagree</th>
<th>Agree</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compared to other ministries in the ministry or ministries in government responsible for energy is/ are effective in issuing out operating permits to power procedures.</td>
<td>64.2</td>
<td>24.8</td>
<td>23.0</td>
<td>100.00</td>
</tr>
<tr>
<td>The regulations on RE are easy to understand and applied</td>
<td>24.8</td>
<td>43.0</td>
<td>32.1</td>
<td>100.00</td>
</tr>
<tr>
<td>It is easy to secure an operating permit or license to produce RE in the country</td>
<td>21.8</td>
<td>39.4</td>
<td>38.9</td>
<td>100.00</td>
</tr>
<tr>
<td>The agencies responsible for regulating the activities in the RE sector provide support for small and big power producers to secure land for sitting plants</td>
<td>26.0</td>
<td>39.4</td>
<td>34.5</td>
<td>100.00</td>
</tr>
<tr>
<td>The agencies responsible for RE sector ensures that power producers follow environmental and local laws where plants are located</td>
<td>12.1</td>
<td>28.3</td>
<td>59.6</td>
<td>100.00</td>
</tr>
</tbody>
</table>

The laws and regulations on RE
The regulatory and administrative procedures are devoid of bureaucratic bottlenecks. The regulatory agencies ensure compliance with environmental impact assessment before permits are issued to RE power producers.

<table>
<thead>
<tr>
<th>Description</th>
<th>Disagree</th>
<th>Neither agree nor disagree</th>
<th>Agree</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>deployment are monitored to ensure compliance by power producers</td>
<td>11.6</td>
<td>27.4</td>
<td>61.0</td>
<td>100.00</td>
</tr>
<tr>
<td>The regulatory agencies ensure compliance with environmental impact assessment before permits are issued to RE power producers</td>
<td>25.6</td>
<td>34.8</td>
<td>39.6</td>
<td>100.00</td>
</tr>
<tr>
<td>Regualtion/Administration</td>
<td>14.4</td>
<td>45.0</td>
<td>40.6</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Note: $\bar{x} = 5.73$, $SD=1.65$, $Min=0$, $Max=10$, $N=165$

The descriptive statistics showed that most (64.2%) of the respondents disagreed that the government agencies and ministries responsible for issuing operating permits to power producers were effective, while 23.0% expressed that the agencies were effective, with 24.8% of them neither agreeing nor disagreeing. This finding was also confirmed in the qualitative interviews where the participants expressed their opinions that the ministries and agencies responsible for issuing operating permits demanded money before processing their documents. This finding suggests some form of corrupt practices involved in the administrative procedures in issuing operating permits. With regards to the understanding of regulations and the application of the requirements for operating permits by power producers, 24.8%
disagreed that power producers understood and applied the regulations to their operating permits. However, 32.1% agreed that the power producers understood and applied the rules, while the majority of the respondents, 43.0%, expressed that they did not know whether the power producers understood and applied for their operating permits or not.

Another observation from the results showed that most of the respondents, 39.4%, neither agreed nor disagreed that it was easy to obtain an operating permit to produce RE in the country, while 38.9% agreed that it was easy to obtain operating permits, with 21.8% disagreeing. Further, 34.5% of the respondents agreed that the agencies responsible for RE provided support to small and big power producers to secure land for siting RE plants. Yet 26.0% of them stated that the government agencies do not provide support for land leases for power producers, and 39.4% of them neither had the information to support or contradict the statement. This finding was also confirmed in the qualitative interviews. Individual power producers, whether small or big, were responsible for securing their own land through leaseholds and the process of public hearing of key stakeholders, especially the community members, to state their agreement or disagreement over the siting of the power plants before the final operating permit is issued.

In terms of environmental monitoring, especially impact assessments, most of the respondents (57.3%) indicated that impact assessments are carried out before permits are issued, while only 17.7% of them disagreed. Similarly, 59.6% of the respondents agreed that the regulatory agencies that monitored power producers meet regulations and local laws. However, 12.1 disagreed, with 28.3% of them expressing neither agreement nor disagreement. The results showed that 61.0% of the respondents think that laws and regulations are effectively monitored to ensure compliance, whereas 11.6% disagreed, with 27.4% expressing neither of the two views.

Interestingly, the majority represented by 39.6% expressed that there is an absence of bureaucratic bottlenecks in regulatory and administrative procedures, 25.6% disagreed, while 34.8% neither supported nor disagreed with the statement. The finding on regulatory and administrative procedures appears to be cumbersome, since most of the interviewed, especially solar rooftop owners, indicated the difficulty
that they had to go through with EGAT in transacting business with the Electricity Authority.

5.2.4.4 Stakeholder Involvement

The results showed a mean score of 5.55, and a standard deviation of 1.34, suggesting no major dispersion of the data from the mean. The minimum score was 2 and the maximum score was 10. The results, however, showed that the responses to the eight items varied (table 5.9).

**Table 5.9** Descriptive Results of Stakeholder Involvement

<table>
<thead>
<tr>
<th>Description</th>
<th>Disagree</th>
<th>Neither agree or disagree</th>
<th>Agree</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Government policy frameworks ensure adequate consultation with communities where RE plants and technology are located</td>
<td>21.8</td>
<td>39.4</td>
<td>38.8</td>
<td>100.00</td>
</tr>
<tr>
<td>How would you rate the ministry or ministries with responsibility for RE compared to other agencies and businesses in the energy sector</td>
<td>19.4</td>
<td>54.5</td>
<td>26.1</td>
<td>100.00</td>
</tr>
<tr>
<td>How would you compare the Thai ministry or ministries responsible for RE to others in the ASEAN region</td>
<td>18.2</td>
<td>49.7</td>
<td>32.1</td>
<td>100.00</td>
</tr>
<tr>
<td>Description</td>
<td>Disagree</td>
<td>Neither agree or disagree</td>
<td>Agree</td>
<td>Total</td>
</tr>
<tr>
<td>----------------------------------------------------------------------------</td>
<td>----------</td>
<td>--------------------------</td>
<td>-------</td>
<td>--------</td>
</tr>
<tr>
<td>The regulatory agencies share information on its activities regularly with</td>
<td>13.4</td>
<td>45.1</td>
<td>41.5</td>
<td>100.00</td>
</tr>
<tr>
<td>other stakeholders in the sector</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The government is willing to change policy direction in the light of</td>
<td>21.7</td>
<td>36.1</td>
<td>42.2</td>
<td>100.00</td>
</tr>
<tr>
<td>suggestions made by other energy stakeholders</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The policy and regulatory agencies frequently acknowledge persons in the</td>
<td>18.3</td>
<td>42.1</td>
<td>39.6</td>
<td>100.00</td>
</tr>
<tr>
<td>community who have made significant contributions to RE development</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The regulatory agencies have considerable control over the operations of</td>
<td>7.3</td>
<td>37.6</td>
<td>55.1</td>
<td>100.00</td>
</tr>
<tr>
<td>RE producers</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The regulatory agencies are often forced to change policy direction because</td>
<td>13.3</td>
<td>44.9</td>
<td>41.8</td>
<td>100.00</td>
</tr>
<tr>
<td>the demands of the key</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Overall, the results showed that 12.1% disagreed that there was enough policy dialogue with major stakeholders in the RE during the policy formulation and implementation phases by regulatory agencies, 46.7% neither agreed nor disagreement while 41.2% indicated their agreement to the effect that there was stakeholder participation in the RE policymaking process. Notwithstanding the overall rating, there were different responses to some of the items that sought to elicit their rating on the stakeholder variable. For example, 38.8% of the respondents indicated that there was enough consultation with key actors in the communities where RE or solar plants are located, 21.8% disagreed, while 39.4 neither agreed nor disagreed.

In terms of the performance of the policy institutions responsible for RE policy, compared with other agencies and businesses, 19.4% rated them poorly, 54.5% were neutral, while 26.1 rated them highly. In order to further validate this aspect of stakeholder involvement, the respondents were asked to rate the performance of the ministries responsible for RE policy development compared with other agencies in the ASEAN region. About 49.7%, which formed the majority, expressed that they neither agreed nor disagreed that the ministries were performing relatively high or low compared with others in the sub-region, while 32.1% rated the
performance as high, and 18.2% disagreed that their performance was comparable to other agencies in other ASEAN member countries.

In order to find out if the information is readily available and shared with stakeholders in the RE sector, 41.5% said that the information was being shared with stakeholders, and 13.4 disagreed, whereas most of them, 45.1%, neither expressed agreement nor disagreement. Subsequently, 42.2% of the respondents suggested that stakeholder inputs are given consideration during policy dialogue and formation, whereas 21.7% of them disagreed, with 36.1% neither agreeing nor disagreeing. Regarding stakeholder contribution and recognition, 42.1% of them suggested that a majority neither expressed agreement nor disagreement whether persons in communities where RE plants are sited who have contributed immensely to RE development are being rewarded or acknowledge. Some of them, 18.3%, said that the persons that have excelled in RE are not being recognized, while 39.6% agreed that the persons that have excelled in their contribution to RE development are being recognized.

In order to understand if there is tight control of power producers by regulatory agencies in the RE sector, the majority - 55.1%, supported the statement that the regulatory agencies have considerable control over power producers. Further, 7.3% of them disagreed with the statement and held that there was little control of power producers by regulatory agencies; and 37.6% of the respondents expressed mixed reactions in the sense that they neither believed that there was tight control over power producers by regulatory agencies nor less control. Furthermore, the results indicated that some level of pressure and demand of key stakeholders in the RE sector has been reflected in the changes to policy. For example, 41.8% said that stakeholder pressure and demands are captured in policy changes, 13.3% disagreed, while 44.9% neither agreed nor disagreed.

5.2.5 Summary of Descriptive Results for the Sub-Scales

This section presents the descriptive statistics for the total scales for the six sub-components of the independent variables. The results of the survey instrument show that the mean score for the knowledge variable was 2.98, SD= 0.63, there was a minimum score of 2, and a maximum of 5 (table 5.10).
**Table 5.10** Summary of Descriptive Results for the Sub-Scales

<table>
<thead>
<tr>
<th>Factor</th>
<th>Disagree</th>
<th>Neither/agree nor disagree</th>
<th>Agree</th>
<th>Total (%)</th>
<th>Mean</th>
<th>SD</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effective Policy Measures</td>
<td>14.4</td>
<td>40.4</td>
<td>45.2</td>
<td>100</td>
<td>5.65</td>
<td>1.40</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>Policy stability</td>
<td>12.7</td>
<td>-</td>
<td>87.3</td>
<td>100</td>
<td>1.13</td>
<td>0.33</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Knowledge</td>
<td>18.1</td>
<td>68.1</td>
<td>13.8</td>
<td>100</td>
<td>2.98</td>
<td>0.63</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Perception</td>
<td>11.4</td>
<td>46.4</td>
<td>42.2</td>
<td>100</td>
<td>5.61</td>
<td>1.55</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>Government Subsidies</td>
<td>68.7</td>
<td>-</td>
<td>31.2</td>
<td>100</td>
<td>1.69</td>
<td>0.47</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Gov.R&amp;D</td>
<td>18.8</td>
<td>28.5</td>
<td>52.7</td>
<td>100</td>
<td>6.01</td>
<td>2.06</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>Reg/Administrative Procedures</td>
<td>14.4</td>
<td>45.0</td>
<td>40.6</td>
<td>100</td>
<td>5.73</td>
<td>1.65</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>Stakeholder Involvement</td>
<td>12.1</td>
<td>46.7</td>
<td>41.2</td>
<td>100</td>
<td>5.55</td>
<td>1.34</td>
<td>0</td>
<td>10</td>
</tr>
</tbody>
</table>

Table 5.10 shows that perception had a mean score of 5.61, SD= 1.55, a minimum score of 0, and a maximum score of 10, while the effective policy measure variable had an average of 5.65, a standard deviation of 1.40, a minimum score of 2, and a maximum score of 10. The government R&D framework had a mean score of 6.01, a standard deviation of 2.06, with the minimum score being 0, and the maximum score was 10. Similarly, regulation and administrative procedures had an average score of 5.73, a standard deviation of 1.65, a minimum score of 0, and the maximum score was 10. Stakeholder involvement had a mean score of 5.55, a standard deviation of 1.34, with a minimum score of 2 and the maximum score was 10. The mean score for policy stability was 1.13, SD=0.33, the minimum was 1, and the maximum score was 2, while the mean score for government subsidies was 1.69, SD= 0.47. The minimum score was 1 and the maximum score was 2.
5.2.6 Descriptive statistics for Dependent and Independent variables

This section of the report presents the descriptive results for the total scales, which were used to measure the two main independent variables and the dependent variable. The results in Table 5.11 indicate that social factors had a mean score of 8.59, a standard deviation of 1.78, a minimum score of 3, and the maximum score was 13.

Table 5.11 Descriptive Statistics for Main Variables

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social Factors</td>
<td>166</td>
<td>3</td>
<td>13</td>
<td>8.59</td>
<td>1.782</td>
</tr>
<tr>
<td>Institutional Factors</td>
<td>165</td>
<td>9</td>
<td>32</td>
<td>18.97</td>
<td>4.193</td>
</tr>
<tr>
<td>Sustainable Solar Energy Policy Development</td>
<td>166</td>
<td>3</td>
<td>12</td>
<td>6.77</td>
<td>1.507</td>
</tr>
</tbody>
</table>

Furthermore, the institutional factors had an average of 18.97, the standard deviation was 4.19, the minimum score was 9, and the maximum score was 32. Also, sustainable RE policy development had a minimum score of 3 and a maximum score of 12, with a mean score of 6.77 and a standard deviation of 1.51 (see Table 5.11 above).

5.2.7 Correlation Results

This section presents the correlation matrix for the relationships between the individual component variables and the dependent variable components. Correlation and other primary tests are presented since multiple regression assumes a linear relationship between the variables. Table 5.13 depicts the part of the conceptual framework that links the relationship between the dependent variable and two of the independent variables. The correlation matrix between the sub-component variables indicated a strong correlation between the variables.

5.2.7.1 Correlation Results for the Antecedents of Sustainable RE Policy Development

After a preliminary test of the various assumptions of the multiple regression analysis techniques, the data were found to be devoid of multicollinearity and there
was no collinearity presence in the data. The next step was to consider if each sample was an independent observation and whether the sample size of 166 was adequate to proceed with the multivariate analysis. The results of the correlation showed that most of the variables had correlation values higher than 0.2 and less than 0.8, with only a few variables giving higher correlation values since these variables were combined to measure others and that showed consistency in the measures. For example, in the case of perception and social factors (0.94, s¹), however, the relationship was positive and significant at p<0.01, Similarly, effective policy measures and sustainable RE policy development were highly correlated (0.98) yet statistically significant at p<0.01 because effective policy measures are one of the components of sustainable RE policy development.

In Table 5.12, the results show that there were positive correlations among policy stability (0.21, p <0.01), knowledge, and effective policy measures (0.33), which were statistically significant at p<0.01. Another trend observed in the correlation matrix below indicates that perception and effective policy measures were positively correlated (0.43) and the p-value was significant at 0.01. However, there was a negative relationship between government subsidies and effective policy measures was (-0.23, p<0.01). The correlation between effective policy measures and R&D indicated a positive strong relationship (0.63, p<0.01). Whereas effective policy measures and regulation/administrative procedures were positively correlated with (0.55) and p<0.01. Stakeholder and effective policy measures were positively correlated at (0.69) and p<0.01. Social factors and effective policy measures had a positive strong relationship and were statistically significant (0.49, p<0.01). Effective policy measures and institutional factors were positively related (0.718, p<0.001) (see Table 5.12 below for more details).

Policy stability and knowledge were positively correlated with (0.10) and were statistically insignificant. Closer observation showed that perception and policy stability were positively correlated, where (0.11, ns²) government subsidies and policy stability were not statistically significant but had a negative association (-0.06, ns). Policy stability and government R&D had a positive correlation but were statistically

¹ s= statistically significant  
² ns= Not statistically significant
insignificant (0.10, ns), and regulation/administrative procedures and policy stability had a positive association yet an insignificant effect (0.14, ns). Additionally, there was a negative relationship and a significant effect on stakeholder and policy stability (0.17, p<0.05). For both the social and institutional factors, the relationships were positive but insignificant, while sustainable RE policy development and policy stability were positive and significant (0.41, p<0.01).

For knowledge and perception, the correlation was positive and significant (0.19, p<0.05), knowledge and government subsidies had a negative relationship that was statistically insignificant (-0.08, ns), and government R&D and knowledge had a positive relationship, where a unit change in one led a corresponding change in the other (0.39, p< 0.01). A critical observation of the results revealed that knowledge and regulations/administrative procedures had a positive correlation (0.44, p<0.01), while knowledge and stakeholder involvement had a positive 0.38 and was statistically significant at p<0.01. Additionally, social factors and knowledge had a positive relationship and a significant effect (0.52, p<0.01), institutional factors and knowledge had a positive and significant relationship at 0.48 and p<0.01, while sustainable RE policy development and knowledge had a positive and significant relationship (0.33, p<0.01).

Additionally, knowledge and total social factors were highly correlated, indicating multicollinearity since the knowledge variable was combined with perception to measure social factors. Hence the positive and high correlation of (0.53) with p<0.01 explains that the knowledge variable and social factors were measuring the same thing. Also, knowledge and the institutional factors were positively correlated at (0.47) and were statistically significant at p<0.01. However, knowledge and government subsidies were negatively related with no statistical significance (0.09, ns).

Regarding perception and government subsidies, there was an inverse relationship (-0.15, ns), and perception and government R&D were positive (0.42, p<0.05), while perception and regulation/administrative procedures were negatively correlated (-0.26, p<0.01). Further, perception and stakeholder involvement were negatively correlated, suggesting that a unit change in perception leads to a corresponding decrease (-0.23, p<0.01) in stakeholder involvement. Similarly,
perception and social factors were negatively correlated with a statistically significant effect (-0.16, p<0.05), while institutional factors and perception were negatively correlated (-0.15, ns). Similarly, sustainable RE policy development and perception were negatively associated but significant (-0.23, p<0.01).

For government R&D the relationship with regulation/administrative procedures was positive (0.58, p<0.01), government R&D and stakeholder involvement were positive and significant (0.0.57, p<0.01), government R&D and social factors (0.51, p<0.01), government R&D and institutional factors (r=0.88, p<0.01). Further, the relationship between sustainable RE policy development and government R&D was positive and statistically significant (0.60, p<0.01).

Regulation and administrative procedures provided a strong relationship among the other variables. For instance, regulation/administrative procedures and social factors were at (0.42, p<0.01, institutional and regulation/administrative procedures (0.83, p<0.01). Stakeholder involvement and regulation/administrative procedures were positively correlated (0.59, p<0.01), while sustainable RE policy development and regulation/administrative procedures were positively associated and significant (0.55, p<0.01). The rest of the variables showed that social factors and stakeholder involvement had a positive and significant relationship (0.45, p<0.01), stakeholder involvement and institutional factors (0.80, p<0.01). On the other hand, stakeholder involvement and sustainable RE policy development were positively correlated and significant (0.68, p<0.01).

