MASTERS THESIS

The evaluation of policy strategies and the functioning in the electricity market on the expansion of renewable energy: Case from Taiwan

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ABSTRACT

The development of renewable energy is essential for reducing CO_2 emissions while continuing to meet the growing demand for energy with cleaner sources. Today, Taiwan is actively promoting the expansion of renewable energy in order to increase energy independence and speed up the progress of energy transition. However, without a sufficient practice in promoting renewable energy, the Taiwanese government is attempting to search for suitable strategies from renewables precursor countries to stimulate the expansion of renewable energy on the islands. The Taiwanese government expects these methods to contribute to the achievement of its renewable energy goals by 2025. Currently, two renewables promotion strategies are being applied in Taiwan, which are: "implementing renewable energy promotion policy" and "deregulating the electricity market," respectively. Nevertheless, there is doubt that these two strategies are suitable for the current energy status in Taiwan. Because the system integration of renewable energy in Taiwan is still in the very beginning stage, it is questionable that these strategies can effectively stimulate renewable energy domestically to meet the government's target. Therefore, this research aims to do an in-depth evaluation with desk research and interviews to find out what influence these two renewable energy strategies have on the expansion of renewable energy in Taiwan. This research also helps to better understand the current status of renewable energy in Taiwan.

Keywords: electricity market deregulation, energy transition, feed-in tariff, competitiveness.

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LIST OF ACRONYMS/ABBREVIATIONS

ACRONYMS	DEFINITION
CO_2	Carbon Dioxide
EU	European Union
RE	Renewable Energy
FiT	Feed-in Tariff
RPS	Renewable Portfolio Standard
REC	Renewable Energy Certificate
PPA	Power Procurement Agreement
T&D	Power Transmission and Power Distribution Sectors
HHI	Herfindahl–Hirschman Index
CAT	Competition Assessment Toolkit
REDA	Renewable Energy Development Act
IEA	International Energy Agency
NRECC	Renewable Energy Certification Center
MOEA	Ministry of Economic Affairs
IDB	Industrial Development Bureau
IPP	Independent Power Producers
T-REC	Taiwan Renewable Energy Certificate
APV	Agrophotovoltaics
RSPRC	Risk Society and Policy Research Center
TWD	New Taiwan dollar
kW	Kilowatt
kWh	Kilowatt per hour
MW	Megawatt
TWh	Terawatt per hour

Chapter 1 Introduction

1.1 Background

About 40 % of CO_2 emissions derive from the processes of electricity and heat generation (IEA, 2019a). Even though renewable energy production is expanding in advanced economies, mainly in wind and solar PV, the global energy-related CO2 emissions in 2019 still hit record highs (22.0 Gt CO_2) (Figure 1) because of the increased demand (400Mt) from the rest of the world. This is especially true in Asian countries, which are responsible for 80 % of CO_2 emissions (IEA, 2019). To halt the excessive CO_2 emissions, the European Commission (EU) has proposed the 2030 climate & energy framework with some specific targets (e.g. improve energy efficiency, promote the share of renewable energy) to implement its commitments under the Paris Agreement (EU, 2020). As a result, Member States in the EU are required to speed up the energy transition in order to meet the EU regulation.

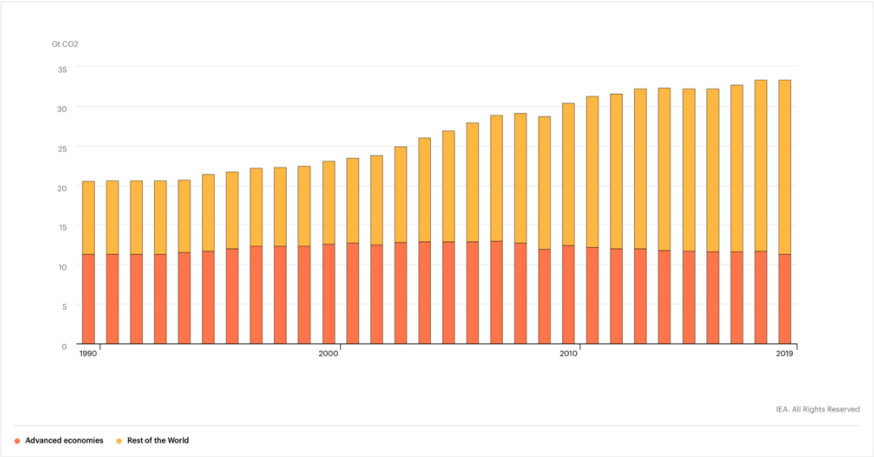

Figure 1 Energy related CO_2 Emissions (IEA, 2019)