For the social factors and institutional factors, the two variables were positive and significant (0.54, p<0.01), and social factors and sustainable RE policy development were positively related and significant (0.0.48, p<0.01). In the case of the institutional variable and sustainable RE policy development, the results showed that the two variables were positively correlated and significant (0.70, p<0.01) (table 5.12).
Table 5.12 Correlation Results for Sub and Main Variables

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Effective Policy Measures</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Policy Stability</td>
<td>.206**</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Knowledge</td>
<td>.330**</td>
<td>.098</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Perception</td>
<td>.430**</td>
<td>.108</td>
<td>.199*</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Government Subsidies</td>
<td>-.231**</td>
<td>-.056</td>
<td>-.082</td>
<td>-.146</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Government R&amp;D</td>
<td>.623**</td>
<td>.096</td>
<td>.394**</td>
<td>.429**</td>
<td>-.170*</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Regulation &amp; administrative Procedures</td>
<td>.553**</td>
<td>.140</td>
<td>.436**</td>
<td>.312**</td>
<td>-.261**</td>
<td>.576**</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Stakeholder Involvement</td>
<td>.689**</td>
<td>.171*</td>
<td>.379**</td>
<td>.368**</td>
<td>-.231**</td>
<td>.569**</td>
<td>.586**</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Social Factors</td>
<td>.490**</td>
<td>.129</td>
<td>.524**</td>
<td>.939**</td>
<td>-.156*</td>
<td>.506**</td>
<td>.418**</td>
<td>.448**</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Institutional Factors</td>
<td>.718**</td>
<td>.151</td>
<td>.475**</td>
<td>.435**</td>
<td>-.148</td>
<td>.880**</td>
<td>.834**</td>
<td>.803**</td>
<td>.539**</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>11. Sustainable RE Policy</td>
<td>.976**</td>
<td>.413**</td>
<td>.329**</td>
<td>.424**</td>
<td>-.227**</td>
<td>.601**</td>
<td>.545**</td>
<td>.679**</td>
<td>.484**</td>
<td>.701**</td>
<td>1</td>
</tr>
</tbody>
</table>

**. Correlation is significant at the 0.01 level (2-tailed), *. Correlation is significant at the 0.05 level (2-tailed), Listwise: N=165
5.2.8 Regression Results

This section is composed of six parts. The first presents the multiple regression results for the social determinants of sustainable RE policy development with a focus on the individual sub-components of the social variable. The second section presents the effect of the institutional factors on the dependent variable. The third part focuses on all of the sub-components of the individual independent variables in terms of sustainable RE policy development. The fourth section will focus on the main independent variables effect on the dependent variable. The fifth part will provide the results of the multiple regression and the control variables. The sixth section will present the results of the main variables of the study using stepwise regression to observe the effect and the explanatory power of each independent variable on the dependent variable. The aim is to determine which factors best explain sustainable RE policy development. The details are presented below.

5.2.8.1 Regression Results for the Social Factor Sub-Components and the Dependent Variable

This section deals with the results of the multiple regression technique of the determinants effect of the social variable on sustainable RE policy development. The results suggest that the model was statistically significant, and it provides a total variance of 24.2% \( (r^2=0.242) \), and the Durbin-Watson value was significant, which was 2.01 as recommended in social science research (Pallant, 2011). The model was statistically significant \( F_{(26.05, 163, p<0.000)} \). Table 5.13 depicts the coefficients of the model and the standardized coefficients are presented.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Beta</th>
<th>( R^2 )</th>
<th>Adj.( R^2 )</th>
<th>( F )</th>
<th>( t )</th>
<th>( P )-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Constant)</td>
<td>2.910</td>
<td>5.081</td>
<td></td>
<td></td>
<td></td>
<td>.000</td>
</tr>
<tr>
<td>Knowledge</td>
<td>0.255</td>
<td>0.242</td>
<td>0.233</td>
<td>26.05</td>
<td>3.662</td>
<td>.000</td>
</tr>
<tr>
<td>Perception</td>
<td>0.374</td>
<td>0.242</td>
<td>0.233</td>
<td>26.05</td>
<td>5.370</td>
<td>.000</td>
</tr>
</tbody>
</table>

Note: Dependent variable: Sustainable RE Policy Development, Standardized Beta values, S.E= 1.320, Durbin-Watson=2.014
The results indicate that perception contributed more to explaining the variance in sustainable RE policy development than knowledge, with $\beta = 0.374$, while knowledge contributed $\beta = 0.26$ to the total variance explained. This implies that the respondents’ perception of RE use, such as their fears about health-related issues, have some form of association with the kind of policies developed to ensure the deployment of RE in the country. Similarly, the respondents rated that the use of RE was risk-free since no hazards were experienced using this form of energy for either domestic or industrial uses. Generally, the respondents trust the use of RE in terms of health and the effects on the environment than other sources of energy.

Additionally, the respondents’ knowledge of RE use and associated technologies was moderate, and most of them rated their knowledge level as average. The implication is that RE and its related technologies are an officially-known phenomenon since the interviews suggested that there are various promotions organized by some tech companies to use solar rooftop panels for one’s energy needs. At the same time, government policy on residential rooftop provides a good pricing mechanism by offering 12 baht for the solar rooftop to individuals that add a surplus of their electricity to the national grid.

1) Regression Results for Institutional Factors Sub-components and the Dependent Variable

The results for this regression indicated that the four sub-components of the institutional determinants were statistically significant. The model was able to explain 53.9% of the variation in the sustainable RE policy development ($r^2 = 0.539$), while the Durbin-Watson=1.839 (table 5.14).

### Table 5.14 Regression Results for Institutional factors

<table>
<thead>
<tr>
<th>Variable</th>
<th>Beta</th>
<th>T-Stat</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>2.509</td>
<td>4.725</td>
<td>0.000</td>
</tr>
<tr>
<td>Gov R&amp;D</td>
<td>0.274</td>
<td>3.907</td>
<td>0.112</td>
</tr>
<tr>
<td>Reg/Adm</td>
<td>0.115</td>
<td>1.598</td>
<td>0.000</td>
</tr>
<tr>
<td>Stakeholder Inv.</td>
<td>0.446</td>
<td>6.282</td>
<td>0.000</td>
</tr>
<tr>
<td>Gov. Subsidies</td>
<td>-0.042</td>
<td>-0.748</td>
<td>0.455</td>
</tr>
</tbody>
</table>
The table above suggests that stakeholder involvement provided more explanatory power and provided a $\beta =0.45$, followed by the government R&D framework, which contributed $\beta =0.27$, while regulation/administrative procedures and government subsidies provided the least value in explaining the dependent variable with $\beta =0.12$ and $\beta =-0.04$ respectively. However, the regression result for government subsidies was negative, suggesting an inverse relationship between the two variables. The implication is that a unit change in regulatory procedures leads to a decrease in sustainable RE policy development. This finding needs to be interpreted with caution since it does not mean that regulatory procedures lead to unsustainable policies on RE. However, this finding may suggest that there are fundamental challenges with the regulatory and administrative procedures in place to support investors in establishing and producing RE for the national grid.

In terms of statistically-significant effects, two variables were seen to have an effect on sustainable RE policy development, the government R&D framework and stakeholder involvement, where the p-values for the two variables were less than (<0.000), indicating a highly-significant effect at the 99% confidence level, which means that the effect was not due to chance but was the real effect of the independent variable on the dependent variable.
5.2.8.2 Combined Effect of the Independent Variable Sub-Components and the Dependent Variable

In this section, the purpose is to present the results for the combined effect of the independent variable sub-components and their effect on the dependent variable. The results in Table 5.15 show that the total variance explained by the six sub-scales was 55.6% with a standard error of 1.007, and the Durbin Watson test fell within an acceptable range (1.895), which should not be greater than 2 (table 5.15).

### Table 5.15 Regression Results for Independent Variables Sub-Components

<table>
<thead>
<tr>
<th>Variable</th>
<th>Beta</th>
<th>T-Stat</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>1.008</td>
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<td>0.004</td>
</tr>
<tr>
<td>Knowledge</td>
<td>0.084</td>
<td>1.380</td>
<td>0.169</td>
</tr>
<tr>
<td>Perception</td>
<td>0.116</td>
<td>1.949</td>
<td>0.053</td>
</tr>
<tr>
<td>Gov R&amp;D</td>
<td>0.223</td>
<td>3.081</td>
<td>0.002</td>
</tr>
<tr>
<td>Reg/Adm</td>
<td>0.090</td>
<td>1.235</td>
<td>0.219</td>
</tr>
<tr>
<td>Stakeholder Inv.</td>
<td>0.416</td>
<td>5.832</td>
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</tr>
<tr>
<td>Gov. Subsidies</td>
<td>-0.039</td>
<td>-0.708</td>
<td>0.048</td>
</tr>
</tbody>
</table>

**Summary Statistics**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>R</td>
<td>0.745</td>
</tr>
<tr>
<td>R²</td>
<td>0.556</td>
</tr>
<tr>
<td>Adjusted R²</td>
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<tr>
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<tr>
<td>F stat</td>
<td>32.929</td>
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<tr>
<td>df</td>
<td>158</td>
</tr>
<tr>
<td>P value</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

**Note:** Dependent Variable: Sustainable Solar Energy Policy Development, standardized beta values, Durbin Watson=1.895

The results above show that the model was significant at p<0.001. In terms of the individual variables’ contributions to the dependent variable, stakeholder involvement provided the highest explanatory power with $\beta=0.42$, followed by government R&D, with $\beta=0.22$, and perception, with $\beta=0.12$. In terms of statistical significance, government R&D and stakeholder involvement were both significant at p<0.001, while perception was significant at p<0.0. The three least contributors to explaining the dependent variable were regulation/administrative procedures, and
knowledge and government subsidies, $\beta=0.09$, $\beta=0.08$, and -0.04 respectively. However, these three variables were not statistically significant. This finding suggests that stakeholder involvement and government R&D supports sustainable RE policy development and that the government should pay more attention to strengthening active stakeholder involvement and invest more in R&D on solar technologies.

1) Regression Results for the Main Independent Variables and the Dependent Variable

In this model the results for the two variables show that the variation in the dependent variable was 51.2%, the standard error was 1.04, and the p-value was less than <0.001. Table 5.16 displays the coefficients for the two variables.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Beta</th>
<th>T-Stat</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>1.500</td>
<td>3.403</td>
<td>0.001</td>
</tr>
<tr>
<td>Social Factors</td>
<td>0.169</td>
<td>2.589</td>
<td>0.011</td>
</tr>
<tr>
<td>Institutional Factors</td>
<td>0.611</td>
<td>9.375</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Summary Statistics

<table>
<thead>
<tr>
<th>R</th>
<th>0.716</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R^2$</td>
<td>0.512</td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>0.506</td>
</tr>
<tr>
<td>S.E.</td>
<td>0.506</td>
</tr>
<tr>
<td>F stat</td>
<td>1.042</td>
</tr>
<tr>
<td>df</td>
<td>82.033</td>
</tr>
<tr>
<td>P value</td>
<td>162</td>
</tr>
<tr>
<td></td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Note: Dependent Variable: sustainable RE policy development, standardized beta values, Durbin-Watson=1.829

In Table 5.16, the individual contributions to the dependent variable exhibit some variations. The highest contribution to the total variance was institutional factors with $\beta=0.611$, followed by social factors with $\beta=0.169$. Institutional factors were statistically significant at $p<0.001$, while the social factors had $p$ values $<0.05$. This finding implies that efforts to strengthen institutional variables that support policy implementation may provide effective outcomes for solar energy policy and other RE policies in Thailand. However, it is also important for the government agencies...
responsible for RE development to create awareness on the part of the public regarding the usefulness of using RE, especially solar rooftop energy, where the government is providing incentives in the form of higher prices (12 baht per Kilowatt) of electricity added to the grid. This will help individuals install solar panels in their residential homes. Similarly, the cost of installation should also be subsidized by the government in order to encourage many households to use this option to enable the RE target of 30%.

5.2.8.3 Regression Results for the Independent Variables, the Control Variables, and the Dependent Variable

The next regression results depict the two independent variables while controlling for the six variables of the study: age, sex, rank, generating capacity, type of producer, and role in the RE sector. However, the regression results showed that the number of employees and the role in the Re sector were removed from the model because their coefficients could not be estimated. According to the output of the results, two models were produced with their coefficients. Table 5.18 shows the two models, and the results depict that the first model explained a variance of 46.0% ($R^2=0.460$) with a standard error of 1.193, while the second model explained the dependent variable with 58.8% standard error = 1.103, which showed a 0.128-unit change in the total variance in the second model (table 5.17).
Table 5.17 Model Summary for the Independent Variables and Control Variables

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error of the Estimate</th>
<th>Durbin-Watson</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.678a</td>
<td>.460</td>
<td>.437</td>
<td>1.193</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>.767b</td>
<td>.588</td>
<td>.518</td>
<td>1.103</td>
<td>2.311</td>
</tr>
</tbody>
</table>

1: F=19.599, df=46, P<0.001
2: F=8.368, df=41, P<0.001

a. Predictors: (Constant), Institutional Factors, Social Factors
b. Predictors: (Constant), Institutional Factors, Social Factors, Generating Cap MW, Age, Rank, Sex, Type of producer
c. Dependent Variable: Sustainable RE Policy Development

In the second results output, the two regressions models’ constants were significant at p<0.05 and p<0.01 respectively. The first model shows that the institutional factors contributed most to explaining the changes in the dependent variable with $\beta=0.633$, $p<0.001$, while the social factors provided $\beta=0.083$ and were insignificant. However, the second model improved over the previous one when the control variables were added into the regression equation. In the second model, the contributions of the institutional factors’ explanatory effect reduced from 0.633 to 0.558, a decrease of a 0.075 difference. This means that age, sex, rank, generating capacity, and type of producer influence the model and to a large extent determine the changes in the dependent variable. However, the social variable improved in the second model when the five variables were controlled for, increasing from 0.083 to 0.164 but insignificant (table 5.18).
Table 5.18 Regression Results for the Independent Variables, Control Variables

<table>
<thead>
<tr>
<th>Model</th>
<th>Variable</th>
<th>Beta</th>
<th>T-Stat</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(Constant)</td>
<td>2.265</td>
<td>2.919</td>
<td>.005</td>
</tr>
<tr>
<td>1</td>
<td>Social Factors</td>
<td>0.083</td>
<td>.667</td>
<td>.508</td>
</tr>
<tr>
<td></td>
<td>Institutional Factors</td>
<td>0.633</td>
<td>5.087</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>(Constant)</td>
<td>3.726</td>
<td>2.866</td>
<td>.007</td>
</tr>
<tr>
<td></td>
<td>Social Factors</td>
<td>0.164</td>
<td>1.360</td>
<td>.181</td>
</tr>
<tr>
<td></td>
<td>Institutional Factors</td>
<td>0.558</td>
<td>4.462</td>
<td>.000</td>
</tr>
<tr>
<td>2</td>
<td>Age</td>
<td>0.150</td>
<td>1.345</td>
<td>.186</td>
</tr>
<tr>
<td></td>
<td>Sex</td>
<td>-0.098</td>
<td>-.896</td>
<td>.375</td>
</tr>
<tr>
<td></td>
<td>Rank</td>
<td>0.057</td>
<td>.522</td>
<td>.604</td>
</tr>
<tr>
<td></td>
<td>Generating Cap MW</td>
<td>-0.341</td>
<td>-2.857</td>
<td>.007</td>
</tr>
<tr>
<td></td>
<td>Type of producer</td>
<td>-0.195</td>
<td>-1.689</td>
<td>.099</td>
</tr>
</tbody>
</table>

Note: Dependent variable: sustainable RE policy development, standardized beta values

For the control variables, two variables were statistically significant, generating capacity and type of producer at p<0.01). In terms of the variation in the dependent variable, generating capacity had a negative relationship with the dependent variable, with $\beta=-0.341$, followed by the type of producer, with $\beta=-0.195$. This means that an increase in any of the variables will lead to a decrease of -0.341 and -0.195 in the dependent variable. Also, the sex of the respondents was negatively associated with sustainable RE policy development with $\beta=0.098$, but this was insignificant. However, age and rank were positively related to the dependent variable, with betas of 0.150 and 0.057 respectively, with no statistical effect on the dependent variable.

5.2.9 Stepwise Regression for the Sub-Components

To be able to accurately predict the model fit of the data, stepwise regression was performed for the three different models or combinations of the explanatory variables and their effect on the dependent variable. The results indicated that model 1 explained variance of 46.1% ($R^2=0.461$) and the variable that was included in this
model was only stakeholder participation. This is confirmed in the second table (table 5.19)—that the variable contributed about 0.679 to the total variance in sustainable RE policy development (table 5.20). Model 2 explained a total variance in the dependent variable by 52.9%, an improvement over the first model by about 0.68 points in explaining the changes in sustainable RE policy development when government R&D was added to stakeholder involvement. The results for the second model suggest that stakeholder involvement contributed most to the total variance explained, with a beta of 0.498, while government R&D contributed 0.318. Closer observation showed that the stakeholder coefficient was reduced when government R&D was added to the model (table 5.20).

Table 5.19 Model Summary for Stepwise Regression of Independent Variables Sub-Components

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error of the Estimate</th>
<th>Durbin-Watson</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.679a</td>
<td>.461</td>
<td>.457</td>
<td>1.092</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>.727b</td>
<td>.529</td>
<td>.523</td>
<td>1.024</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>.735c</td>
<td>.541</td>
<td>.532</td>
<td>1.014</td>
<td>1.901</td>
</tr>
</tbody>
</table>

1: F=139.188 df= 46
P<0.001
2: F= 90.910
df=41
p<0.001
3: F=63.234
df=161
p<0.001

a. Predictors: (Constant), Stakeholder Involvement
b. Predictors: (Constant), Stakeholder Involvement, Government R&D
c. Predictors: (Constant), Stakeholder Involvement, Government R&D, Perception
d. Dependent Variable: Sustainable RE Policy Development

Further, the stepwise regression in model 3 indicates that three variables—stakeholder involvement, government R&D, and perception—predicted the model better. The model showed a variation of 54.1%, suggesting an improvement when the perception was added to the model. In terms of the contributions of each of the three variables, stakeholder contributed most with $\beta=0.475$, followed by government R&D framework with $\beta=0.277$, while perception contributed marginally with $\beta=0.124$. However, three variables were excluded when the stepwise regression was performed.
They included regulation/administrative procedures, knowledge, and government subsidies. The implication is that these variables do not predict the dependent variable, while stakeholder, government R&D, and perception predict sustainable RE policy development better. This finding has implications for policymakers since the contributions and input of key stakeholders regarding policy formation are more likely to lead to desirable outcomes of policy goals. Similarly, the government should invest more in R&D activities to support the growth of RE technology and other RE to ensure more efficient and effective supply of RE to the national grid. Nonetheless, regulation/administrative procedures, and government subsidies should be improved in order to attract more investors to the sector to support the government’s target of 30% RE by 2036.

Additionally, the use of stepwise regression has its drawbacks since most of the important information and variables may have been lost because only variables with significant parameters and estimates were included in the model. Hence this model only supports the previous results and is not a standalone analysis. Overall, all of the models were significant with p values <0.001. However, with the individual, stakeholder involvement - government R&D were significant at p values <0.001, except for perception, which was statistically significant at p<0.05 (table 5.20). Additionally, stepwise regression was not performed for the two main independent variables since the results in the previous analysis showed the major contribution of each of the variables to the dependent variable.
Table 5.20 Stepwise Beta Standardize Beta Values and P-Values for Independent Variables Sub-Components

<table>
<thead>
<tr>
<th>Model</th>
<th>Variable</th>
<th>Beta</th>
<th>T-stat</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>(Constant)</td>
<td>2.636</td>
<td>7.267</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>Stakeholder Involvement</td>
<td>0.679</td>
<td>11.798</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>(Constant)</td>
<td>2.370</td>
<td>6.878</td>
<td>0.000</td>
</tr>
<tr>
<td>2</td>
<td>Stakeholder Involvement</td>
<td>0.498</td>
<td>7.597</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>Government R&amp;D</td>
<td>0.318</td>
<td>4.843</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>(Constant)</td>
<td>2.018</td>
<td>5.288</td>
<td>0.000</td>
</tr>
<tr>
<td>3</td>
<td>Stakeholder Involvement</td>
<td>0.475</td>
<td>7.221</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>Government R&amp;D</td>
<td>0.277</td>
<td>4.092</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>Perception</td>
<td>0.124</td>
<td>2.060</td>
<td>0.041</td>
</tr>
</tbody>
</table>

Note: Dependent Variable: sustainable solar energy policy development, standardize beta values

5.3 Presentation of Secondary Data

This section is the major part of this chapter and describes the secondary data analysis and the steps that were taken to prepare the data for further analysis. This section is divided into three sub-sections. The first presents the descriptive statistics of the variables, where the measures of central tendencies, such as mean and standard deviations, are provided. The second part presents the bivariate correlations of the variables, and the third part presents the regression results for the individual variables.