At present, Taiwan is not the state party of the Paris Agreement, so it is not compulsory for the Taiwanese government to follow the agreement. However, Taiwan has its own reasons to facilitate energy transition and expand renewable energy on the island. The first reason is that Taiwan has a shortage of self-produced energy. Without the natural resources of coal and natural gas, about 98% of energy demand in Taiwan is imported from other countries (Bureau of Energy, 2017). The second reason is that Taiwan has been utilizing coal as the main source to generate power, however; the burning of coal not only results in excessive CO_2 emissions but also exacerbates the air pollution in the western part of Taiwan[1]. Therefore, in order to

[1] The air quality guideline value from WHO suggests that the concentration (annual mean) of fine particulate meter (PM2.5) should below 10 $\mu g/m^3$, yet the annual mean concentration of PM2.5 in the western part Taiwan ranged from 15 $\mu g/m^3$ to 25 $\mu g/m^3$ in 2018 (WHO, 2018; EPA, 2019).

augment the ability of energy independence and mitigate the problem of air pollution, the Taiwanese government has been implemented a series of strategies, including the promotion of renewable energy, to accelerate the progress of the energy transition since 2009 (Figure 2).

Currently, there are two primary strategies[2] chosen by the Taiwanese government to increase domestic renewable energy development.. The first strategy is implementing RE promotion policy to encourage investment from developers who are interested in the renewable energy industry. In addition to this, the Taiwanese government has also passed an amendments to the Electricity Act in 2016 and partly deregulated the electricity market, which allows private renewable energy companies to engage in market activities in the power generation sector. This is expected to facilitate the share of green electricity to meet the renewable energy goals by 2025.

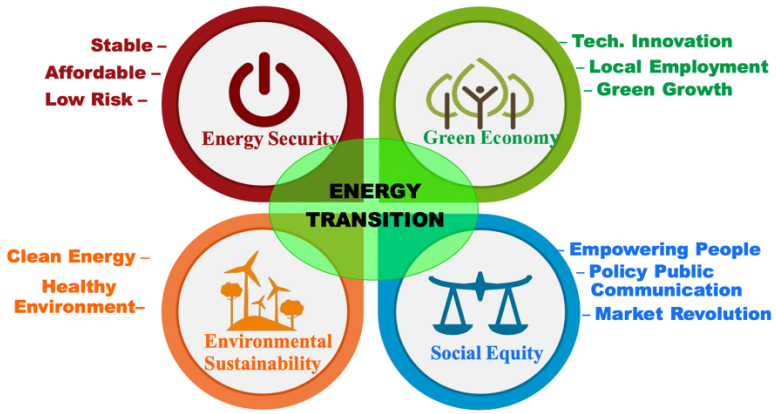

Figure 2 Core value of energy transition in Taiwan (Source: Bureau of Energy, 2017)

1.2 Problem Statement

Even Taiwan is not regulated by the Paris Agreement, the Taiwanese government is initiative to facilitate the development of renewable energy to speed up the progress of the energy transition for its own considerations. The Taiwanese government has set a goal that "20% of electricity is to be generated from renewable sources by 2025" and expects this target to stimulate the expansion of renewables. Based on the experience from renewables forerunner countries, there are two strategies in Europe that the Taiwanese government was interested in and considered to be the example for Taiwan to learn from. The first strategy is implementing RE promotion policy with specific policy instruments, such as the feed-in scheme policy, to stimulate the expansion of renewable energy. Currently feed-in schemes are the most popular and general-accepted policy instruments to support the generation of renewable energy (Jenner et al., 2013). The second strategy is to enhance the competitiveness of green

[2] In this thesis, strategies are defined as policies or policy instruments used by governments towards a specific objective or end.

electricity through the electricity market deregulation. The perception behind the strategy is that the deregulation of the electricity market encourages the establishment of private renewable energy companies, and the participation of renewable energy companies to the market indicates that more electricity would be generated from renewable source (green electricity). Therefore, it can be said that if green electricity is competitive in the electricity market, it will be conducive to the expansion of renewable technologies while increasing the share of renewable energy in a country (Szabo´& Waldau, 2007).

However, the question is that if the Taiwanese government can fully replicate the successful experience from Europe through the above two strategies. Since the situation and country characteristics between two territories are completely different, it is unlikely to assert that similar policy implementation in Europe would lead to the same result in Taiwan.
It is questionable whether the Taiwanese government has chosen a suitable strategy to promote renewable energy based on the current situation in Taiwan. If this is not the case, it is necessary to investigate why these strategies did not work as expected. It is important for the government to do a comprehensive consideration before implementing the policy, because if the government applies an unfit strategy, it may fail to promote the share of green electricity in the market and miss the goal it set. Therefore, it is necessary to do an evaluation of the current RE promotion policy and the current electricity market status in Taiwan to have a deeper understanding of how these strategies affect the promotion of renewable energy. This evaluation may then bridge the gap between real implementation and anticipation.

1.3 Research objective

The objective of this research is to understand different mechanisms behind each strategy of promoting renewable energy and to evaluate how these strategies may be applied in the case of Taiwan.

1.4 Research questions

The following research questions are formulated to achieve the objective in this research:

Main research question

To what extent do renewable energy policy and the electricity market deregulation affect the promotion of green electricity, particular to the case in Taiwan?

Research sub-questions

1. How do specific policy mechanisms within RE promotion strategies relate to the increase of green electricity in a country of similar characteristics as Taiwan?

2. What are the policy instruments within RE promotion policy and what is the electricity market structure in Taiwan?
3. What is Taiwan's current progress in reaching it green electricity goals?
4. To what extent can the achievement of the green electricity goals in Taiwan be explained by specific policy instruments within RE promotion policy and the functioning of the conditional deregulated electricity market?

1.5 Structure of the thesis

This thesis is divided into six chapters. Chapter 1 provides background knowledge about the current renewable energy situation in Taiwan and introduces a series of specific research questions in the thesis. Chapter 2 is the theoretical framework that utilizes theory for readers to better understand the building material in the research. Chapter 3 presents the conceptual model and the research design of the thesis to demonstrate the methodology which is conducted in the research. Later the thesis starts the discussion of a case study in Taiwan. Chapter 4 shows two strategies that the Taiwanese government conducts and introduces the current renewable energy goals in Taiwan. Chapter 5 offers an in-depth evaluation of the case in Taiwan. Finally, Chapter 6 answers all of the research questions to conclude the thesis.

Chapter 2 Theoretical framework

This research mainly discusses two relations behind renewable energy promotion strategies in Taiwan (Chapter 5). The first relation is how do RE promotion policy influence the position of green electricity in the market, and the second relation is how does a deregulated electricity market increase the share of green electricity. Thus, the role of the theoretical framework is to theorize how the share of green electricity be increased. Also, this chapter is giving an answer on the sub-question 1 "*How do specific policy mechanisms within RE promotion strategies relate to the increase of green electricity in a country of similar characteristics as Taiwan?* " from the theoretical perspective. The scheme of Chapter 2 is presented in Figure 3.

Before analyzing the influence among different relations in Chapter 5, we have to understand what is the mechanism behind each relation first. There are various potential mechanisms to promote the share of renewable energy (i.e. provide a subsidy, impose renewable energy obligation, provide tax incentive, etc.), while Chapter 2 only focuses on three mechanisms that relate to the strategy what the Taiwanese government is now applying, which are "Conducting supportive instruments (FiT, certificate)", "Deregulating the electricity market", and "Enhancing the competitiveness of green electricity in the electricity market". Three mechanisms have their connection to the promotion of renewable energy. "Supportive instruments" bring the most direct support to facilitate renewable energy development; the "deregulation of the electricity market" can be regarded as a potential strategy to introduce more green electricity by allowing renewable energy companies to compete with conventional energy, and "enhance the competitiveness of green electricity" is another potential mechanism that can provide green electricity a better position in the electricity market. Therefore, the purpose of this chapter is to use theory to better understand how do these mechanisms lead to the increase of green electricity.