5.3.1 Descriptive Statistics for Variables

This section presents the descriptive statistics for the secondary data variables. The description includes the mean, the standard deviations of the rate of RE development, Feed-in-Tariff, national installed capacity, and RE-installed capacity as the dependent variables. According to Table 5.21, the rate of RE development had a mean of 30.41, Std Dev.= 22.58, the minimum was 71, while the maximum was 60.9. Also, the results showed that the feed-in-tariff had a mean of 6.91, Std Dev=1.17, minimum=5.66, maximum=8.00, while national installed capacity had a mean of 135570.7, Std Dev.=65770.68, the minimum was 51, and the maximum was
Additionally, RE installed capacity had a mean of 12859.3, Std Dev.=5150.11, minimum=6724, and maximum=19542.0.

For the independent variables, the unemployment rate had a mean of 4.31, Std Dev=0.920, minimum=2.9, and maximum=5.9. Additionally, air quality had a mean of 81.25, Std Dev.=5.06, minimum=73.24, maximum=88.42, while CO2 emissions had a mean of 21140.1, Std Dev.=11807.08, minimum=195487.0, and maximum=233211.0. Regarding the economic indicators, GDP had a mean of 8606984, Std Dev. = 816883.2 with minimum = 7579558, and maximum=9808878. Trade had a mean of -9854.3, Std Dev=8704.78, minimum= -30089, and maximum=442, while RE investment cost had a mean of 37716.63, Std Dev.=4119.44, minimum= 0, and maximum= 1331038. This means that for trade the country imported more electricity than it exported; hence, there is an import deficit in the electricity trade between Thailand and neighboring countries such as Laos, Malaysia, Cambodia, and Myanmar (table 5.21).

Table 5.21 Descriptive Statistics for Secondary Data Variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Observations</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>RORED</td>
<td>10</td>
<td>30.406</td>
<td>22.5837</td>
<td>7.1</td>
<td>60.9</td>
</tr>
<tr>
<td>Feed_In_Tariff</td>
<td>10</td>
<td>6.914</td>
<td>1.171819</td>
<td>5.66</td>
<td>8</td>
</tr>
<tr>
<td>Nat_Ins_Cap</td>
<td>10</td>
<td>135570.7</td>
<td>65770.68</td>
<td>51</td>
<td>187640.0</td>
</tr>
<tr>
<td>RE_Ins_Cap</td>
<td>10</td>
<td>12859.3</td>
<td>5150.112</td>
<td>6724</td>
<td>19542.0</td>
</tr>
<tr>
<td>Unemploy_rate</td>
<td>10</td>
<td>4.31</td>
<td>0.9206881</td>
<td>2.9</td>
<td>5.9</td>
</tr>
<tr>
<td>AIRL_QUAL</td>
<td>10</td>
<td>81.25033</td>
<td>5.059614</td>
<td>73.23556</td>
<td>88.42444</td>
</tr>
<tr>
<td>CO2_emiss</td>
<td>10</td>
<td>211404.1</td>
<td>11807.08</td>
<td>195847.0</td>
<td>233211.0</td>
</tr>
<tr>
<td>GDP</td>
<td>10</td>
<td>8606984</td>
<td>816883.2</td>
<td>7579558</td>
<td>9808878</td>
</tr>
<tr>
<td>Trade</td>
<td>10</td>
<td>-9854.3</td>
<td>8704.78</td>
<td>-30089</td>
<td>442</td>
</tr>
<tr>
<td>RE_Invest_Cost</td>
<td>10</td>
<td>37716.63</td>
<td>4119.44</td>
<td>0</td>
<td>131038</td>
</tr>
</tbody>
</table>

5.3.2 Correlation Results for Secondary Data

This section describes the correlations among the variables making up the secondary data to determine their suitability for the multiple regression as a technique for further analysis. The results for the pairwise correlation using STATA Version
13.0 indicated that there were some significant correlations between the dependent variables and the independent variables. Table 5.22 below shows that the rate of renewable development (RORED) and Feed-In-Tariff (-0.9507) were negatively correlated and were statistically significant at p<0.05, while national generation installed capacity (0.4402) was positively correlated with RORED but was insignificant. Additionally, renewable installed capacity (-0.2104) was negatively correlated with RORED, CO2 emissions (0.8296), and RORED are positively correlated and significant at p<0.05. Similarly, air quality and RORED (0.7884) were positively correlated, and unemployment and RORED (-0.0405) were negatively related but this was insignificant, while the relationship between GDP and RORED (0.9479) was statistically significant and positive. Additionally, trade and RORED (-0.81060) were negatively correlated and significant. Renewable investment cost and RORED (0.4223) were positively correlated but insignificant.

Secondly, the correlation between Feed-In-Tariff and national generation installed capacity (-0.2931) were insignificant, feed-in-tariff and renewable installed capacity were positively correlated but insignificant, while CO2 emission and Feed-in-Tariff (-0.7762) were negatively related and statistically significant at p <0.05. Additionally, feed-in-tariff and air quality were negatively correlated (-0.7995) and highly significant at p <0.05, whereas the unemployment rate and Feed-in-Tariff were positive (0.10404) but insignificant. However, GDP and Feed-in-Tariff were negative (-0.9364) and statistically significant at p<0.05, and at the same time, trade and feed-in-tariff (0.7682) and were significant at p<0.05. In addition, RE investment cost and feed-in-tariff were negatively (-0.3451) correlated and exhibited no significant effect (table 5.22).

Thirdly, RE installed capacity and national generation were negatively correlated (-0.0575) but insignificant, while national generation was positively correlated with CO2 emissions (0.3903) and air quality (0.5955). Further, national generation installed capacity was positively correlated with the unemployment rate (0.2441), GDP (0.3741) and renewable investment cost (0.0295), while trade had a negative correlation of -0.3379 (see Table 5.22 below). Fourthly, RE installed capacity had a negative correlation with CO2 emissions (-0.4007), air quality (-0.4702), and GDP (-0.3779), while unemployment rate (0.8135), trade (0.0834) and
renewable investment cost (0.5789) had positive correlations with RE installed capacity. However, unemployment rate and renewable installed capacity had a significant relationship with p <0.05 (table 5.22).

Fifthly, CO2 emissions had a positive and significant relationship with air quality (0.7581), but the emissions were negatively related with the unemployment rate (-0.2954), GDP (-0.2951) and RE investment cost (-0.2748). However, trade was positively correlated with CO2 emissions. CO2 emissions were positively correlated with trade (0.1886) (refer to Table 5.22 below). Sixthly, air quality positive and significant relationship with GDP (0.8289), where p <0.05, and positively related to RE investment cost (0.2196). On the other hand, air quality had a negative and significant relationship with trade (-0.06994) related with a p-value <0.05 (see Table 5.22 below). The seventhly, unemployment rate had a significantly (p<0.05) and positive relationship with GDP (0.9262) and was negatively and significantly related with trade (-0.8650), while RE investment cost was positively related with the unemployment rate (0.3532). Further, GDP and trade were negatively (-0.8774) related and significant, while GDP and RE investment cost were positively correlated (0.4382), and trade and RE investment cost were negatively (-0.1402) related (table 5.22).
**Table 5.22** Correlation Results of Secondary Data Variables

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. RORED</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Feed_In-Tariff</td>
<td>-0.9507*</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Nat_Ins_Cap</td>
<td>0.4402</td>
<td>-0.2931</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. RE_Ins_Cap</td>
<td>-0.2104</td>
<td>0.2346</td>
<td>-0.0575</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. CO2_emiss</td>
<td>0.8296*</td>
<td>-0.7762*</td>
<td>0.3903</td>
<td>-0.4007</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. AIR_QUAL</td>
<td>0.7884*</td>
<td>-0.7995*</td>
<td>0.5955</td>
<td>-0.4702</td>
<td>0.7581*</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Unemploy_rate</td>
<td>-0.0405</td>
<td>0.1404</td>
<td>0.2441</td>
<td>0.8135*</td>
<td>-0.2954</td>
<td>-0.3296</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. GDP</td>
<td>0.9479*</td>
<td>-0.9364*</td>
<td>0.3741</td>
<td>-0.3779</td>
<td>-0.2951</td>
<td>0.8289*</td>
<td>0.9262*</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Trade</td>
<td>-0.81060*</td>
<td>0.7682*</td>
<td>-0.3379</td>
<td>0.0834</td>
<td>0.1886</td>
<td>-0.6994*</td>
<td>-0.8650*</td>
<td>-0.8774*</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>10. RE_Invest_Cost</td>
<td>0.4223</td>
<td>-0.3451</td>
<td>0.0295</td>
<td>0.5789</td>
<td>-0.2748</td>
<td>0.2196</td>
<td>0.3532</td>
<td>0.4382</td>
<td>-0.1402</td>
<td>1</td>
</tr>
</tbody>
</table>

*. Correlation is significant at the 0.001 level (2-tailed), Observations=10
5.3.3 Regression Results for Secondary Data

This section presents the results for the secondary using STATA Version 13.0 to analyze the variables using linear regression models. The section was divided into subheadings by testing the effect of the components of the independent variables on the four levels of the dependent variable: the rate of RE development (RORED), Feed-In-Tariff (Feed_In_Tariff), national generation installed capacity (Nat_Ins_Cap), and RE-installed capacity (RE_Ins_Cap). The section is divided into four main sub-sections.

5.3.3.1 Regression Results for the Sub-Components of the Independent Variables and Rate of RE Development as a Sub-Component of the Dependent Variables

This section presents the regression results for the rate of RE development and the environmental, social, and economic factors variables. Three main regressions were run for this section.

1) Environmental Factors and Rate of RE Development as a Sub-Component of the Dependent Variable

After the correlation tests of the four components of the dependent variable with the sub-components of the independent variables, another herculean task was to test for the statistical effect of the independent variables on the four components of the dependent variable. The results for this model indicated that the F-statistic (0.0080) was statistically significant with p<0.001. The variance explained by the independent variables was 74.81% (R²=0.7481) with an adjusted R² of 0.6761 (67.61%) (table 5.23).

Table 5.23 Regression Results of Environmental factors and Rate of RE Development as a Dependent Variable

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>Number of observations = 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>3433.91711</td>
<td>2</td>
<td>1716.95856</td>
<td>F (2, 7) = 10.39</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Prob &gt; F = 0.0080</td>
</tr>
</tbody>
</table>
Source | SS | df | MS | Number of observations = 10
---|---|---|---|---
Residual | 1156.29413 | 7 | 165.184875 | R-squared = 0.7481
Total | 4590.21124 | 9 | 510.023471 | Adj R-squared = 0.6761

| RORED | Coef. | Std. Err. | t | P>|t| | [95% Conf. Interval] |
|---|---|---|---|---|---|---|
CO2 | 0.0010429 | 0.0005564 | 1.87 | 0.103 | -0.0002727 | 0.0023585 |
AIR_QUAL | 1.674303 | 1.298317 | 1.29 | 0.238 | -1.395729 | 4.744335 |
_cons | -326.1082 | 78.53066 | -4.15 | 0.004 | -511.8036 | -140.4127 |

The coefficients of the two environmental variables suggest that air quality contributed most (1.674) to the total variance of the dependent variable, while CO2 emissions provided 0.001 in explaining the dependent variable. However, neither air quality nor CO2 emissions were statistically significant since the p values were greater than 0.05. The following equation was obtained from the model:

\[ RORED = -326.1082 + 0.0010429CO2 + 1.674303AIR\_QUAL \]

2) Regression Results for the Social Factors and Rate of RE Development as a Dependent Variable

The results showed that the relationship between the unemployment rate and the rate of development is insignificant. This is the case because the more that RE firms expand and increase their production, the more likely are people to be employed in these firms. However, this finding should be treated with caution since it may be due to conditions in the country, which helped in employment generation. The \( R^2 \) was very small and the model explained only 0.16% of the total variance in the dependent variable. However, for this model, the adjusted \( R^2 \) was 12.32%, and hence the adjusted \( R^2 \) was more appropriate to be used in place of the \( R^2 \) in this model (table 5.24).
Table 5.24 Regression Results of Social factor and Rate of RE Development as a Dependent Variable

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>Number of observations = 10</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>F (1, 8) = 0.01</td>
<td></td>
</tr>
<tr>
<td>Model</td>
<td>7.53648221</td>
<td>1</td>
<td>7.53648221</td>
<td>Prob &gt; F = 0.9115</td>
</tr>
<tr>
<td>Residual</td>
<td>-4582.67476</td>
<td>8</td>
<td>572.834345</td>
<td>R-squared = 0.0016</td>
</tr>
<tr>
<td>Total</td>
<td>4590.2124</td>
<td>9</td>
<td>510.023471</td>
<td>Adj R-squared = -0.1232</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Root MSE = 23.934</td>
<td></td>
</tr>
</tbody>
</table>

RORED

<table>
<thead>
<tr>
<th>Coef.</th>
<th>Std. Err.</th>
<th>t</th>
<th>P&gt;t</th>
<th>[95% Conf. Interval]</th>
</tr>
</thead>
<tbody>
<tr>
<td>-0.9939179</td>
<td>8.665242</td>
<td>0.11</td>
<td>0.912</td>
<td>-20.976 -18.98817</td>
</tr>
<tr>
<td>34.68979</td>
<td>38.10638</td>
<td>0.91</td>
<td>0.389</td>
<td>-53.18369 122.5633</td>
</tr>
</tbody>
</table>

The results above indicate a negative relationship between the unemployment rate and the rate of RE development, suggesting that a unit change in the unemployment rate leads to a -0.9939 decrease in the rate of RE development. However, this does not mean that expansion in RE production automatically leads to employment generation or a reduction in unemployment. This is because overall the RE industry is small and many RE companies employ fewer people. The equation for this model is given by:

\[ RORED = 34.68979 -0.9939179 \text{unemploy\_rate} \]

3) Regression Results of Economic Factors and Rate of RE Development as a Dependent Variable.

Three variables made up the economic factors: annual GDP growth, trade, and RE investment cost. The model was statistically significant with the F-statistic having value of 0.0021. The model explained 89.97% of the variance in the dependent variable (table 5.25).
Table 5.25 Regression Results of Economic Factors and Rate of RE Development as a Dependent Variable

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>Number of observations = 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>4129.72263</td>
<td>3</td>
<td>1376.57421</td>
<td>Prob &gt; F = 0.0021</td>
</tr>
<tr>
<td>Residual</td>
<td>460.488612</td>
<td>6</td>
<td>76.748102</td>
<td>R-squared = 0.8997</td>
</tr>
<tr>
<td>Total</td>
<td>4590.21124</td>
<td>9</td>
<td>510.023471</td>
<td>Adj R-squared = 0.8495</td>
</tr>
</tbody>
</table>

Root MSE = 8.7606

**RORED** = -212.485 + 0.0000285GDP + 0.0002248Trade -9.66e-06RE_Invest_Cost

The coefficients of the three variables showed that GDP and trade were positively related to the dependent variable, while RE investment cost was negatively related to the dependent variable. With regards to the statistical significance of the independent variables, only GDP was significant at 0.05. Trade and RE investment cost were not statistically significant, with p values greater than 0.05 (see Table 5.25 above). The model’s equation was obtained as follows:

5.3.3.2 Regression Results for the Sub-Components of the Independent Variables and Feed-In-Tariff as a Sub-Component of the Dependent Variable

This section presents the results for feed-in-tariff and independent variables. This section divides the analysis into three sections. The results are presented as follows:
1) Regression Results for the Environmental Factors and Feed-In-Tariff as a Dependent variable

The results showed that the two environmental variables—CO2 emissions and air quality—were both negatively related to feed-in-tariff. The F-statistic was statistically significant (Prob>F0.0136). The model explained about 70.73% of the total variance in the dependent variable (table 5.26).

**Table 5.26** Regression Results of Environmental factors and Feed-in-tariff As a Dependent Variable

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>Number of observations = 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>8.74069118</td>
<td>2</td>
<td>4.37034559</td>
<td>F (3, 6) = 8.46</td>
</tr>
<tr>
<td>Residual</td>
<td>3.61774882</td>
<td>7</td>
<td>.516821259</td>
<td>Prob &gt; F = 0.0136</td>
</tr>
<tr>
<td>Total</td>
<td>12.35844</td>
<td>9</td>
<td>1.37316</td>
<td>Adj R-squared = 0.6236</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Feed_In_Tariff</th>
<th>Coef.</th>
<th>Std. Err.</th>
<th>t</th>
<th>P&gt;t</th>
<th>[95% Conf. Interval]</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO2_emiss</td>
<td>-.0000397</td>
<td>.0000311</td>
<td>-1.28</td>
<td>0.243</td>
<td>-0.0001133 - 0.0000397</td>
</tr>
<tr>
<td>AIR_QUAL</td>
<td>-.1149682</td>
<td>.0726216</td>
<td>-1.58</td>
<td>0.157</td>
<td>-0.286691 - 0.0567546</td>
</tr>
<tr>
<td>_cons</td>
<td>24.64506</td>
<td>4.392626</td>
<td>5.61</td>
<td>0.001</td>
<td>14.25814 - 35.03197</td>
</tr>
</tbody>
</table>

The results above suggest that the values for each of the two variables were greater than 0.05. The negative relationship between CO2 and the dependent variable indicates that a unit change in CO2 will lead to a decrease in feed-in-tariff and at the same time, a unit change in air quality will lead to a decrease in feed-in-tariff. The equation for the regression line is given by:

\[
\text{Feed\_In\_Tariff} = 24.64506 - 0.0000397 - 0.1149682
\]
2) Regression Results for the Social Factor and Feed-In-Tariff as a Dependent Variable

The results showed that the independent variable only explained variance of 2.2% in the dependent variable; however, the adjusted $R^2$ provided a variance of 10.0% in the dependent variable. Hence it was considered appropriate to use the adjusted $R^2$ for this model (table 5.27).

**Table 5.27** Regression Results of Social Factor and Feed-in-tariff as a Dependent Variable

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>Number of observations = 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>0.272031506</td>
<td>1</td>
<td>0.272031506</td>
<td>F (1, 8) = 0.18</td>
</tr>
<tr>
<td>Residual</td>
<td>12.0864085</td>
<td>8</td>
<td>1.51080106</td>
<td>Prob &gt; F = 0.6825</td>
</tr>
<tr>
<td>Total</td>
<td>12.35844</td>
<td>9</td>
<td>1.37316</td>
<td>R-squared = 0.0220</td>
</tr>
</tbody>
</table>

| Feed_In_Tariff | Coef.  | Std. Err. | t     | P>|t|     | [95% Conf.] | Interval |
|----------------|--------|-----------|-------|--------|------------|-----------|
| Unemploy_rate  | 0.1888321 | 0.4450101 | 0.42  | 0.912  | -0.20976   | 18.98817  |
| _cons          | 6.100134  | 1.956982  | 3.12  | 0.014  | 1.587325   | 10.61294  |

The coefficients showed that the unemployment rate was positively associated with feed-in-tariff, which indicates that any change in the unemployment rate will lead to a 0.1888 increase in feed-in-tariff. However, the p-value for the unemployment rate was insignificant. The regression line equation was obtained from the model as follows:

$$\text{Feed}_\text{In}_\text{Tariff} = 6.100134 + 0.1888321\text{Unemploy}_\text{rate}$$

3) Regression Results for the Economic Factors and Feed-In-Tariff as a Dependent Variable

The regression results showed that the model fit the data with the F-statistic being significant (Prob>F=0.0012) and the model explained 91.64% of the total
variation in the dependent variable (table 5.28). The model residuals were not affected by p-value error term, which indicated that the sample data were non-zero.