After theorizing these relations in chapter 2, the research moves to the study in Taiwan's current situation (Chapter 4) and evaluates how the strategy in Taiwan is supposed to work and how far do they remain to their RE target. In Chapter 5, the research goes into a specific in-depth study to discuss relationships between the strategy (RE promotion policy & market deregulation) and RE target, particularly focuses on 1) how is the performance of renewable promotion instruments (FiT & certificate) in Taiwan, and 2) if the market deregulation functions as it was expected to promote the share of green electricity or not. In a nutshell, the theoretical framework can be regarded as the building bricks for the entire thesis.

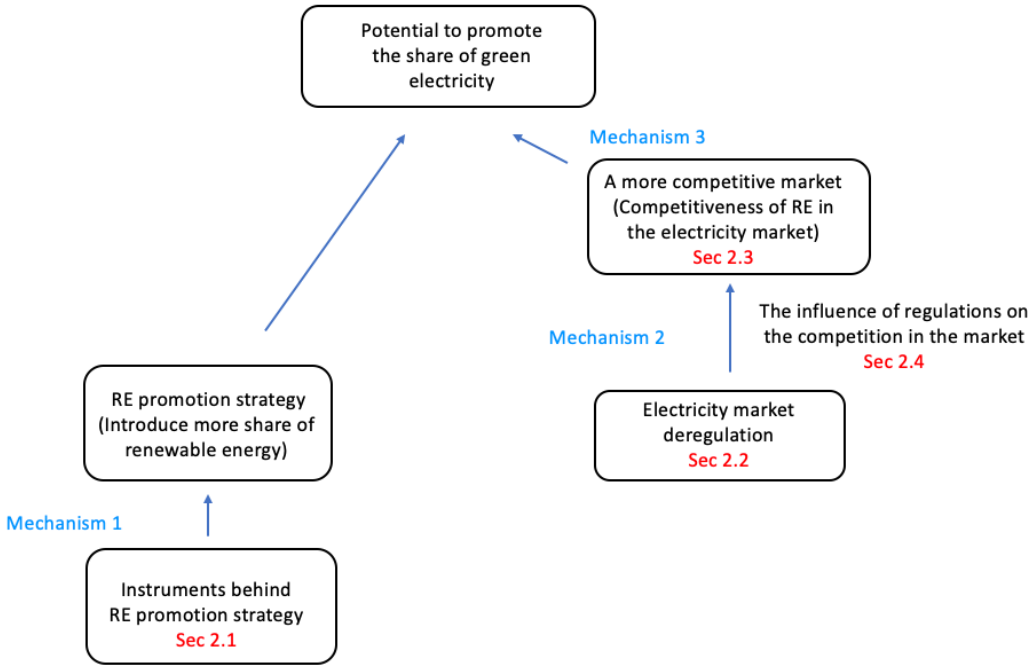

Figure 3 Scheme of Chapter 2

2.1 The current prevailing instruments within renewable energy promotion policy

This section introduces the first mechanism, which is the supportive instruments that are primarily used to promote the share of renewables. Currently, the Taiwanese government has chosen the hybrid strategy (FiT and certificate) as a tool to support renewables development, so this section explains the principle behind two supportive instruments to let the readers understand how this mechanism relates to the promotion of renewables.

2.1.1 Feed-in Tariff (FiT)

Today, FiT has been applied by more than 63 countries worldwide and has been considered as the most effective instruments to foster the expansion of renewable energies (Couture & Gagnon, 2010; European Commission, 2008; Mendonça, 2007). Different from the government subsidies which are supported by the taxation from the citizen, the core design behind FiT is by offering guaranteed prices for a fixed period (normally 20 years) to renewables suppliers, and the extra fee is shared by the electricity bill (Fell, 2018). Advantages of FiT is that its favorable revenue can maintain developers' confidence to invest in the renewable energy industry and reduce the market risk. It can be said that the FiT is a straightforward way to provide financial support to increase the expansion of renewables, also this is the main instrument that the Taiwanese government conducts to expand the development of domestic solar PV and wind power industry since 2010. Moreover, it encourages the general public, including households, small businesses, citizen-led energy cooperative to participate in the deployment of different renewable technologies, and

stimulates domestic renewable installation, which is helpful to accelerate the progress of energy transition (Klein et al., 2008).