**Table 5.28** Regression Results of Economic Factors and Feed-in-tariff as a Dependent Variable

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>Number of observations = 10</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>F(3, 6) = 21.94</td>
</tr>
<tr>
<td>Model</td>
<td>11.3257902</td>
<td>3</td>
<td>3.77526341</td>
<td>Prob &gt; F = 0.0012</td>
</tr>
<tr>
<td>Residual</td>
<td>1.03264977</td>
<td>6</td>
<td>0.172108295</td>
<td>R-squared = 0.9164</td>
</tr>
<tr>
<td>Total</td>
<td>12.35844</td>
<td>9</td>
<td>1.37316</td>
<td>Adj R-squared = 0.8747</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Root MSE= 0.41486</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Feed-In-Tariff</th>
<th>Coef.</th>
<th>Std. Err.</th>
<th>t</th>
<th>P&gt;t</th>
<th>[95% Conf.]</th>
<th>Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP</td>
<td>-2.07e-06</td>
<td>4.72e-07</td>
<td>-4.39</td>
<td>0.005</td>
<td>-3.23e-06 to -1.84e-06</td>
<td>-9.18e-07</td>
</tr>
<tr>
<td>Trade</td>
<td>-0.00063</td>
<td>0.000402</td>
<td>-1.57</td>
<td>0.168</td>
<td>-0.001613 to 0.000353</td>
<td>0.000353</td>
</tr>
<tr>
<td>REInvestCost</td>
<td>6.33e-06</td>
<td>4.54e-06</td>
<td>1.40</td>
<td>0.212</td>
<td>-4.77e-06 to 0.0000174</td>
<td>0.000174</td>
</tr>
<tr>
<td>_cons</td>
<td>23.88726</td>
<td>3.589328</td>
<td>6.66</td>
<td>0.001</td>
<td>15.10449 to 32.67003</td>
<td>32.67003</td>
</tr>
</tbody>
</table>

Additionally, the results showed that only p-value GDP was statistically significant with p values less than 0.001, while trade and RE investment cost were statistically insignificant with p values greater than 0.05. The results indicate that GDP and trade were negatively associated with feed-in-tariff, where an increase in GDP and trade will lead to -.07 and -0.000063 decreases in feed-in-tariff respectively. However, the model showed that the sample data were equal to zero because of the disturbances in RE investment cost and GDP. The equation is given by:

\[
Feed\_In\_Tariff = 23.88726 -2.07e-06GDP-0.000063Trade + 6.33e-06Re\_Invest\_Cost
\]
5.3.3.3 Regression Results for the Sub-Components of the Independent Variables and National Installed Capacity as a Sub-Component of the Dependent Variable

This part of the report provides the regression results for the five components of the independent variable and their effect on national installed capacity. The results are presented in three sub-sections as follows.

1) **Regression Results for the Environmental Factors and National Installed Capacity as a Dependent Variable**

The results showed that the model behavior was due to the error or disturbances in the sample data, which suggests that the predicted value and model values were equal to zero, supporting the null hypothesis (table 5.29). The model also explained 36.34% of the total variance in the dependent variable. The model fit suggests that the F-statistic was not significant (Prob>F=0.2058).

**Table 5.29 Regression Results of Environmental Factors and National Installed Capacity as a Dependent Variable**

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>Number of obs = 10</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>F (2, 7) = 2.00</td>
</tr>
<tr>
<td>Model</td>
<td>1.4149e+10</td>
<td>3</td>
<td>2.1861e+09</td>
<td>Prob &gt; F = 0.2058</td>
</tr>
<tr>
<td>Residual</td>
<td>3.2374e+10</td>
<td>6</td>
<td>5.3956e+09</td>
<td>R-squared = 0.3634</td>
</tr>
<tr>
<td>Total</td>
<td>3.8932e+10</td>
<td>9</td>
<td>4.3258e+09</td>
<td>Adj R-squared = 0.1815</td>
</tr>
</tbody>
</table>

| Nat_Ins_Cap | Coef.   | Std. Err. | t       | P>|t| [95% Conf. Interval] |
|-------------|---------|-----------|---------|---------------------|
| CO2_emiss   | -0.8007245 | 2.575727  | -0.31  | 0.765 -6.891352 5.289903 |
| AIR_QUAL    | 9157.672 | 6010.698  | 1.52   | 0.171 -0.5055.37 23370.71 |
| _cons       | -439216.8 | 363566  | -1.21  | 0.266 -1298914 420480.3 |

Further, the results indicated that air quality contributed most to explaining the dependent variable with 9157.672 coefficients, while CO2 contributed less (-0.8007245) to explaining the dependent variable. There was a positive association between air quality and national installed capacity, where an increase in the former...
will lead to an increase of 9157.672 in national installed capacity. On the other hand, CO2 was negatively associated with the dependent variable, suggesting that a unit change in CO2 will lead to a decrease of \(-0.8007245\) in national installed capacity (see Table 5.29 above). The equation for the regression is given as:

\[
Nat_{\ _\ Ins\ _\ Cap} = -439216.8 - 0.8007245 CO2_{\ _\ emiss} + 9157.672 AIR\ _{\ _\ QUAL}
\]

2) **Regression Results for the Social Factor: Unemployment Rate and National Capacity as a Sub-Component of the Dependent Variable**

The results for this model indicated that the model fit was not significant, with the F-statistic being greater than 0.05. The total variance explained by the model was 6.0\% (table 5.30).

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>Number of observations = 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>2.3199e+09</td>
<td>1</td>
<td>2.3199e+09</td>
<td>Prob &gt; F = 0.4967</td>
</tr>
<tr>
<td>Residual</td>
<td>3.6612e+10</td>
<td>8</td>
<td>4.5765e+09</td>
<td>R-squared = 0.0596</td>
</tr>
<tr>
<td>Total</td>
<td>3.8932e+10</td>
<td>9</td>
<td>4.3258e+09</td>
<td>Adj R-squared = 0.0580</td>
</tr>
</tbody>
</table>

Root MSE = 67650

<table>
<thead>
<tr>
<th>Nat_Ins_Cap</th>
<th>Coef.</th>
<th>Std. Err.</th>
<th>t</th>
<th>P&gt;t</th>
<th>[95% Conf. Interval]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unemploy_rate</td>
<td>17438.17</td>
<td>24492.54</td>
<td>0.71</td>
<td>0.497</td>
<td>-39041.72</td>
</tr>
<tr>
<td>_cons</td>
<td>60412.17</td>
<td>107708.7</td>
<td>0.56</td>
<td>0.590</td>
<td>-187964.5</td>
</tr>
</tbody>
</table>

The results above suggest that the coefficients for unemployment rate were positive and hence the relationship between the two were positive, where an increase in the unemployment rate will lead to a 17438.17 increase in national generation installed capacity. However, the p-value was greater than 0.05. The following equation was obtained:

\[
Nat_{\ _\ Ins\ _\ Cap} = 60412.17 + 17438.17 unemploy\_rate + 3.8932e+10
\]
3) Regression Results for the Economic Factors and National Capacity as a Dependent Variable

The results for the regression indicated that the sample dataset predicted that the value was zero and the evidence of the null hypothesis (refer to source and SS for details in Table 5.31). However, the model explained a total of 16.85% of the variance in the dependent variable. The F-statistic was not significant; however, the adjusted $R^2$ (0.2473) had more explanatory power than the $R^2$ (0.1685) (table 5.31).

Table 5.31 Results of Economic Factors and National Installed Capacity as a Dependent Variable

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>Number of observations = 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>6.5584e+09</td>
<td>3</td>
<td>2.1861e+09</td>
<td>$F (3, 6) = 0.41$</td>
</tr>
<tr>
<td>Residual</td>
<td>3.2374e+10</td>
<td>6</td>
<td>5.3956e+09</td>
<td>Prob &gt; $F = 0.7550$</td>
</tr>
<tr>
<td>Total</td>
<td>3.8932e+10</td>
<td>9</td>
<td>4.3258e+09</td>
<td>$R^2$-squared = 0.1685</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Nat_Ins_Cap</th>
<th>Coef.</th>
<th>Std. Err.</th>
<th>t</th>
<th>P&gt;t</th>
<th>[95% Conf. Interval]</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP</td>
<td>0.0520966</td>
<td>0.0834892</td>
<td>0.62</td>
<td>0.556</td>
<td>-0.1521941 to 0.2563873</td>
</tr>
<tr>
<td>Trade</td>
<td>1.496661</td>
<td>7.112837</td>
<td>0.21</td>
<td>0.840</td>
<td>-15.90783 to 18.90115</td>
</tr>
<tr>
<td>RE_Invest_Cost</td>
<td>-0.3619772</td>
<td>0.8037879</td>
<td>-0.45</td>
<td>0.668</td>
<td>-2.328775 to 1.604821</td>
</tr>
<tr>
<td>_cons</td>
<td>-284422.5</td>
<td>635524.8</td>
<td>-0.45</td>
<td>0.670</td>
<td>-1839496 to 1270651</td>
</tr>
</tbody>
</table>

Additionally, the coefficients of the model suggested that trade (1.4967) contributed the most to the total variance in the dependent variable, followed by GDP (0.0521); and the RE investment cost contributed the least. GDP and trade were positively correlated with national installed capacity, while RE investment cost was negatively related with the dependent variable, which indicates that anytime there is a change in RE investment cost it will lead to a -0.362 unit decrease in national installed capacity. At the same time, a unit increase in GDP will also lead to a 0.0521 increase
in national installed capacity. The p values for the three variables were not significant since the values were greater than 0.05. The regression line is as follows:

\[
Nat\_Gen\_Ins\_Cap= -284422.5 + 0.0520966GDP + 1.496661Trade - 0.3619772RE\_Invest\_Cost + 3.8932e+10
\]

5.3.3.4 Regression Results for the Sub-Components of the Independent Variables and Renewable Installed Capacity as a Dependent Variable

This section presents the results of the regression analysis for the five components of the independent variables and their impact on the dependent variable: RE installed capacity. The results are presented in the following.

1) Regression Results for Environmental and RE Installed Capacity as a Dependent Variable

The results indicated that the model and the residuals were not affected by the error term; however, the probability of the F-statistic is not significant, implying that the independent variables had no any significance regarding the dependent. However, the total variance explained in the dependent variable was 22.57% by the two independent variables (table 5.32).

Table 5.32 Results of Environmental Factors and RE Installed Capacity as a Dependent Variable

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>Number of observations = 10</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F (3, 6) =</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model</td>
<td>53871008.4</td>
<td>2</td>
<td>26935504.2</td>
<td>Prob &gt; F = 0.4085</td>
</tr>
<tr>
<td>Residual</td>
<td>184841920</td>
<td>7</td>
<td>26405988.5</td>
<td>R-squared = 0.2257</td>
</tr>
<tr>
<td>Total</td>
<td>238712928</td>
<td>9</td>
<td>26523658.7</td>
<td>Adj R-squared = 0.0044</td>
</tr>
</tbody>
</table>

Root MSE= 5138.7

| RE_Ins_Cap | Coef. | Std. Err. | t      | P>|t| | [95% Conf.| Interval | |
|------------|-------|-----------|--------|------|-----------------|----------|
| CO2_emiss  | -.0454103 | 2224446 | -0.20 | 0.844 | -.5714082 | .4805877 |
| AIRQUAL    | -398.2514 | 519.0951 | -0.77 | 0.468 | -1625.716 | 829.2134 |
| _cons      | 54817.28  | 31398.24 | 1.75  | 0.124 | -19427.76 | 129062.3 |
With regards to the coefficients of the two variables, the results indicated that both were negatively associated with RE installed capacity. For example, a unit increase in CO2 emission leads to a unit decrease of 0.0454103 in RE installed capacity, while air quality unit change will lead to a decrease of -398.2514 in the dependent variable. The p values for the two variables were greater than 0.05. The following equation was obtained from the model:

\[ RE_{Ins\_Cap} = 54817.28 - 0.045103CO2\_emiss - 398.2514AIR\_QUAL \]

**2) Regression Results for the Social Factor and RE Installed Capacity as a Dependent Variable**

The regression results demonstrated that the model was statistically significant, with the F-statistic having values less than 0.001 (\( \text{Prob}>F=0.0042 \)). Concerning the total variance explained by the independent variable, the unemployment rate was at 66.18% (table 5.33).

**Table 5.33 Regression Results of Social Factors and RE Installed Capacity as a Dependent Variable**

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>Number of observations = 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>157976867</td>
<td>1</td>
<td>157976867</td>
<td>( F \left( 1, \ 8 \right) = 15.65 )</td>
</tr>
<tr>
<td>Residual</td>
<td>80736061.4</td>
<td>8</td>
<td>4.5765e+09</td>
<td>( \text{Prob &gt; F} = 0.0042 )</td>
</tr>
<tr>
<td>Total</td>
<td>238712928</td>
<td>9</td>
<td>10092007.7</td>
<td>( \text{R-squared} = 0.6618 )</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>( \text{Adj R-squared} = 0.6195 )</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>RE_Ins_Cap</th>
<th>Coef.</th>
<th>Std. Err.</th>
<th>t</th>
<th>( P&gt;t )</th>
<th>[95% Conf.]</th>
<th>Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unemploy_rate</td>
<td>4550.54</td>
<td>1150.151</td>
<td>3.96</td>
<td>0.004</td>
<td>1898.286</td>
<td>7202.794</td>
</tr>
<tr>
<td>_cons</td>
<td>-6753.528</td>
<td>5057.92</td>
<td>-1.34</td>
<td>0.219</td>
<td>-18417.11</td>
<td>4910.058</td>
</tr>
</tbody>
</table>

According to the results above, the relationship between the unemployment rate and RE-installed capacity was positive, suggesting that a unit change in the unemployment rate will lead to a 4550.54 increase in RE installed capacity. Further, the predicted value was statistically significant with \( p \) values less than 0.001 (see Table 5.33 above). The regression equation is given as follows:
3) Regression Results for the Economic Factors and RE Installed Capacity as a Dependent Variable

The results for this model showed that the independent variables explained a total variance of 45.12% in the dependent variable. However, the F-statistic was not significant (table 5.34).

Table 5.34 Regression Results of Economic Factors and RE Installed Capacity as a Dependent variable

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>Number of observations = 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>107705397</td>
<td>3</td>
<td>35901799</td>
<td>F (3, 6) = 1.64</td>
</tr>
<tr>
<td>Residual</td>
<td>131007531</td>
<td>6</td>
<td>21834588.5</td>
<td>Prob &gt; F = 0.2763</td>
</tr>
<tr>
<td>Total</td>
<td>238712928</td>
<td>9</td>
<td>26523658.7</td>
<td>R-squared = 0.4512</td>
</tr>
<tr>
<td>RE_Inc_Cap</td>
<td>Coef.</td>
<td></td>
<td>Std. Err.</td>
<td>Adj R-squared = 0.1768</td>
</tr>
<tr>
<td>GDP</td>
<td>-0.0059839</td>
<td></td>
<td>0.0053111</td>
<td>Root MSE= 4672.7</td>
</tr>
<tr>
<td>Trade</td>
<td>0.4660091</td>
<td></td>
<td>0.4524755</td>
<td></td>
</tr>
<tr>
<td>RE_Invest_Cost</td>
<td>-0.0342375</td>
<td></td>
<td>0.0511321</td>
<td></td>
</tr>
<tr>
<td>_cons</td>
<td>61062.07</td>
<td></td>
<td>40428.23</td>
<td></td>
</tr>
</tbody>
</table>

Furthermore, the results suggest that the three variables had a negative relationship with the dependent variable, where a unit change in GDP will lead to a -0.0059839 decrease in RE installed capacity, and a unit change in trade will lead to a -0.4660091 decrease in the dependent variable. Likewise, a change in RE investment cost will lead to a -0.0342375 decrease in RE installed capacity. The model fit of the variables suggested that the p values were greater than 0.05. The following equation was obtained:

\[
RE_{Ins\_Cap} = 61062.07 - 0.0059839GDP - 0.4660091Trade - 0.0342375RE_{Invest\_Cost}
\]
5.4 Testing of the Research Hypotheses

This part of the report presents the testing of the hypotheses of the research. The regression results above demonstrate the effects of the sub-components of the independent variables on policy stability, effective policy measures, feed-in-tariff, the rate of RE development, national generation capacity, and RE-installed capacity jointly as the dependent variable: sustainable RE policy development. First, the section is divided into two parts; the first discusses the survey component of the hypotheses, while the second part discusses the secondary data component. In all five models were developed for testing the hypotheses. There were four (4) main hypotheses and twenty-eight sub-hypotheses. In all 32 hypotheses were tested.

5.4.1 Hypothesis Testing of the Survey Data

The regression results were used to test eight (8) hypotheses developed from the conceptual framework of the study. The regression results from the survey data were used to identify how much the variance in each of the dependent variable sub-components could be explained by the independent variables and their contributions to the models. The results for model 1 and 5 are shown in table 5.35.
<table>
<thead>
<tr>
<th>Model</th>
<th>Independent Vb.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a</td>
<td>Soc_Fact</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Inst_Fact</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Knowledge</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Perception</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Summary of Hypotheses Testing for Survey Data**

<table>
<thead>
<tr>
<th>Dependent Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sus_RE_POD</td>
</tr>
<tr>
<td>Sus_RE_POD</td>
</tr>
<tr>
<td>Sus_RE_POD</td>
</tr>
<tr>
<td>Sus_RE_POD</td>
</tr>
<tr>
<td>Sus_RE_POD</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.169**</td>
<td>0.611***</td>
<td>0.255***</td>
<td>0.374***</td>
<td>0.274***</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Secondary data</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Secondary data</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Secondary data</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Secondary data</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Secondary data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td>5</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Gov_R&amp;D</td>
</tr>
<tr>
<td>Reg_Admin_Proce</td>
</tr>
<tr>
<td>Stak_Invol</td>
</tr>
<tr>
<td>Gov_Sub</td>
</tr>
<tr>
<td>Summary Statistics</td>
</tr>
<tr>
<td>df</td>
</tr>
<tr>
<td>R²</td>
</tr>
<tr>
<td>Adjusted R²</td>
</tr>
<tr>
<td>F stat</td>
</tr>
<tr>
<td>P value</td>
</tr>
</tbody>
</table>

Note: the coefficients in the Cells are standardized beta values
Method: Enter: ***=P<0.001, **=P<0.05
Sus_RE_POD=Sustainable RE policy development
Soc_Fact=Social-Factors; Inst_Fact=Institutional-Factors
5.4.2 Hypothesis Testing for Secondary data

The secondary data resulted in four different regression analyses and the results were used to test the hypotheses of this part of the two datasets. Table 5.43 below shows that six models were significant in all. However, only the hypotheses predicted for the secondary data to be confirmed, while the rest were not supported. Table 5.36, 5.37, 5.38, and 5.39 below depict the results of the regression analysis that were used to test the 24 hypotheses for the secondary data.