In spite of its advantages to the expansion of renewables, several shortcomings of the FiT might have the potential to disturb the function of the electricity market in the long-run. Firstly, the fix-price FiT does not reflect the real market price of electricity, which means the electricity price is not flexible under the FiT scheme. Secondly, the FiT scheme provides little incentives for suppliers to compete fiercely, which may limit the market innovation and competition. Thirdly, it creates a financial burden for the government and consumers in the long-term (Couture et al., 2010). To improve the problem of price inelasticity, FiT has evolved into various types of schemes (i.e. premium-price tariff, front-end loaded tariff) depend on the country's policy. For instance, the presence of the premium-price FiT has made the feed-in scheme more tend to be market dependent and makes the system more cost-effective. Even it has evolved into several derivative feed-in schemes after years of implementation, nevertheless, the core principle of "providing direct support to renewable developers" remains the same. In this moment, the pioneer country in energy transition, such as Germany, has been applied FiT for at least two decades and achieved a remarkable outcomes in the expansion of renewables. The share of green electricity in Germany has reached to 44% in the first half of 2019, while the number was around 6% in 2000 (IEA, 2020; BMWi, 2018).

2.1.2 Renewable Portfolio Standard (RPS)

Unlike the government-dominated policy instrument like FiT, the mechanism behind RPS is more market-oriented. While the standards and policies of RPS do vary among different states or countries, the principle of the RPS does not have much difference. In short, the core concept of the RPS is that the government would obligate that energy companies should utilize a certain minimum quantity of eligible renewable sources in their electricity-generation process (Yin & Powers, 2010; Ryan et al., 2007). If the power generation companies fail to achieve the standard regulated by the mandatory RPS policy, then they have to complement shortfalls by purchasing renewable energy certificates (REC) from the certificate market. The T-REC that the Taiwanese government introduced in 2017 was based on the concept of certificate trading from the RPS. Since the certificate prices in the market are volatile, the generation costs and revenue for energy companies would be more changeable under the RPS scheme. Therefore, In comparison to the FiT, the effectiveness of the renewable promotion by the RPS policy seems to be more latent and indirect.

Although the RPS policies have become prevalent and have been applied in the US and UK for a long while, however; their influence on the electricity market and the renewable

installation still remain uncertain. Since RPS is a market-based policy, it is ambiguous to determine whether the increase of renewable electricity usage is spurred by the policy scheme, or it is due to the market mechanism. Upton & Snyder (2017) had proposed a hypothesis that the RPS would lead to an increase in electricity prices, while not having a significant impact on the promotion to renewable generation. They argue that because RPS is a consumption-based mandate, so power utilities can also choose to purchase required RECs in the market instead of generating renewable energy to meet their obligation. Therefore, the cost of RECs would be passed onto the electricity price but does not have any effect to the promotion of renewables.

In general, there is a consensus in the academic field that in comparison to the RPS scheme, FiT is a more efficient instrument to promote the expansion of renewable energy (Menanteau et al., 2003; Lewis & Wiser, 2007). While based on Sun & Nie (2015)'s research, the RPS scheme may be more efficient at improving consumer surplus and reducing CO_2 emission. Since policy objectives are various and countries have their own consideration, it is complicated to make an accurate judgment to determine which instrument is the most effective method to the expansion of renewable energy.

2.1.3 Empirical practice of instruments within renewable energy promotion policy

In the last section, the study discusses supportive instruments in theoretical aspect, this section demonstrates how these instruments work from the empirical perspective. In this study, Germany is selected as the representative country of the FiT method, and the UK is selected as the proponent country of the RPS system.

2.1.3.1 Germany (FiT)

The FiT in Germany was regulated through the Electricity Feed-in Law (SEG) between 1991 to 1999 and was taken over from the Renewable Energy Sources Act (EEG) since 2000 (Böhringer et al., 2017). Undeniably, the application of SEG and EEG have brought up the gross electricity from renewables massively from 3.4% in 1990 to 42.1% in 2019 (AGEE-Stat, 2019). However, Frondel et al (2010) criticized that an over-favorable FiT rate like EEG can hinder the deployment of other technologies which may be more efficient in the mid-run of the implementation, also burden households for the surcharge on electricity bill (Böhringer et al., 2017).