Table 5.36 Summary of Hypotheses Testing for Environmental, Economic and Social Factors and Rate of RE Development as DV

<table>
<thead>
<tr>
<th>Model</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model3a</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Independent Vb.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental Factors:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2_emiss</td>
<td>0.0010429</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AIR_QUAL</td>
<td>1.674303</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social Factor</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unemploy_rate</td>
<td></td>
<td></td>
<td>-0.9939179</td>
</tr>
<tr>
<td>2c</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economic Factors:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GDP</td>
<td></td>
<td></td>
<td>0.0000285**</td>
</tr>
<tr>
<td>Trade</td>
<td></td>
<td></td>
<td>0.0002248</td>
</tr>
<tr>
<td>RE_Invest_Cost</td>
<td></td>
<td></td>
<td>-9.66e-06</td>
</tr>
<tr>
<td>Summary Statistics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>df</td>
<td>7</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>R²</td>
<td>0.748</td>
<td>0.0016</td>
<td>0.8997</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.6761</td>
<td>-0.1232</td>
<td>0.8495</td>
</tr>
<tr>
<td>F stat</td>
<td>10.39</td>
<td>0.01</td>
<td>17.94</td>
</tr>
<tr>
<td>P value</td>
<td>&lt;0.001</td>
<td>&gt;0.05</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Note: the coefficients in the Cells are standardized beta values: Method: Enter, **=P<0.05

RO_RED = Rate of RE development
CO2_emiss = CO2 emission
AIR_QUAL = Air quality
Unemploy_rate = Unemployment rate  
GDP                   = Gross Domestic Product  
Trade                 = Trade (Import & export of electricity)  
RE_Invest_Cost = RE investment cost  

**Table 5.37** Summary of Hypotheses Testing for Environmental, Economic and Social Factors and Feed-in-tariff as DV  

<table>
<thead>
<tr>
<th>Model</th>
<th>Independent Vb.</th>
<th>Feed_In_Tariff</th>
<th>Feed_In_Tariff</th>
<th>Feed_In_Tariff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model3b</td>
<td>Environmental Factors:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CO2_emiss</td>
<td>-0.0000397</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>AIR_QUAL</td>
<td>-0.1149682</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model1d</td>
<td>Social Factor</td>
<td></td>
<td>0.1888321</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Unemploy_rate</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model4b</td>
<td>Economic Factors:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>GDP</td>
<td></td>
<td>-2.07006</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Trade</td>
<td></td>
<td>-.000063</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RE_Invest_Cost</td>
<td></td>
<td>6.33006</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Summary Statistics</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>df</td>
<td>6</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.7073</td>
<td>0.0220</td>
<td>0.9164</td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>0.6236</td>
<td>-0.1002</td>
<td>0.8747</td>
</tr>
<tr>
<td>F stat</td>
<td>8.46</td>
<td>0.18</td>
<td>21.94</td>
</tr>
<tr>
<td>P value</td>
<td>&lt;0.05</td>
<td>&gt;0.05</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Note: the coefficients in the Cells are standardized beta values: Method: Enter,  
Feed_In_Tariff   = Feed-In-Tariff  
CO2_emiss       = CO2 emission  
AIR_QUAL      = Air quality  
Unemploy_rate   = Unemployment rate  
GDP              = Gross Domestic Product  
Trade            = Trade (Import & export of electricity)  
RE_Invest_Cost = RE investment cost
Table 5.38 Summary of Hypotheses Testing for Environmental, Economic and Social Factors and NationalInstalled Capacity as DV

<table>
<thead>
<tr>
<th>Model</th>
<th>Independent Vb.</th>
<th>Nat_Ins_Cap</th>
<th>Nat_Ins_Cap</th>
<th>Nat_Ins_Cap</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model3c</td>
<td>Environmental Factors:</td>
<td>CO2_emiss</td>
<td>-0.8007245</td>
<td>AIR_QUAL</td>
</tr>
<tr>
<td></td>
<td>Social Factor</td>
<td>Unemploy_rate</td>
<td>17438.17</td>
<td></td>
</tr>
<tr>
<td>Model1e</td>
<td>Economic Factors:</td>
<td>GDP</td>
<td></td>
<td>Trade</td>
</tr>
<tr>
<td></td>
<td>RE_Invest_Cost</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Summary Statistics

<table>
<thead>
<tr>
<th></th>
<th>df</th>
<th>R^2</th>
<th>Adjusted R^2</th>
<th>F stat</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nat_Ins_Cap</td>
<td>7</td>
<td>0.3634</td>
<td>0.0596</td>
<td>0.1685</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Nat_Ins_Cap</td>
<td>8</td>
<td>0.1815</td>
<td>0.0580</td>
<td>0.2473</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Nat_Ins_Cap</td>
<td>6</td>
<td>2.00</td>
<td>0.51</td>
<td>0.41</td>
<td>&gt;0.05</td>
</tr>
</tbody>
</table>

Note: the coefficients in the Cells are standardized beta values: Method: Enter

Nat_Ins_Cap = National installed capacity
CO2_emiss = CO2 emission
AIR_QUAL = Air quality
Unemploy_rate = Unemployment rate
GDP = Gross Domestic Product
Trade = Trade (Import & export of electricity)
RE_Invest_Cost = RE investment cost

Table 5.39 Summary of Hypotheses Testing for Environmental, Economic and Social Factors and RE Installed Capacity as DV

<table>
<thead>
<tr>
<th>Model</th>
<th>Independent Vb.</th>
<th>RE_Ins_Cap</th>
<th>RE_Ins_Cap</th>
<th>RE_Ins_Cap</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model3d</td>
<td>Environmental Factors:</td>
<td>CO2_emiss</td>
<td>-0.0454103</td>
<td>AIR_QUAL</td>
</tr>
<tr>
<td></td>
<td>Social Factor</td>
<td>Unemploy_rate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model1f</td>
<td>Economic Factors:</td>
<td>GDP</td>
<td></td>
<td>Trade</td>
</tr>
<tr>
<td></td>
<td>RE_Invest_Cost</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model4d</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Model 1

This model used sustainable RE policy development measured by effective policy measures and policy stability as the dependent variable for the survey data. This model resulted in two hypotheses, using the survey from the conceptual framework (H1, and H2).

\[ \text{Sus_RE_POD} = a + 0.169 \text{Soc_Fact} + 0.611 \text{Inst_Fact} \]

The results of the model suggested that social factors and institutional factors were statistically significant, with the two independent variables having a positive effect on sustainable RE policy development: \( F_{2, 162} = 82.033, P < 0.001, R^2 = 0.512 \). The adjusted \( R^2 \) showed that 50.6% of the variance in the dependent variable was explained by the model. Subsequently, the results supported the two hypotheses tested in this model (H1 and H2). Institutional factors had the most significant effect, as a unit increase in the variable increased sustainable RE policy development by 0.611, while the social factors increased the dependent variable by 0.169. The two hypotheses, H1 and H2, were supported.

Model 2 A, B, C, and D

This model tested the effect of the environmental variables—CO2 emissions and air quality—on one of the dependent variables: the rate of RE development, feed-
in-tariff, national generation installed capacity, or RE installed capacity. The hypotheses for this model included H3a, H3b, H3c, H3d, H3e, H3f, H3g, and H3h.

\[ RO_{RED} = a + 0.0010429CO2_{emiss} + 1.674303AIR_{QUAL} \rightarrow Model 2a \]

\[ Feed_{In}\_Tariff = a - 0.0000397CO2_{emiss} - 0.1149682AIR_{QUAL} \rightarrow Model 2b. \]

\[ Nat_{Gen}\_Ins\_Cap = a - 0.8007245CO2_{emiss} + 9157.672AIR_{QUAL} \rightarrow Model 2c \]

\[ RE_{Ins}\_Cap = a - 0.0454103CO2_{emiss} - 398.2514AIR_{QUAL} \rightarrow Model 2d \]

The four sub-models used the secondary data. The first model results showed that the two variables had a positive effect on the dependent variable component but a significant effect on the rate of development: \( F_{2,7} = 10.39, P = 0.001 \). Thus, H3a and H3b were not supported. The model indicated that \( R^2 = 0.748 \) and the adjusted \( R^2 \) explained a total of 67.61% in the rate of RE development. The coefficients of the two variables indicated that air quality contributed strongly to explaining the dependent variable, where a unit increase will increase 1.674303 in the rate of RE development, while air quality will increase the dependent by 0.0010429.

Furthermore, model “2b” tested H3c and H3d, suggested the model of the variables that were negatively and had a statistically significant effect on feed-in-tariff: \( F_{2,6} = 8.46, P < 0.05, R^2 = 0.7073 \). The adjusted \( R^2 \) explained about 62.3% of the total variation of the dependent variable. The results showed that an increase in CO2 emission and air quality will decrease the dependent variable by -0.0000397 and -0.1149682 respectively. Hence H3c and H3d were not supported.

Additionally, this model tested the hypotheses of the two environmental variables—CO2 emissions and air quality—in relation to national generation installed capacity. The hypotheses showed that CO2 emissions had a negative and insignificant effect on the dependent variable, while air quality was positive but insignificant in connection to the dependent variable: \( F_{2,7} = 2.00, P > 0.05, R^2 = 0.3634 \). The results indicated that the adjusted \( R^2 \) explained 18.1% of the variation in the dependent variable. The hypotheses were rejected and thus, the null hypotheses were retained for this sub-model. The weights of the coefficients showed that air quality had the greatest beta value, where an increase in air quality will increase the dependent variable by 9157.672, while an increase in CO2 emissions will decrease the dependent variable by -0.8007245. In this model, H3e and H3f were not supported by the data.
Further, the fourth model indicated that the effect of CO2 emissions and air quality on RE installed capacity showed a positive and negative effect on the dependent variable respectively. Further, the model had a statistically insignificant effect on RE installed capacity: $F_{2, 6} = 1.02$, $P > 0.05$, $R^2 = 0.4085$. The results suggest that an increase in CO2 emission will increase RE installed capacity by 0.0454103, while an increase in air quality will decrease RE installed capacity by -398.2514. The hypotheses (H3g & H3h) for this model were not supported.

**Model 3 A, B, C, D, and E**

The results for these models tested the three components of the social factors: knowledge, the perception of using survey data for sustainable RE policy development, and the unemployment rate on the RE development progress using secondary data. The model tested six hypotheses: H1a, H1b, H1c, H1d, H1e, and H1f. The models are indicated as follows:

- $\text{Sus}_\text{RE}_{-}\text{POD} = a + 0.255\text{Knowledge} + 0.374\text{Perception}$
- $\text{RO}_\text{RED} = a - 0.9939179\text{Unemploy}\_\text{rate}$
- $\text{Feed}_\text{In}\_\text{Tariff} = a + 0.1888321\text{Unemploy}\_\text{rate}$
- $\text{Nat}_\text{Ins}\_\text{Cap} = a + 17438.17\text{Unemploy}\_\text{rate}$
- $\text{RE}_\text{Ins}\_\text{Cap} = a + 4550.54\text{Unemploy}\_\text{rate}$

The results for Model 3a indicate that H1a and H1b were all positive and had a statistically significant effect on sustainable RE policy development: $F_{2, 163} = 26.05$, $P = 0.001$, $R^2 = 0.242$. The model shows that the adjusted $R^2$ explained 23.3% of the variation in sustainable RE policy development. For this model, the two hypotheses were supported (H1a, and H2a), where an increase in perception had a high effect on sustainable RE policy by 0.374, followed by knowledge, which was 0.255. Therefore, this model’s hypotheses H1a and H1b were supported. For the model labeled “3b,” unemployment rate had a negative relationship and an insignificant effect on RE development: $F_{1, 8} = 0.01$, $P > 0.05$, $R^2 = 0.0016$. The model showed that the adjusted $R^2$ explained 12.32% of the variation in the dependent variable. The results of this model showed that the hypothesis was not supported. The unemployment rate unit increase will decrease the rate of RE development by -0.9939179. This means that any time the
unemployment rate goes up, RE development also goes down. For this model, H1c was not supported.

Additionally, model “3c” showed that H1d was positive but had an insignificant effect on Feed-In-Tariff: $F_1, \gamma = 0.18, P>0.05, R^2=0.022$. The results show that the adjusted $R^2$ explained a total of a 10.0% variation in the Feed-In-Tariff. The model depicts that an increase in the unemployment rate will increase Feed-In-Tariff by 0.1888321. In this model, H1d was not supported, indicating that the null hypothesis was retained. Similarly, model “3di.” tested hypothesis H1c.iii. in order to observe the effect of the unemployment rate on national generation installed capacity. The results for this variable showed that the unemployment rate had a positive but insignificant effect on national installed capacity: $F_1, \gamma = 0.51, P>0.05, R^2=0.0596$. The adjusted $R^2$ explained a 5.8% variance in national generation installed capacity, where a unit increase in unemployment will increase national generation installed capacity by 17438.17. Thus, hypothesis H1e was not supported.

Likewise, the model in “3e” tested the effect of the unemployment rate on RE installed capacity and the hypothesis for H1f was positive and had a significant effect on RE installed capacity: $F_1, \gamma = 15.65, P=0.001, R^2=0.6618$. The adjusted $R^2$ explained the variance in the dependent variable by 62%. The independent variable contributed 4550.54 to explaining the changes in the dependent variable. This shows that an increase in the unemployment rate will increase RE installed capacity by 4550.54. Hence, in this model hypothesis, H1f was supported and there was a positive and significant effect of the unemployment rate on RE installed capacity.

**Model 4, A, B, and C**

This model had three sub-models labeled a, b, and c. The model tested the effect of economic factors on the four indicator variables of the dependent variable: the rate of RE development, feed-in-tariff, national generation installed capacity, and RE-installed capacity. The hypotheses included H4a, H4b, H4c, H4d, H4e, H4f, H4g, H4h, H4i, H4j, H4k, and H4l. The models were as follows:

$$RO\_RED=a+0.0000285GDP+0.0002248\text{Trade}-9.66e-06\text{RE\_Invest\_Cost} \rightarrow \text{Model 4a}$$
Feed_In_Tariff=a-2.07006GDP-0.000063Trade+
6.33006RE_Invest_Cost--------> Model 4b

Nat_Ins_Cap=a+0.0520966GDP+1.49661Trade-
0.3619772RE_Invest_Cost--------> Model 4c

RE_Ins_Cap=a-0.0059839GDP-0.4660091Trade-
0.0342375RE_Invest_Cost-------->Model 4d

The results for the four models demonstrated that the first model’s two variables (GDP and trade) were positive, while RE investment cost had a negative effect on the rate of development. The model had a statistically significant effect on the dependent variable: $F_{3, 6}=17.94$, $P=0.001$, $R^2=0.8997$. The adjusted $R^2$ explained about 84.95% of the variation in the dependent variable. The statistical weight of the three variables on the dependent variable showed that GDP contributed the highest, where an increase in trade will increase the rate of development by 0.0002248, followed by GDP at 0.0002285. Further, an RE investment cost increase will decrease the dependent variable by $-9.66e-06$. The hypothesis for this model, H4a, was supported, while H4b and H4c were not supported. Additionally, the model in “b” tested the effect of GDP, trade, and RE investment cost on feed-in-tariff, and the results showed that two of the variables had a negative effect, while RE investment cost had a positive effect on the dependent variable. This model had a statistically-significant effect on feed-in-tariff: $F_{3, 6}=21.94$, $P=0.001$, $R^2=0.9164$. The adjusted $R^2$ explained 97.47% of the variance in feed-in-tariff. The results showed that an increase in RE investment cost will increase the dependent variable by 6.33006, followed by trade -0.000063 decreases in Feed-in-Tariff, and GDP, -2.07006 decreases in feed-in-tariff. Hypotheses H4d, H4e, and H4f were not supported.

Moreover, the third model tested the impact of GDP, trade, and RE investment cost on nation installed capacity, and the results showed that $F_{3, 6}=0.41$, $P>0.05$, $R^2=0.1685$, while the total variance in the dependent explained 24.73% using the adjusted $R^2$. The contributions of the three variables indicated that trade contributed the most at 1.49661 to national installed capacity, followed by GDP=0.0520966, and RE investment cost had a negative correlation and contributed -0.3619772 to the dependent variable. This shows that a unit increases in GDP and trade will increase national installed capacity by 0.0520966 and 1.496661, while an increase in RE
investment cost will decrease national installed capacity by -0.3619772. In this model hypotheses H4g, H4h, and H4i were not supported. Further, the fourth model in “d” tested the effect of the three variables on RE installed capacity as the dependent variable. The hypotheses for this sub-model included H4k, H4l, and H4m. The results showed that all three variables had a negative and insignificant effect on RE installed capacity: $F_{3,6}=1.64$, $P>0.05$, $R^2=0.4512$. The adjusted $R^2$ explained 17.68% of the variance in the dependent variable. The results showed that GDP contributed the least to explaining the variation, with $-0.0059839$, followed by RE investment cost at $-0.0342375$, and trade contributing the most with $-0.4660091$. The implication is that a unit increases in GDP, trade, and RE investment cost will decrease RE investment cost by $-0.0059839$, $-0.4660091$, and $-0.0342375$ respectively. Therefore, hypotheses H4j, H4k, and H4l were not supported.

**Model 5**

This model tested the effect of the institutional factors—government R&D framework, regulation/administrative procedures, stakeholder involvement, and government subsidies—on the dependent variable, sustainable RE policy development. The hypotheses for this model included H2a, H2b, H2c, and H2d.

$$\text{Sus_RE_POD}=a+0.274 \text{GovR&D\_FrameWor} + 0.115 \text{Reg\_Admin\_Proce} + 0.446 \text{Stak\_Invol} - 0.042 \text{Gov\_Sub}$$

The results for this model indicated that two of the hypotheses, H2a and H2c, had a positive and significant effect on sustainable RE policy development, while H2b and H2d had a positive and negative impact but an insignificant one on the dependent variable. However, the overall model effect had a statistically significant effect on the dependent variable: $F_{4,160}=46.748$, $P=0.001$, $R^2= 0.539$. The adjusted $R^2$ explained about 52.8% of the variation in the dependent variable. Stakeholder involvement had the most significant effect on sustainable RE policy development, showing that a unit increase will increase sustainable RE policy development by 0.446, followed by government R&D framework at 0.274, and regulation/administrative procedures at 0.115. However, government subsidies had the least effect on the dependent variable, where a unit increase in the variable will decrease the dependent variable by -0.042. For this model, H2a and H2c were supported, while H2b and H2d were not supported.
5.4.3 Summary of Hypotheses Tested

Table 5.40 displays a summary of the main hypotheses and sub-hypotheses formulated and tested in this study. The results show that eight (8) of the hypotheses predicted were fully supported to have a positive and significant impact on the dependent variable(s), ten hypotheses were partially supported with no significant effect, while fourteen hypotheses were rejected with the data from the secondary sources for environmental and economic variables making the null hypotheses to be true. However, the data from survey data for the social and institutional factor hypotheses were supported, with hypotheses (H2d) and H2b having been partially predicted. In all, 32 hypotheses were tested for the two data sets.

<table>
<thead>
<tr>
<th>Hypotheses</th>
<th>Independent Variables</th>
<th>Dependent Variables</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
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<td>H1b</td>
<td>Perception</td>
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<tr>
<td>H1d</td>
<td>Unemployment rate</td>
<td>Feed-in-tariff</td>
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<tr>
<td>H1e</td>
<td>Unemployment rate</td>
<td>National Installed capacity</td>
<td>+</td>
</tr>
<tr>
<td>H1f</td>
<td>Unemployment rate</td>
<td>RE installed capacity</td>
<td>+</td>
</tr>
<tr>
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<td>Institutional factors</td>
<td>Sustainable RE policy development</td>
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</tr>
<tr>
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<td>Gov.R&amp;D Framework</td>
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<td>+</td>
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<td>CO2 emission</td>
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<td>National installed capacity</td>
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<td>H3f</td>
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<td>H3i</td>
<td>Air quality</td>
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<td>Hypotheses</td>
<td>Independent Variables</td>
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<tr>
<td>H4a</td>
<td>GDP</td>
<td>Rate of RE development</td>
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<td>H4b</td>
<td>Trade</td>
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<td>RE investment cost</td>
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<td>GDP</td>
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<td>H4j</td>
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<td>GDP</td>
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<tr>
<td>H4l</td>
<td>Trade</td>
<td>RE installed capacity</td>
<td>+</td>
</tr>
<tr>
<td>H4m</td>
<td>RE investment cost</td>
<td>RE installed capacity</td>
<td>+</td>
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</tbody>
</table>

Note: ‘+’= positive and significant effect, ‘+ns’= positive and not significant effect, ‘-ns’= negative and not significant effect, ***=P<0.001, **=P<0.05

5.5 Revised Models of Sustainable RE Policy Development

Based on the empirical findings from the survey data and the secondary data on the determinants’ and their sub-components’ effect on the RE policy development and its related sub-indicators, as the dependent variable(s), the following conceptual frameworks in Figure 5.3 to Figure 5.7 were developed to reflect the results of the study and for ease of understanding.

![Figure 5.3 Revised Model for Social and Institutional Variables Effect on Sustainable RE policy Development](image)

Note: ***=P<0.001, **=P<0.05

R^2= 0.512 for social factors, institutional factors and sustainable RE policy development as a single DV
Figure 5.4 Revised Model for Social Variables Effect on Sustainable RE policy Development and its Sub-Components

Note: ***=P<0.001.

R²= 0.242 for knowledge, perception and sustainable RE policy development as a single DV
R²=0.661 for unemployment rate and RE installed capacity as the DV
R²=0.0016 for unemployment rate and rate of RE deployment as the DV
R²=0.0220 for unemployment rate and feed-in-tariff as the DV
R²=0.0596 for unemployment rate and national installed capacity as the DV
Figure 5.5 Revised Model for Institutional Variables Effect on Sustainable RE policy Development

Note: ***=P<0.001, R²= 0.539 for R&D, reg/admin procedures, stakeholder involvement, government subsidies and sustainable RE policy development as a single DV

Figure 5.6 Revised Model for Effect of the Environmental Factors on the Sustainable RE Policy Development Sub-Components

Note: R²=0.661 for CO2, air quality index and rate of RE deployment as the DV
R²=0.7073 for CO2 emission, air quality index and feed-in-tariff as the DV
R²=0.3634 for CO2 emission, air quality index and national installed capacity as the DV
R²=0.4085 for CO2 emission, air quality index and RE-installed capacity as the DV

Figure 5.7 Revised Model for the Effect of the Social Variables on the Sustainable RE Policy Development Sub-Components

Note: **=P<0.05

R²=0.8997 for GDP (0.0000285**), trade (0.0002248), RE investment cost (-9.66e-06) rate and rate of RE deployment as the DV
R²=0.9164 for GDP (-2.07006) trade (-0.000063), RE investment cost (6.33006) and feed-in-tariff as the DV
R²=0.1685 GDP (0.0520966), trade (1.496661), RE investment cost (-0.3619772) and national installed capacity as the DV
R²=0.4512 GDP (-0.0059839), trade (-0.4660091), RE investment cost (-0.0342375) and RE-installed capacity as the DV
5.6 Discussion of Findings

The discussions of the quantitative data results were informed by the unique findings on the conceptual framing of the study. The purpose of the quantitative data sets was to investigate the economic, environmental, institutional, and social factors that support the growth of policies for RE in Thailand. Based on these objectives, the empirical findings have provided very interesting findings; while some propositions were supported by the data, others were rejected. The four main hypotheses, H1, H2, H3, and H4, suggested that social factors, institutional factors, environmental factors, and economic factors had different effects on the dependent variable: sustainable RE policy development and its sub-components. On the other hand, H1 and H2 were supported; H3 and H4 had partial confirmation of their sub-components’ effects on the dependent variables’ four indicators, with GDP and unemployment rate having a positive and significant effect on the rate of development and RE-installed capacity respectively. These findings deviate from and at the same time confirm previous studies and theoretical perspectives on the policymaking process (Sabatier & Mazmanian, 1983).

First, the literature suggests that social factors such as knowledge and perception have a positive and significant effect on sustainable RE policy development and this was strongly supported (coefficients, 0.255 and 0.374, p<0.001). These results suggest that the more people have knowledge of the perceived benefits of RE use and the absence of the fear of harm and health hazards from the use of RE, the more likely they will support and contribute to the success of RE policies in the sector (Assefa & Frostell, 2007; Evans, Strezov, & Evans, 2009). These findings imply that social acceptance will support policy dialogue among stakeholders to ensure sustainability of the government targets (30%) on RE by 2036 (Achawangkul, 2017; Keyuraphan et al., 2012; Square & Tongsopit, 2016; Tongsopit & Greacen, 2013; Wattana, 2014).

Furthermore, the unemployment rate and its effect on the indicators of the dependent variable indicated that the variable has a positive and significant effect only on RE investment cost, while feed-in-tariff and national installed capacity had a positive relationship, with the rate of RE development having a negative relationship
with the unemployment rate. The implication is that when there is expansion in RE investment, the unemployment rate also goes up. Why this is the case requires more investigation since the assumption is that when the government invests in RE it will create more jobs for people (IRENA, 2016). Hence, it is expected that the relationship should be an inverse one, where investments in RE will decrease the unemployment rate. Additionally, the feed-in-tariff suggests that price stabilization through fixed mechanisms will also increase the unemployment rate because the government will have to commit to maintaining the price levels for the RE sector, which has few returns on employment creation. The evidence suggests that the RE sector employs fewer people and therefore its contribution to employment distribution is perhaps insignificant in reducing the unemployment rate in Thailand. However, with increased investments in the sector, the prospects of a large workforce in RE are crucial to further reducing the unemployment rate. Nonetheless, Thailand’s informal sector, which is very viable, has proven to employ most of the population and that could explain why the unemployment rate may be reduced further (Emodi & Ebele, 2016).

It must be noted that awareness creation of the use of RE has been actively pursued by companies such as Home Pro in order to ensure that residential users acquire their own solar rooftop panels, which the government says is a priority area. For example, the residential solar rooftop policy provides 12 baht as the price of electricity generated from households over ground solar farms, as indicated earlier. Similarly, previous studies have made significant findings, suggesting that some communities may accept the location of RE plants due to the perceived fear that it may affect their agricultural land and health (Tongsopit & Greacen, 2013; Wattana, 2014). Therefore, it is important that any policy on RE development in the country should focus on educating the public on the benefits of RE use in the long run.

Second, the findings indicate that institutional factors either support or limited RE policy sustainability (Emodi & Ebele, 2016). For instance, the results for government investment in R&D were highly significant (coefficient=0.274, p<0.001), indicating strong support for RE policy development. This finding is consistent with the literature, which indicates that investment in research and development activities in the RE sector has the potential to discover more technologies to improve and increase the share of RE to the national grid capacity (Musango & Brent, 2010;
similarly, one of the significant findings which confirm previous studies indicates that stakeholder involvement is an important variable that supports the sustainability drive of RE policies globally (IEA, 2012). the results from this study provide a strong foundation and empirical evidence for stakeholder consultation, and participation is needed in achieving policy goals. the variable contributed the most (coefficient=0.446, P<0.001) to explaining the variance in the institutional framework.

further, the institutional variables such as regulation/administrative procedures and government subsidies to RE investments did not have a significant effect on the dependent variable. however, regulation/administrative procedures had a positive relationship but an insignificant effect on sustainable RE policy development. this finding deviates from previous studies, such as those of the EWEA (2010) (EWEA, 2010 cited in Luthi & Prassler, 2011; Luthi & Prassler, 2011), which found that administrative bottlenecks had a significant impact on RE policy implementation. while this finding may be due to the sample population, the interpretation should be treated with caution because not having statistical significance may not rule out the importance of administrative and regulatory procedures in policy sustainability and effectiveness (Achawangkul, 2017; Al-Sarihi et al., 2015; Beck & Martinot, 2004; Buckley & Nicholas, 2017; Emodi & Ebele, 2016; Menanteau, Finon, & Lamy, 2003).

the finding implies that the regulation and administrative procedures do have some relationship with the policy process, which when neglected may affect the desired outcomes regarding policy goals. this was supported with evidence from the qualitative interviews conducted in the previous chapter, which suggested that regulatory and undue delays of the administrative process leading to bureaucratic red tape and corrupt practices by civil servants in regulatory agencies, as well as distribution companies (Byrnes et al., 2013; Luthra et al., 2015; Nasirov et al., 2015; Sheikh et al., 2016. similarly, local partners and authorities are taking advantage of the fragile situation of the unclear administrative procedures to extort potential investors and sometimes demand high profit sharing with RE firms before permits are issued to them.
Another interesting finding in this study was government subsidies to investors, which are said to be effective in achieving higher returns in the RE sector in different countries such as China and Germany (Fouquet & Johansson, 2005; Tongsopit & Greacen, 2013). However, the findings in this study did not support previous evidence because the results suggested a negative relationship and an insignificant effect on the dependent variable. While this finding confirms the interviews in chapter four, that the government is not providing subsidies in terms of tax incentives, tax holidays, or financial credit to investors, the annual reports and documents by the Ministry of Energy (2015) suggest that the government is providing financial incentives through stable prices under the Adder rate policy, which gives investors an added fee in addition to the electricity base fee for 7 and 10 years for different REs and solar energy. At the same time, the current policy on feed-in-tariff indicates that the government is providing incentives through fixed pricing policy, which makes the payback period of investors’ funds 20 and 25 years for biomass, biogas, wind, MSW, and other RE types and solar energy (Tongsopit & Greacen, 2013).

Third, the environmental variables—CO2 emissions and air quality—demonstrated that the findings were not consistent with previous evidence; that is, CO2 emissions and air quality have a positive and significant effect on the four components of sustainable RE policy development: the rate of RE development, feed-in-tariff, national installed capacity, and RE-installed capacity. However, the findings support the notion that the rate of RE development is positively related to CO2 emissions reduction and air quality improvement (Al-Sarihi et al., 2015; Denholm, 2004; Konkel, 2013). However, these two variables were not statistically significant in relation to the rate of RE development, yet the evidence suggests that the more people that use renewable electricity and energy, the less harmful it is to the environment (Al-Sarihi et al., 2015). However, in the case of the Feed-in-Tariff, the two variables were inversely related, indicating that the amount of CO2 emissions reduction and the air quality in a given year decreases the pricing of RE power. This is interesting because, when the government targets RE changes from 25% to 30% by 2030, the pricing mechanism also changes. For example, in 2013 the government changed the Adder rate to a Feed-in-Tariff, where the prices of RE power were
reduced from 8 baht to 6.5 baht for solar and further decreased to 4.5 baht or lower in recent times.

Similarly, air quality and RE-installed capacity were seen to have a positive relationship, yet it had no significant effect; thus, it is plausible that other factors might explain why RE installed capacity has increased at its current development in the country. Further, for national installed capacity, the relationship was negative, indicating that increases in CO2 emissions and air quality decrease the grid capacity. This finding confirms that a concentration on the use of RE will improve the air quality but at the same time, heavy reliance on only RE production may pose challenges to the national grid capacity and energy security and the self-efficiency of the country (Tongsopit & Greacen, 2013).

Fifth, the findings on the economic factors suggest that except for GDP, which had a significant and positive effect on the rate of RE development, trade, and RE investment cost, factors were positive but had no significant effect on the four indicators of the dependent variable. For example, the GDP growth rate provided strong support for the rate of RE development in the Thai experience (coefficient= 0.0000285, p<0.05, R²=.08997). Regarding the other variables, trade and RE investment cost, the former had a positive relationship with the rate of development, but the effect was an insignificant one. The implication is that trade in electricity in terms of imports and exports does have a link with RE development, but it is not statistically significant; however, it does contribute to the rate of RE development. This means that any time the country raises its imports of electricity, the RE sector also expands to make up the energy deficit of the country; thus, in the long run, the country may export more electricity to neighboring countries as the RE sector expands each year. This is consistent with previous findings, which indicated that the more a country invests in RE sources, the less it will depend on electricity imports for domestic and industry consumption (Tongsopit & Greacen, 2013).

Furthermore, the findings also support the idea that national and RE-installed capacities may be influenced by RE investment costs; however, the effect of investments on these two variables was not seen to be statistically significant, yet it is important that the government provides a reliable source of funding for RE types in order to achieve 30% RE use by 2036 under the new AEDP policy. Thailand’s target
for REs is expected to increase to 19000 megawatts, which is almost half of the country’s energy needs, which is 40,000 megawatts (Tongsopit & Greacen, 2013). With increased investments in the RE sector, more manufacturing industries could produce their own energy while households can generate more electrical power from solar panels under the Solar PV Rooftop Residential policy and sell the excess power to the government at 12 baht. Again, further expansions of and investments in other RE types such as biomass, biogas, wind, small hydro, and MSW will further improve the national grid capacity in the long run.

5.7 Chapter Summary

This chapter outlined the data analysis of the survey and secondary datasets. Specifically, the chapter provided descriptive statistics and the multiple regression results for the variables of the study. Additionally, the chapter tested the hypotheses of the study, where some of the hypotheses were supported empirically. The findings demonstrated that social and institutional factors play a more critical role in determining sustainable RE policies. Of critical importance in this role is the contribution of stakeholder involvement, which is lacking in the current policymaking dialogue and collaboration. The secondary data had missing values, which could have affected the findings due to the small sample size of the secondary sources.
CHAPTER 6

SUMMARY, CONCLUSION AND RECOMMENDATIONS

6.1 Introduction

The main purpose of the study was to develop, test, and investigate the determinants of sustainable RE (RE) policy development based on three policymaking models: incremental, and the system theory, combined with the sustainability framework. Institutional factors, adopted from the system theory, were added to the sustainability framework in order to test whether they had a significant role in policy and development sustainability. The data for the study were collected from three different sources: in-depth interviews with 23 participants, and 166 survey questionnaires from 10 RE companies located in both Ayutthaya and Bangkok. The third data source was secondary sources, which included the rate of RE development, the feed-in-tariff, national installed capacity, RE installed capacity, CO2 emissions, air quality, the unemployment rate, GDP, trade, and RE investment costs as sub-components of environmental, economic, and social factors.

The results of the study revealed that RE policy development involved policy instability, unclear policy targets, corrupt practices, and bureaucratic red tape and that these have the potential to affect the country’s target for 30% renewables by 2036. These findings were confirmed in the qualitative interviews and supported by the institutional survey data. Social factors were seen to be key antecedents of RE policy sustainability. The critical finding in this study was that corrupt practices on the part of local partners or local governments have the potential to affect the country’s drive towards 19000 megawatts of RE to the total grid capacity of 40000 megawatts. Although the environmental and economic factors were positive in terms of the indicators of the dependent variable, the effect was insignificant. This section summarizes the major findings of the study. The study sought to answer the four objectives of the study. First, the study investigated the determinants of sustainable
RE (RE) policy development in the Thai context; secondly it examines the environmental and socio-economic factors that influence sustainable RE policy development in Thailand; and last but perhaps most importantly, the study attempted to find out how institutional factors and policy and objectives impact sustainable RE policy development (figure 6.1). This section outlines the summary of the major findings, the conclusion, and recommendations of the study.

![Policy Incrementalism](image)

**Figure 6.1 Policy Incrementalism**

**Source:** International Finance Corporation, World Bank Group, 2018, adapted by the author.

### 6.2 Summary of Major Findings

The major findings of the study can be categorized into five main subsections. This is particularly important for capturing the main objectives and arriving at a clear appreciation of the various data sources used in this study. The following are the major findings of the study:

#### 6.2.1 Determinant of Sustainable Renewable Policy Development in Thailand

The results indicated that there are several determinants of RE policy suitability and the findings suggest that the current policy on RE has been challenged
with uncertainties in terms of policy stability and the effectiveness of the policy measures. The following were the findings as revealed by the qualitative interviews:

- The RE policy framework was divided into three phases. The first phase was the Adder rate, where SPP and VSPP were paid on top of the electricity base fee for 7 years and 10 years for biomass, biogas, MSW, wind, other RE types and solar energy. According to the results, solar energy was paid higher than other sources of RE, at 8 baht, while the other REs attracted between 3 baht and 2.50 baht. The second phase was the feed-in-tariff, where a fixed price is set for all RE types, except that some REs attract higher prices than others. For example, solar energy is fixed at 5.66 baht for 25 years while others, such as MSW, wind, biomass, biogas, and small hydro plants, attract less, with a 20-year payback period. The third phase comprised cooperative systems where RE investors partner with locals to construct and set up an RE plant. In this form of cooperation, the investor is supposed to provide the initial cost of investment; however, the local partners have the right to share profits with investors. This phenomenon is creating bottlenecks in the process of acquiring permits and power purchase agreements, with regulatory and distribution agencies on the side of the government.

- The findings indicate that the current RE policy goals lack clarity and consistency. One applicant explained in depth that the government should be committed to its formulated and implemented policy, not changing it without considering the burden it would have on private producers.

- In terms of policy success, goal clarity to a large extent has had an impact on the sustainability of RE energy policies. The results of the interviews revealed that, though the goals and intentions are clear, the definitions and directions, or roadmap of RE policies in general, lead to a different goal. Therefore, the main finding is that the policy goals and objectives lack coordination and direction and may affect the target of 30% by 2036.

- Weak laws and regulations governing the operations of the RE sector and inconsistency mainly due to changes in the institutional rules that occur more frequently
• Bureaucratic red tape, bottlenecks, and undefined administrative procedures. The queuing time is shrouded in secrecy and the distribution agencies processes are not cost-effective for plant owners to obtain their PPAs.

• Transparency in transacting business and obtaining contracts defines the sustainability of RE policy development, yet there is a lack of openness and fair play in transacting business with regulatory agencies. There is no openness in the process of obtaining operating licenses or the bidding process.

• Related to transparency issues are corrupt practices by local governments and local partners, who demand bribes and high profit sharing with RE power plant owners before issuing permits.

• Information is key to successful RE policy outcomes; however, the results indicated that there is information symmetry between RE investors and government agencies.

• The bidding process has created dissatisfaction among MSW, biomass, wind, biogas, and small hydropower owners. For example, garbage, biomass, and biogas are using bidding and drawing. The owners of biogas and biomass plants are offered lower electricity prices compared to those that own solar cells. However, the production cost for these RE types is expensive because of the high wages paid to employees of this type. As a result, most biogas producers have gone bankrupt. Previously there was a free waste but now the waste is sold to them at higher prices.

6.2.2 Environmental Factors Influence on RE Policy Development

The environment variables depict positive relationships among sustainable RE policy development indicators. The major finding in this study on the environmental factors was that there is a relatively small impact. For example, air quality and CO2 emissions were seen to have a significant effect on feed-in-tariff, the rate of RE development, and national installed and RE-installed capacity. This finding suggests that probably the small nature of the RE power has little significance on the
improvement of policy development because the country relies heavily on natural gas for its energy use, at about 67% of total energy use. Another reason probably is because of the locations of the RE power plants and their service locations, which are outside the heavy energy consumption zone such as Bangkok. For instance, most of the RE firms are found in the southern part of Thailand.

### 6.2.3 Social Factors Influence on RE Policy Development

The findings on this variable indicate strong support for policy development in the RE sector. By strengthening social acceptance by educating the public, the perceived benefits of RE use will provide knowledge of the health implications of some types of energy sources, such as fossil fuels and move towards using clean energy from solar panels, especially utilizing government policy on solar rooftops for the residential user. The perception of people regarding the fear of possible health hazards was not supported since the respondents were aware of the positive benefits of switching to RE. However, there is low public awareness regarding the setting up of RE power plants in some communities. The interviews revealed some clashes between plant owners and communities where there have been protests instigated by local politicians. Therefore, the government should make efforts to strengthen public hearings and make the clearance process more transparent and effective by including diverse views in the siting of RE power plants in local communities. Additionally, the unemployment rate is likely to reduce further as the RE sector expands. There should be strengthening of RE investments by providing more credit facilities and incentives to attract more investors into the sector. However, the present restrictions on the number of permits being issued to investors may affect the expansion drive of the RE sector.

### 6.2.4 Economic Factors Influence on Sustainable RE Policy Development

The systems theory holds that the policy arena is made up of different systems, for example, the economic system, with important variables turning the objectives and goals of the transformation process into the desired outcomes. Although the economic factors were seen to be insignificant, the importance they play in the RE sector cannot
be ignored, since it has a large societal impact. The summary of each of the three indicators follows:

6.2.4.1 Annual Gross Domestic Product (GDP)

The findings suggest that the GDP growth rate has an impact on the rate of RE development and that efforts should be made in developing and producing more RE power since more production will reduce the country’s reliance on imports of electricity from neighboring countries and increasing the RE production would increase the GDP of the country. However, the GDP contributes little to the feed-in-tariff while national and RE-installed capacities tend to decrease with increases in the GDP. However, the present study was unable to explain why this is the case and further studies are needed in this respect.

6.2.4.2 Trade

Trade was seen to have little influence on the rate of RE development, the feed-in-tariff, national installed capacity, or RE installed capacity. However, the relationship between the rate of RE development and national capacity was positive. Further, there is a trade deficit in electricity as imports exceed exports. Therefore, strengthening the policies on RE will help to increase electricity production through solar, wind, biomass, biogas, MSW, and small hydropower sources.

6.2.4.3 RE Investment Cost

The investment costs of RE are associated with sustainable RE policy indicators, such as the feed-in-tariff, the rate of RE development, the national installed capacity, and RE-installed capacity. There was fundamental evidence from the findings that if government assistance to the RE sector increases it will help the country achieve its target of 30% of RE consumption by 2036. Therefore, efforts should be made toward supporting firms to produce more RE through tax incentives, tax holidays, and credit facilities through long-term payback periods in order to attract more investors into the sector.

From the military government of General Surayud Chulanont to the government of the People Power party and the democrat party, the three phases of Adder rate implementation marked a golden phase for investors, but it was a burden for the governments. As one deputy governor explained, “it is like a learning process. There is no way the government can foresee that the technology would decrease the
cost as it did.” Since 2007, the financial incentives for RE have decreased constantly, while the intentions, plans, and goals of the governments have increased consistently as well. From the first implemented “RE Development Plan,” or REDP, to the AEDP 2012, then adjusted in 2015 to align with the UN’s SDG, the various Thai governments have made an effort to support and improve the deployment of RE. The Adder was a burden for the government because the Adder is not fixed and is always added on top of the electricity buying price without considering that the price of electricity and electricity buying is increasing all the time, while the technology helps to decrease the costs of RE at an increasing rate. This is why the fixed rate of the Feed-in-Tariffs helps mark a meeting point, or grid parity, where the financial incentives meet the electricity-buying price (figure 6.2).

![GRID PARITY](image)

**Figure 6.2 Incremental Financial Incentives Policy Model Representing Adder Policy, FiT Policy, and Bidding Policy, for Solar Energy, with The Assumption of Electricity Price Increasing at an Average of 3.25% and Grid Parity**

**Source:** Ministry of Energy, Adder, Feed-in Tariffs, and Bidding Policy, 2007-2017, adapted by the author.

### 6.2.4.4 Stakeholder Involvement

Stakeholder involvement is viewed as a significant antecedent of sustainable RE policy development and is effective in achieving the stated goals and objectives of the AEDP. Both the interviews and the surveys confirmed that stakeholder consultation and dialogue are a key determinant of successful outcomes on policy goals. However, the interviews revealed that there is little or an absence of
stakeholder participation and collaboration in policy development and implementation. More awareness should be spread among all stakeholders for the public’s interest and benefit. The findings suggest that all stakeholders should have symmetry of information, and the public should have equal access to all announcements, rules, procedures, and hearings in order to benefit the system as a whole. The key players, such as small power producers, independent power producers, community leaders, and local governments should take part in the implementation and policy dialogue process.

6.2.4.5 Government Research and Development Framework

The findings suggest that there are few completed or relevant government investments in R&D, yet the contribution of R&D is significant in fostering the sustainability of government policies on RE in the country. The few R&D activities being pursued are not well targeted to ensure that the learning and development centers enhance the technology used in the RE sector, as in Germany and other global contenders. Therefore, efforts in increasing and targeting training and development activities in order to ensure that the country builds its own RE technology will ensure that initial costs incurred for installing technologies will be cheaper. For example, the solar cells are currently imported from Germany and China as stated earlier.

6.2.4.6 Regulation and Administrative Procedures

Regulations and administrative procedures need to be strengthened and made effective in serving customers, especially investors. The findings imply that regulations and administrative procedures are characterized by bureaucratic bottlenecks and red tape. Additionally, the queuing time is undefined and sometimes people take advantage of the situation by “jumping the queue.” For example, the findings indicate that local governments and local partners deliberately delay the issuance of RE permits with the hope of requesting high-profit sharing from investors. Additionally, corrupt practices exist in the issuance of operating permits and undue delays, leading to payments of cash to some middlemen or corrupt officials.

6.2.4.7 Government subsidies

There is an absence of government direct subsidies through financial engineering to investors. However, government agencies are of the view that the incentives provided by the government in the form of pricing, especially under adder
rate in the past and the current FIT, are sufficient to attract investors to the production of RE. The findings revealed that the government has placed limitations on RE permits in order to streamline and reduce the number of power plants. There are no tax incentives for producers under the current policy, except for the fixed number of years between 20-25 years for the payback period that investors are provided depending on the type of RE. It is important to note that the government’s target of 30% RE consumption by 2036 is realistic without incentivizing producers. Most of the investors that produce real RE power are likely to fold up because of the low prices being offered; for instance, solar power is between 4.50-3.0 baht while biomass, biogas, and others attract about 2.50 baht for the FIT policy, unlike the adder rate, which pays 8.0 baht for solar power and 2.50 baht for waste and others, exclusive of the electricity base price.

6.3 Conclusion

The general conclusion is that few of the hypotheses related to the three models of policymaking were supported by the secondary data, while most of the survey hypotheses were supported. Though preventing corruption through good governance is a key feature in all of the NESDPs, the analysis of the qualitative interviews results showed that the present policy measures under the Adder, Feed-in-Tariff, and even bidding, are challenged by corrupt practices, lack of stakeholder consultation, high costs of investment, political interference, unclear policy goals, and high profit sharing between local government partners and private investors. The qualitative interviews were supportive of the survey data by finding that clear administrative policy goals, transparency, strong regulations, and laws support policy sustainability. The model in total had a causal effect on sustainable RE policy development. The role of institutional factors was accepted with a strong effect of the total scale, while the performance of the subscales varied. Among the strong institutional factors for sustainable RE policy development was stakeholder involvement. Additionally, the two social factors, knowledge and perception, were relevant as well. Moreover, the secondary data hypotheses on the variables—environmental, economic, and social, were not strongly supported statistically.
Based on the findings, this study concludes that the government’s target of 30% (about 20000 megawatts) RE is likely not to be achieved due to the several institutional challenges facing the RE sector. For example, the report of corrupt practices, the undefined queuing process, high-profit sharing, low information flow, red tape, and bureaucratic bottlenecks with the administrative procedures may impede further expansion of the RE sector in the country.

Moreover, the gaming of the system in which RE firms bid for setting up RE power plants yet fail to produce success and add to the RE installed capacity is a major limitation affecting the bidding and drawing process. For example, the firms bid with much lower prices with the view that the weak regulatory system will only give them a period of three years to begin production, and when they are unable to set up a plant, they are required to produce a letter of guarantee. Most firms that bid for lower prices are termed “ghost investors” because they do not produce any renewable power during the lifespan of the permit. While these firms benefit by increasing their stock prices, the actual producers are given low prices which affect their production costs. Therefore, the government should strengthen the regulations and laws in order to force firms to comply with the terms of their permits and contracts.

While the survey data results indicated that social and institutional factors have a strong and significant causal effect on the development of sustainable RE policies, the secondary data tested the effect of the environment, and the economic indicators on the dependent variable using ten-year baseline data from 2007-2016. The results suggested that there was no significant effect of these two variables on the dependent variable: sustainable RE policy development. The study recommends that the “best practice” approach in policy development via through wider stakeholder consultation and awareness creation in order to enable the government to achieve 40 percent renewables by 2036. Hence, the government of Thailand should equally involve key players, such as small power producers, independent power producers, community leaders, and local governments, in the implementation and policy dialogue process.
6.4 Policy Alternatives and Recommendations

Based on the summary of the major findings above, this study makes key contributions on policy alternatives and recommendations. The major findings suggest that bad governance is a big obstacle in achieving the targets in the RE sector. As with other sectors, good governance is the key to solving the institutional problems in this sector. The UN defines good governance as having the following 8 characteristics: consensus oriented, accountable, transparent, responsive, equitable and inclusive, effective and efficient, follow the rule of law, and participatory (UNESCAP 2014). (See Figure 6.3)

Figure 6.3 UNESCAP 8 Characteristics of Good Governance

Source: UNESCAP United Nations Economic and Social for Asia and the Pacific, Good Governance, 2014, adapted by the author.

UNESCAP defines being consensus-oriented as “the best interest of the whole community and how this can be achieved. It also requires a broad and long-term perspective on what is needed for sustainable human development and how to achieve the goals of such development. This can only result from an understanding of the historical, cultural and social contexts of a given society or community” (UNESCAP 2009). This is also true in the RE sector of Thailand. The findings suggest that the various governments of Thailand see the importance of supporting RE and have consistently updated their plans to align them with the global trend of becoming an
energy-secure nation. However, the findings also suggest that the process of accomplishing these plans is not leading to much success.

UNESCAP defines participatory as “a key cornerstone of good governance. Participation could be either direct or through legitimate intermediate institutions or representatives. It is important to point out that representative democracy does not necessarily mean that the concerns of the most vulnerable in society would be taken into consideration in decision making. Participation needs to be informed and organized. This means freedom of association and expression on the one hand and an organized civil society on the other hand” (UNESCAP 2009). The findings suggest that there should be more of stakeholder involvement, from bottom to top. Asymmetry of information was one of the key problems found in the findings. All of the announcements, procedures, and regulations should be open to the public, not only to a few. This would give an opportunity to incoming producers that are interested in pursuing RE production. The findings suggest that the government should provide information to the public and provide more public hearings, hence involving all stakeholders in pursuing the whole public’s interest and public benefit. Many cases in the findings suggest personal interest and benefits, omitting “unimportant” or “small” stakeholders.

UNESCAP defines rule of law as “fair legal frameworks” (UNESCAP 2009). The findings suggest that the government has a gap in terms of such frameworks. Many firms bid at cheaper prices and fail to produce RE in the long run. The findings suggest that there should be harsher punishment for “ghost investors.” There also should be stricter laws and regulations to ensure that firms that breach contractual agreements are sanctioned in order to deter others. Moreover, there is no proper assessment of firms before licenses are issued. One applicant from the qualitative interview, who claimed that he was a victim of corruption, suggested that the government should provide a digital copy to ensure safety from corruption from administrators pulling documents out, as mentioned in the interview results. Once this is done, there will be proof of corruption and punishment can follow.

UNESCAP defines effectiveness and efficiency as, “processes and institutions produce results that meet the needs of society while making the best use of resources at their disposal. The concept of efficiency in the context of good governance also
covers the sustainable use of natural resources and the protection of the environment” (UNESCAP 2009). The findings suggest that conflicts of interest are an obstacle to effectiveness and efficiency. The private producers view that EGAT should play a lesser role in producing and buying energy. The interviewees suggested that the plan of peer-to-peer and a smart grid in the future will reduce the role of EGAT and help with effectiveness and efficiency of the overall process.

UNESCAP defines equity and inclusiveness as “ensuring that all its members feel that they have a stake in it and do not feel excluded from the mainstream of society. This requires all groups, but particularly the most vulnerable, have opportunities to improve or maintain their well-being” (UNESCAP 2009). According to the findings, many small producers complain about the lack of equitableness, and the smaller producers feel that they are “second-class producers, either because they do not have access to the information that the big and connected producers have, or because they do not lobby and plan to engage in corruption.”

UNESCAP defines responsiveness as institutions and processes serving “all stakeholders within a reasonable timeframe” (UNESCAP 2009). The findings suggest that the Thai governments have not served some of the producers in a timely matter or have not served them at all. The small producer that claimed he was a victim of corruption when the administrator pulled his files out explained that he tried to dispute it, but there was no agency or anyone to whom he could report the matter, or that would listen to him. This is also true when the claimed inconsistency of policy, where few big producers had to absorb the cost when EGAT requested to them to pull out their excess plants. They could not report this because there was no appropriate agency or procedure for them to do so.

UNESCAP defines transparency as, “decisions are taken, and their enforcement are done in a manner that follows rules and regulations. It also means that information is freely available and directly accessible to those who will be affected by such decisions and their enforcement. It also means that enough information is provided and that it is provided in easily understandable forms and media” (UNESCAP 2009). According to the various corruption cases indicated in the findings, the government needs to find tools to monitor the actions of administrators. Only in this way can transparency be measured and achieved.
UNESCAP defines accountability as “a key requirement of good governance. Not only governmental institutions but also the private sector and civil society organizations must be accountable to the public and to their institutional stakeholders. Who is accountable to whom varies depending on whether decisions or actions taken are internal or external to an organization or institution. In general, an organization or an institution is accountable to those who will be affected by its decisions or actions. Accountability cannot be enforced without transparency and the rule of law” (UNESCAP 2009). As defined by UNESCAP, accountability cannot be enforced without transparency or the rule of law. With stricter laws governing the administrative body, punishing wrongdoers, and a measure of and monitoring transparency, the findings suggest that accountability, which is one of the key problems revealed in the interviews, can be achieved.

Beyond good governance, the findings suggest greater support from the government in terms of solar, biomass, biogas, and waste products. One interviewee explained that the government first supported solar power a lot due to the fact that it did not cause loud noise, as does wind-producing energy, and does not produce a bad smell as with biomass, biogas, and waste. The only obstacle for solar power is that it can only be produced during the day. The only way to fix this issue is through storage or the use of a battery. Currently, the cost of the storage is very high. This is why many solar producers request that the government support greater storage or batteries, perhaps until technology reaches a functional level as it did with solar panels. The biomass, biogas, and waste producers, on the other hand, suggest that the government should provide more subsidies to them. This would be beneficial because doing so would help manage and eliminate waste, which has been steadily costly for the government.

6.4.1 Policy and Practical Implications

The findings have practical implications for policymakers and implementers. Based on the summary of the study, a number of observations have been made to guide policy. First, policymakers should assess RE investors through strong joint ventures or partnerships since the initial investment is huge for single companies. New prospective investors should partner with experienced firms that have a track
record of RE production in order to ensure that the government is shortchanged when they bid for lower prices and when stock prices go up without adding a kilowatt of electricity to the national grid. Second, in terms of policy measures, between the Adder rate and Feed-in-Tariff, according to the participants, the former is better because of its price stability, which has a longer payback period. However, whether Adder or FIT it depends on fuel type. The Adder policy has a basic retail price, plus the Adder rate given to producers. Therefore, according to this policy, investors gain through the electricity retail and also, an added price any time they add to the grid. Under the Adder policy, the basic electricity price during the day or peak period is 3.20 baht to 3.70 + Adder 50 satang, which in the sum provided price of 4.20 baht for biogas. However, during the night the basic electricity price is 2.20 baht plus 50 satang, and that provides 2.70, baht which is almost half the price during the day and is not profitable. Hence, biogas companies produced gas during the day because of the Adder rate between 2007-2013. However, with the Feed-in-Tariff, it is able to adjust to get equal and become a breakeven price whether day or night in terms of electricity prices. All the same, firms that are using biogas prefer to produce during the day than the night. The FIT policy appears to be accepted by the biogas investors; however, they are of the view that the pricing mechanism should be reviewed to favor some fuel types.

Third, pricing is a serious challenge in the RE sector. The solar energy firms are more comfortable with the pricing formulas but other REs are struggling to meet their production costs while retaining some profit. The government should provide incentives for investors to commit to the RE sector via high prices. Lowering the prices of RE will only attract few investors. This is because only a small profit may be realized. Fourth, the government should restrict licenses in order to prevent licenses from being issued to firms that sell them to other companies after receiving the permits, while nothing of the RE unit is added to the grid. For example, in Germany, the government provides quotas for the bidding process while in Thailand this is not so. For instance, in Germany, the government provides scores for existing power plant owners and the score will determine how well a producer is performing before adding or lowering the price. Additionally, newcomers have not given new investors more incentives than previous power producers had received. However, the priority is given
to stable firms in RE. In some cases, individuals establish companies to bid for the price and use that to increase their stock prices and sell the license they obtain to other potential investors. About 70% of companies sell their franchise to other firms.

This is the case because the government is giving out licenses to newcomers that are not interested in developing RE but only in increasing their stocks without investment in renewables. The only penalty is a guarantee letter after three years. The punishment is that these companies usually bid for cheaper prices and in the bids without producing the RE. Additionally, the government should encourage other RE types than solar since the investment costs for solar energy is high and most often companies are only interested in collecting permits and bidding for lower prices to increase their stock price. The bottom line is that solar power alone cannot support the government to 30% of RE by 2030 or 2036. The RE mix should focus on the three RE energy sources in Thailand, i.e. biomass, biogas, and waste.

Fifth, the R&D initiative by the government is ineffective. For example, the respondents were of the opinion that the government employs specialists through a state monopoly. For example, the government selects people that they already know, and there is no portfolio to measure them, which leads specialist to perform fewer experiments. The expertise of these specialists is below expectations and this affects the growth of the sector. In addition, the RE technology is affected by the lack of skills and expertise, which is needed to keep plants longer and stable. Many companies have shut down because of the low technical capacity of the specialists provided by the government to ensure that the plants operate optimally. Most of the companies end up closing or going bankrupt. However, some companies are able to obtain the technical know-how themselves. Additionally, they have to search for the optimal machines and technology themselves. With this situation, investors or entrepreneurs obtain two forms of cost: the cost incurred in using government expertise and the cost incurred for looking for quality knowledge compared with other countries. The current state of policy sustainability implies that Thailand is learning in terms of policy; however, the quality of the policy is insufficient and inefficient.

Sixth, although the RE sector has a potential for growth, it can only be a supplementary power source for the country and may not be able to replace natural gas sources of energy. Electricity consumption is high in the country and the RE
sector cannot provide that, as indicated earlier. Further, wind energy has been reported to be inefficient for RE investment. The agricultural potentials of RE appear to be more tangible than other forms of RE. This is because Thailand is an agricultural country and the best sources of RE according to some respondents are biomass and biogas since the country generates a lot of waste from the food sector and agricultural produce. However, these two areas are not adequately supported because the government provides lower prices for them. The government supports sugar plant production, which produces high pollution, especially in terms of the residuals of the sugar, which releases molasses. However, the investment in biogas is very expensive. The raw material for biogas waste, for example, used to be 200 baht per ton; however, with time, the price has increased to 1,200 baht. However, due to the high investment costs in the waste sector, most investors are not willing to venture into biogas plants.

6.4.2 Theoretical Implications

This study adds a modest contribution to the literature on policymaking and implementation in the area of RE. The literature on RE and policy sustainability is often focused on financial risks and environmental and economic impacts. As a result, this approach has often led to policy reforms that barely understand or appreciate the contribution of institutional and social factors to the creation of public policy, especially at the macro-level of energy policymaking. However, focusing only on the macro level makes one view the micro level role and ensuring that the energy sub-sector policies may not be effective to trigger the development of alternative sources and lesser-known energy in the country (Assefa & Frostell, 2007; Evans, Strezov, & Evans, 2009; IRENA, 2016). The view is that policies that tend to use a macro-level framework probably will lead to a trickle-down effect on other sectors of the energy policy arena, thereby ensuring that the energy targets are achieved in the long run (Achawangkul, 2017; Keyuraphan et al., 2012; Sabatier & Mazmanian, 1983; Square & Tongsopit, 2016; Tongsopit & Greacen, 2013; Wattana, 2014).

Therefore, this emphasis has created a gap in theory about what kinds of factors support RE policy sustainability. Hence, this study bridged this gap by contributing to the sustainability framework of renewable policy through the social and institutional factors that play a critical role in theorizing about policy
implementation using a multi-theoretical framework in order to understand how these factors, together with others, support policy outcomes. The conceptual framework provides an opportunity to explain the factors that determine the sustainability of policy outcomes on RE supply and energy reforms in general. The study developed a framework using key independent variables—economic, environmental, institutional, and social factors—using the system, incremental, and rational decision-making models that impact sustainable RE policy development. Even though some of the variables have been conceptualized to affect sustainable RE policy development and implementation, few studies have provided empirical multi-theoretical perspectives to explain their effects. Therefore, the findings in this study are beneficial and have implications for explaining sustainable RE policy development, as two of the variables, social and institutional factors, have provided strong predictive evidence as antecedents have been established.

Furthermore, the study has expanded the discussion on policy sustainability in the RE sector, explaining how gaming, corrupt practices, stakeholder consultations, and goal clarity and a strong regulatory framework can support policy targets by 2036 in achieving 30% (190000) megawatts of energy from clean sources. Similarly, government subsidies, R&D, perceptions, knowledge, and administrative procedures have implications in driving policy goals in the long run. This is of importance to the literature because it aims at theorizing the factors that strongly predict policy sustainability and effective outcomes regarding RE policy targets. Generally, the findings support the determinants of policy implementation and sustainability from the developing-country perspective, especially within the South-East Asia region³.

### 6.4.3 Limitations of the Study and Research Implications

This study, although it was an empirical one, has limitations. First, an attempt has been made to establish the reliability and validity of the study constructs, especially regarding the survey data; however, the study could not perform a reliability or validity test for the secondary data used in the analysis. At the same time, the qualitative interviews relied on the self-reported data from the respondents.

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³ Bangladesh, Bhutan, Democratic People's Republic of Korea, India, Indonesia, Maldives, Myanmar, Nepal, Sri Lanka, Thailand, Timor-Leste.  
⁴ http://www.searo.who.int/countries/env/
which could be verifiable, although several documents were reviewed to support and validate the interviews. Secondly, the inherent limitations of the survey data were that they relied on information obtained from the perspectives of RE plant owners, which could have been biased since they tended to rate themselves either high or low on some of the scales. However, this is not to say that these respondents were not knowledgeable or that they did not have the correct information on sustainable RE policy development.

Another major limitation of this study was the use of secondary data sources, especially in terms of the small nature of the sample, which was only 10 years. This small sample size limited the use of time series analysis, which requires a large enough sample to run various forecasting models for the data. Additionally, the data violated the key assumptions of time series analysis, which is the non-stationary of the data. Similarly, the secondary data were aggregate data that suggested that vital time series were missing in the yearly data, unlike quarterly data time series. Overall, the regression technique was used in the analysis of the secondary data, which was inappropriate for this type of data, which is affected by time.

Future research could use a larger sample size to test the effect of environmental and economic variables on sustainable RE policy development using a time series model to forecast the future energy supply of each of the six types of RE: solar, wind, small hydropower, biomass, and biogas and MSW. Further studies should conduct a longitudinal analysis of the institutional indicators in order to observe the different effects of policy sustainability on RE targets. Moreover, future research should focus on the implementation outcomes of specific policy interventions, such as the effect of the Adder and Feed-in-Tariff rate on RE grid capacity to include the share of RE consumption for the residential and industrial sectors. This will enable the government to concentrate on policies that will allow huge energy users to supplement their energy needs through RE. With regards to the conceptual model, future studies should focus on other theoretical models that will test the effect of sustainable policy development on the environmental, economic, social, and institutional impacts among plant owners and regulatory agencies.
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APPENDICES
Appendix A:

Interview Guide for Social and Political Factors
Interview Guide for Social and Political Factors

Informed Consent Form

Dear Participants,

These questions are designed to investigate the historical development of the Renewable Energy sector in Thailand and how the government and key stakeholders have played their roles to ensure that the country becomes a sustainable energy country by 2036 to mark the deadline for the sustainable development goals (SDGs) objective globally. The survey is also interested in gathering information from both public and private institutions that have been set the government to support the deployment of alternative sources of energy. The aim of this survey is to understand the general attitudes and behaviour created by the government agencies and private actors in the renewable energy sector to enhance its sustainability in the long-term.

Section A: Background Information

Name of organization: _________________________________________________
Position/Rank________________________________________________________
Size of organization___________________________________________________
Number of Employees in the organization_______________________________
Generating Capacity___________________________________________________
Type of producer/User_________________________________________________
Age_______________________________Sex______________________________
Role in the Renewable Energy Sector__________________________________

Section A: Social Factors:

i. Social Acceptance

1. Name of the Community Where Renewable Energy plant sited:

____________________________________________________________________

2. Geographic location (use GPS): ________________________________

3. Who owns the land where the Renewable energy plants are installed?

____________________________________________________________________
4. Distance from the renewable energy generation plant to the community (use GPS and/or provide an estimate in meters): ___________________________________

5. Type of renewable energy source: __________________________

6. Renewable energy plant generating size (kW): _______________

7. Specify Generating VOLTS: _______________

8. Specify Generating Cycles: _______________

9. Describe the type of structure used for the plant:
_____________________________________________________________________

ii. Employment Creation and Grid Capacity

Characteristics of Renewable Energy Distribution Grid Capacity

10. Voltage of operation: _____________________________________________

11. Installed K.V.A.: ________________________________________________

13. Number of distribution transformers: _____________

System Operation


15. Origin of the RE: _____________________

16. How are operation expenses handled?
_____________________________________________________________________

17. Who transports or transmit the Renewable energy fuel?
_____________________________________________________________________

18. Total Renewable energy fuel use (liters per month) __________________

19. Who pays for the fuel? _________________________

20. How many times has the generator/s failed in the past year? _________

21. Where do you obtain spare parts? __________________

22. Specify yearly maintenance costs (THB/year):
_____________________________________________________________________

23. Number of plant operators? _______________

24. How much are the operators paid per month? _________________________

25. Who pays their salaries?
_____________________________________________________________________

26. How many jobs have been created for the last 5-10 years of the plant operations?
i. Share of household income spent on fuel and electricity
   27. What is the average amount of income from households is used for fuels and electricity for the past 10-15 years?
   28. How much per unit of electricity is consumed by households in the four seasons, fall, spring, winter and summer?

Section C: Political factors
i. Political Stability:

1. What is the political environment effect on renewable energy deployment in Thailand?
2. Does political stability affect the country’s energy security?
3. What is the level of commitment of the government of Thailand in achieving the renewable energy target of 30% by 2036?
4. Are there any strategies put in place ensure that the country achieves green energy use in the next 10 years?
5. How many policies have been developed since 1990 to support renewable energy technology use in Thailand?
6. What are main sources of renewables in Thailand? and which of them constitute the largest in terms of grid capacity?

ii. Policy issues/regulations/administrative procedures
7. Have there been any significant policy change in the last 15 years on renewable energy deployment in the country?
8. What are the main policy goals of past and present policy instruments?
9. Does the current policy on renewable energy support rapid deployment and investment in renewable technology and R&D?
10. How do independent power producers obtain financing for investments in renewable energy technologies in the country?
11. What is the strategic focus of the Alternative Energy Development Plan (AEDP) for the next five years?
12. What are the key components of the policy in your view would help prospective investors into the renewable energy sector?
13. Does the current feed-In-tariffs support small energy producers? And how does this benefit the state and the private power producers?
14. Is the renewable energy policy process transparent? And how do investors secure permits before they begin their operations?
15. What kind of monitoring system is in place to check corruption and administrative bottleneck among central agencies responsible for issuing permits and licenses?
16. Do you have guidelines for an environmental assessment for investors and communities before sitting plants?
17. How do investors procure land for plant installation?
18. Does the policy formulation include wider consultation of all stakeholders in the energy sector?
19. What are the challenges facing the implementation of the Renewable energy policies in the country?
20. In what ways would these challenges be addressed?
21. Are there any prospects of renewable energy sustainability in Thailand?

iii. **Government R&D Framework**
22. Does the government have a framework for research and development on renewable technology?
23. How effective are these technologies in increasing grid capacity in the last 5 years?
24. Are funds readily available for investors who want to set up laboratories and other equipment to manufacture renewable energy technologies?
25. How much budgetary allocation has been earmarked for R&D activities in the last 10 years?

iv. **Stakeholder involvement**

*Role of stakeholder. These questions are designed to assess the role of stakeholders in the development of renewable energy industries and/or projects.*

26. Do stakeholders involve in decision-making in the renewable energy sector especially at the policy formulation stage?
27. Do you think stakeholder input is important to affect policy change and direction?
28. Can you identify with any individual/s that you would consider to be a champion/s for renewable energy?
29. How many key stakeholders for renewable energy can you think of in the country?
Select one:

1-3
4-6
7-9
10 or more
For the stakeholder that you consider the most influential, indicate by 'clicking' on the appropriate point on the scale the extent to which you agree/disagree that he/she displays the following characteristics.

30. Shows personal commitment
Select one:

1
2
3
4
5
6
7

31. Has a great reputation in the eyes of the community?
Select one:

1
2
3
4
5
6
7

32. Expresses confidence in renewable energy technology
Select one:

1
2
3
4
5
6
7
33. Secures top-level support required
Select one:
1
2
3
4
5
6
7

34. Backs people involved
Select one:
1
2
3
4
5
6
7

35. Does not give up when others say it can't be done
Select one:
1
2
3
4
5
6
7
36. Understands the relationship between business and renewable energy development
Select one:
1
2
3
4
5
6
7

37. Gets the right people involved in projects
Select one:
1
2
3
4
5
6
7

38. Shows persistence in overcoming obstacles
Select one:
1
2
3
4
5
6
7
39. Continues involvement until the project is implemented
Select one:

1  
2  
3  
4  
5  
6  
7

40. Shows optimism about the success of a project
Select one:

1  
2  
3  
4  
5  
6  
7
Appendix B :
Survey Questionnaires
Survey Questionnaires

Informed Consent Form

Dear Respondents,

These questions are designed to investigate the historical development of the Renewable Energy sector in Thailand and how the government and key stakeholders have played their roles to ensure that the country becomes a sustainable energy country by 2036 to mark the deadline for the sustainable development goals (SDGs) objective globally. The survey is also interested in gathering information from both public and private institutions that have been set the government to support the deployment of alternative sources of energy. The aim of this survey is to understand the general attitudes and behaviour created by the government agencies and private actors in the renewable energy sector to enhance its sustainability in the long-term.

Section A: Background Information

Name of organization: ________________________________

Position/Rank__________________________________________

Size of organization____________________________________

Number of Employees in the organization__________________

Generating Capacity____________________________________

Type of producer/User____________________________________

Age____________________Sex_______________________________

Role in the Renewable Energy Sector________________________

Section B: Social Factors

Please 'click' on the appropriate point of the scale to indicate the extent to which you agree/ disagree with the statements as they relate to the government ministry/ministries responsible for energy. If you neither agree nor disagree with the statement, leave the slider at 'neutral.'
ii. **Knowledge of Renewable Energy Deployment in Thailand**

1. How would you rate your knowledge of renewable energy use in the country?
   - Among the worst
   - Below Average
   - Average
   - Above Average
   - Among the best
   - Don't know

2. How would you rate your level of knowledge on renewable energy policies in Thailand?
   - Among the worst
   - Below Average
   - Average
   - Above Average
   - Among the best
   - Don't know

3. How would you rate your knowledge on the sources of renewable energy in Thailand?
   - Among the worst
   - Below Average
   - Average
   - Above Average
   - Among the best
   - Don't know

4. How would you rate your knowledge of renewable energy technologies use in Thailand?
   - Among the worst
   - Below Average
   - Average
   - Above Average
   - Among the best
   - Don't know

5. How would you rate your overall knowledge of renewable energy efficiency compared with traditional sources of energy in the country?
   - Among the worst
   - Below Average
   - Average
   - Above Average
   - Among the best
   - Don't know
iii. Perception

6. Renewable energy sources pose less health-related risks in communities where renewable energy technologies are sited?
   0 Strongly Disagree
   1
   2
   3
   4
   5 Neutral
   6
   7
   8
   9
   10 Strongly Agree

7. The use of renewable energy technologies is considered safer for human habitation compared with fossils fuels.
   0 Strongly Disagree
   1
   2
   3
   4
   5 Neutral
   6
   7
   8
   9
   10 Strongly Agree

8. How you rate the public perception of trust of the use of renewable energy technology deployment in the country?
   0 Strongly Disagree
   1
   2
   3
   4
   5 Neutral
   6
   7
   8
   9
   10 Strongly Agree
9. How you rate your knowledge about specific issues and technologies in the renewable energy sector
   0 Strongly Disagree
   1
   2
   3
   4
   5 Neutral
   6
   7
   8
   9
   10 Strongly Agree

10. The public perception of the uncertainty of renewable energy technology use does not affect sustainable renewable deployment?
    0 Strongly Disagree
    1
    2
    3
    4
    5 Neutral
    6
    7
    8
    9
    10 Strongly Agree

11. Is the public afraid of the effect of the use of renewable energy technology on their health and safety issues?
    0 Strongly Disagree
    1
    2
    3
    4
    5 Neutral
    6
    7
    8
    9
    10 Strongly Agree
12. The public perceived that the use of renewable energy technologies produces noise and visual impairment?
0 Strongly Disagree
1
2
3
4
5 Neutral
6
7
8
9
10 Strongly Agree

13. Do the public has fears on the consequences of the perceived risk of renewable energy technology on the siting of plants on their farmlands?
0 Strongly Disagree
1
2
3
4
5 Neutral
6
7
8
9
10 Strongly Agree

14. The public has the fear that the use of hydro-thermal as renewable energy sources may compete with their irrigation agricultural activities:
0 Strongly Disagree
1
2
3
4
5 Neutral
6
7
8
9
10 Strongly Agree
15. How would you rate the public perceived fear of danger on the siting of renewable energy technologies on their food crops?
   0 Strongly Disagree
   1
   2
   3
   4
   5 Neutral
   6
   7
   8
   9
   10 Strongly Agree

16. How would you rate the public support for leasehold lands for building renewable energy technologies in communities that these plants are sited?
   0 Strongly Disagree
   1
   2
   3
   4
   5 Neutral
   6
   7
   8
   9
   10 Strongly Agree

Section C: Political Factors
Please 'click' on the appropriate point of the scale to indicate the extent to which you agree/ disagree with the statements as candid as possible. You indicate ‘no impact’ you disagree with the statement or if you neither agree nor disagree with the statement, leave the slider at ‘neutral’ in other questions.

i. Political Stability/Policy Issues
17. To what extent does political stability impacts on renewable energy deployment in Thailand?
   of the country:
   No impact
   LittleExtent
   Moderate extent
   Fair Extent
   Good Extent
Great Extent  
Don't know

18. Political stability to a very large extent informs effective public policy on renewable energy:  
Yes/No

19. Government policy on renewable energy development is stable:  
0 Strongly Disagree  
1
2
3
4
5 Neutral  
6
7
8
9
10 Strongly Agree

20. Government support renewable energy policy development through tax incentives and subsidies:  
0 Strongly Disagree  
1
2
3
4
5 Neutral  
6
7
8
9
10 Strongly Agree

21. Does the state government provide a fuel subsidy?  
Yes Specify ____ liters/month  
NO ____
22. The government has provided efficient policy measures on renewable energy technologies in the past:
   0 Strongly Disagree
   1
   2
   3
   4
   5 Neutral
   6
   7
   8
   9
   10 Strongly Agree

23. The renewable energy sector has relatively stable policy instruments for sustainable renewable supply:
   0 Strongly Disagree
   1
   2
   3
   4
   5 Neutral
   6
   7
   8
   9
   10 Strongly Agree

24. The frequent policy changes and discontinuation of policies undermine the growth of the renewable energy sector in Thailand
   0 Strongly Disagree
   1
   2
   3
   4
   5 Neutral
   6
   7
   8
   9
   10 Strongly Agree
25. Political priorities are directed to ensuring that the effectiveness of policy instruments in the renewable energy sector?

0 Strongly Disagree
1
2
3
4
5 Neutral
6
7
8
9
10 Strongly Agree

26. Government commitment to funding and financing renewable energy technology is cost-effective:

0 Strongly Disagree
1
2
3
4
5 Neutral
6
7
8
9
10 Strongly Agree

27. The government has provided intensive capital sources for SMEs that are interested in developing renewable energy technologies at cost-effective prices:

0 Strongly Disagree
1
2
3
4
5 Neutral
6
7
8
9
10 Strongly Agree
28. There are measures put in place to ensure long-term financing options for renewable energy power producers in the sector:
0 Strongly Disagree
1
2
3
4
5 Neutral
6
7
8
9
10 Strongly Agree

29. Government policy on renewable energy accounts for energy price controls
0 Strongly Disagree
1
2
3
4
5 Neutral
6
7
8
9
10 Strongly Agree

30. Government policy instrument on feed-in-tariffs is cost-effective and supports renewable energy deployment by both big and small energy producers:
0 Strongly Disagree
1
2
3
4
5 Neutral
6
7
8
9
10 Strongly Agree
31. The current policy instrument on renewable energy sources can achieve the country’s target of 30% of renewable energy supply by 2036:
   0 Strongly Disagree
   1
   2
   3
   4
   5 Neutral
   6
   7
   8
   9
   10 Strongly Agree

32. How would you rate policy stability on renewable energy in the country?
   0 Strongly Disagree
   1
   2
   3
   4
   5 Neutral
   6
   7
   8
   9
   10 Strongly Agree

ii. **Government R&D Framework**
33. The government has allocated funding for R&D for future renewable energy development:
   0 Strongly Disagree
   1
   2
   3
   4
   5 Neutral
   6
   7
   8
   9
   10 Strongly Agree
34. The government has provided laboratories and learning centers for research on renewable energy technology development:
0 Strongly Disagree
1
2
3
4
5 Neutral
6
7
8
9
10 Strongly Agree

35. Government support technology transfer in the renewable energy sector through research and innovation:
0 Strongly Disagree
1
2
3
4
5 Neutral
6
7
8
9
10 Strongly Agree

36. There is high public support and confidence of government policy measures on renewable energy technology in the country:
0 Strongly Disagree
1
2
3
4
5 Neutral
6
7
8
9
10 Strongly Agree
iii. Regulation & Administrative Procedures

37. Compared to other ministries in the ministry or ministries in government responsible for energy is/are effective in issuing out operating permits to power procedures. Select all that apply
   Moving ahead faster
   Moving slow
   Falling behind
   Don't know

38. The regulations on renewable energy are easy to understand and applied:
   0 Strongly Disagree
   1
   2
   3
   4
   5 Neutral
   6
   7
   8
   9
   10 Strongly Agree

39. It is easy to secure an operating permit or license to produce renewable energy in the country:
   0 Strongly Disagree
   1
   2
   3
   4
   5 Neutral
   6
   7
   8
   9
   10 Strongly Agree
40. The agencies responsible for regulating the activities in the renewable energy sector provide support for small and big power producers to secure land for sitting plants:

0 Strongly Disagree
1
2
3
4
5 Neutral
6
7
8
9
10 Strongly Agree

41. The agencies responsible for renewable energy sector ensures that power producers follow environmental and local laws where plants are located:

0 Strongly Disagree
1
2
3
4
5 Neutral
6
7
8
9
10 Strongly Agree

42. The laws and regulations on renewable energy deployment are monitored to ensure compliance by power producers:

0 Strongly Disagree
1
2
3
4
5 Neutral
6
7
8
9
10 Strongly Agree
43. The regulatory and administrative procedures are devoid of bureaucratic bottlenecks:
0 Strongly Disagree
1
2
3
4
5 Neutral
6
7
8
9
10 Strongly Agree

44. The regulatory agencies ensure compliance with environmental impact assessment before permits are issued to renewable energy power producers:
0 Strongly Disagree
1
2
3
4
5 Neutral
6
7
8
9
10 Strongly Agree

iv. Stakeholder Involvement

45. Government policy frameworks ensure adequate consultation with communities where renewable energy plants and technology are located:
0 Strongly Disagree
1
2
3
4
5 Neutral
6
7
8
9
10 Strongly Agree
46. How would you rate the ministry or ministries with responsibility for renewable energy compared to other agencies and businesses in the energy sector?
   - Among the worst
   - Below Average
   - Average
   - Above Average
   - Among the best
   - Don't know

47. How would you compare the Thai ministry or ministries responsible for Renewable energy to others in the ASEAN region?
   - Among the worst
   - Below Average
   - Average
   - Above Average
   - Among the best
   - Don't know

48. The regulatory agencies share information on its activities regularly with other stakeholders in the sector
   0 Strongly Disagree
   1
   2
   3
   4
   5 Neutral
   6
   7
   8
   9
   10 Strongly Agree

49. The government is willing to change policy direction in the light of suggestions made by other energy stakeholders
   0 Strongly Disagree
   1
   2
   3
   4
   5 Neutral
   6
   7
   8
   9
   10 Strongly Agree
50. The policy and regulatory agencies frequently acknowledge persons in the community who have made significant contributions to renewable energy development:
0 Strongly Disagree
1
2
3
4
5 Neutral
6
7
8
9
10 Strongly Agree

51. The regulatory agencies have considerable control over the operations of renewable energy power producers:
0 Strongly Disagree
1
2
3
4
5 Neutral
6
7
8
9
10 Strongly Agree

52. The regulatory agencies are often forced to change policy direction because of the demands of the key stakeholder in the renewable energy sector:
0 Strongly Disagree
1
2
3
4
5 Neutral
6
7
8
9
10 Strongly Agree
<table>
<thead>
<tr>
<th>NAME</th>
<th>Pasakorn Sakolsatayatorn</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACADEMIC BACKGROUND</td>
<td>2008 Bachelor of Arts, Southeast Asian Studies, University of California, Berkeley (Highest Honor)</td>
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<tr>
<td></td>
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<td>EXPERIENCES</td>
<td>2011 – Present Managing Director NGP (Thailand) Co., Ltd.</td>
</tr>
</tbody>
</table>