Although the FiT in Germany may increase the financial burden, nevertheless, the stable and favorable energy policies spur the innovation in renewable technologies, especially in PV and wind, and increase job creation domestically (Gipe, P., 2011). More and more studies have provided statistic evidence to reinforce the argument that FiT and ancillary policies have

positive influences on the innovation of renewable technologies, external knowledge stock and stimulate the progress of energy transition not only national but also cross-countries boarders (Johnstone et al., 2010a; Walz et al., 2011; Verdolini and Galeotti, 2011). In addition to the innovation benefit from the FiT, efficiency and effectiveness are other indicators to evaluate the performance of energy policies. Pablo and Emilio (2014) adopted the concept that the cost-effectiveness of the supply side can be considered as the criterion to assess the success of policy implementation, and the deployment of renewables in Germany has demonstrated that the feed-in schemes are crucial for the installation of smaller-scale renewable facilities and the expansion of renewable business (e.g. energy cooperative).

The implementation of feed-in scheme in Germany did effectively promote the domestic renewables capacity and provide a successful paradigm of energy transition to the world, however; the EEG amendment of 2014 broke with its traditional feed-in scheme and brought an uncertain condition to the energy business. There were two major policy adjustments that had direct impact to the domestic energy cooperatives and the first was the drastic cut down of the FiT rate, which made the energy business from the cooperative become less profitable. The second change was the replacement of the current FiT implementation. Under the EEG amendment of 2014, German government decided to introduce auction and tendering program as the new strategy to the renewable energy production sector. These changes had occurred criticism from individuals and small-scale renewable energy providers since the new measurements were contradicted to the spirit of EEG, which was supposed to manifest the "energy democracy" through the public participation (Morris & Jungjohann, 2016). In addition, auction is considered more likely to benefit bigger investors because transaction costs and financial risks would become higher for individuals and cooperatives, leading the sharping decline number of energy cooperatives (Hauser et al., 2014; Klagge & Meister, 2018).

2.1.3.2 UK (RPS)

The Renewable Obligation (RO) is designed in the UK based on the concept of RPS. The RO in the UK was launched in 2002, which was one of the earliest mechanism for the promotion of renewables from the electricity generation sector. The core idea of the RO basically adopted principles from the RPS scheme, it allowed the trading of RECs between the electricity supplier or traders to fulfill their renewable energy obligation. The application of the RO in the UK could not be considered as an effective tool for the UK government to achieve its renewable target (Oxford Energy Associates, 2007; Ernst and Young, 2007).

As the result, the RO in the UK is being replaced by the Contracts for difference (CFD) after 2016, while the RO closed to new capacity in 2017, the period of some projects with special

conditions still can be extended up to 2019. From the beginning in 2002 until its end in 2016, the RO scheme has embarked on the energy transition from grey electricity to green electricity in the UK, which contributed to the reduction of 28.3 million tonnes of carbon dioxide-equivalent emissions (Ofgem, 2018).

2.2 Types of the electricity market

There are several reasons for the government to deregulate the electricity market including helping meet policy objectives (e.g. decrease electricity price, increase energy security, promote energy efficiency, etc.). As mentioned in the beginning of the chapter, the deregulation of the electricity market opens access to renewable developers to participate in market activities. Moreover, it has a potential to introduce more green electricity to the market to compete with conventional energy. This is the main reason why the Taiwanese government decided to reform the electricity market in 2016 (Executive Yuan, 2018); to see if the market deregulation can effectively bring more green electricity to the market to meet its RE target by 2025. However, currently the electricity market in Taiwan is conditionally deregulated, which means the market is only partly liberalized and now the operation in the market is between “regulated” and “deregulated”. Thus, this section brings information on both regulated and deregulated markets to provide preliminary knowledge for evaluating the electricity market status in Taiwan (Chapter 5).

2.2.1 Regulated electricity market

The regulated electricity market is a universal market type before the deregulation. In the regulated electricity market, from the power generation to the electricity selling, the operation of electricity services flow is completely controlled by a utility (generally a state-owned enterprise) (Figure 4). In this type of market, no competition happens because the operation (i.e. centralized planning, management of capacity, tariffs, etc.) in the market is highly regulated by the government. In addition, the dealing of energy between supplier and consumers is limited and mainly done by the conventional power procurement agreement (PPA) due to the absence of power trading platform, so the trading of energy issue is less transparent. Therefore, electricity customers in the regulated electricity do not have other purchase options except the power utility. The regulated electricity market limits the innovative activities in the market and may result in power inefficiency in the long run, however; one advantage of the regulated market is that price of the electricity tend to be more constant instead of volatile.

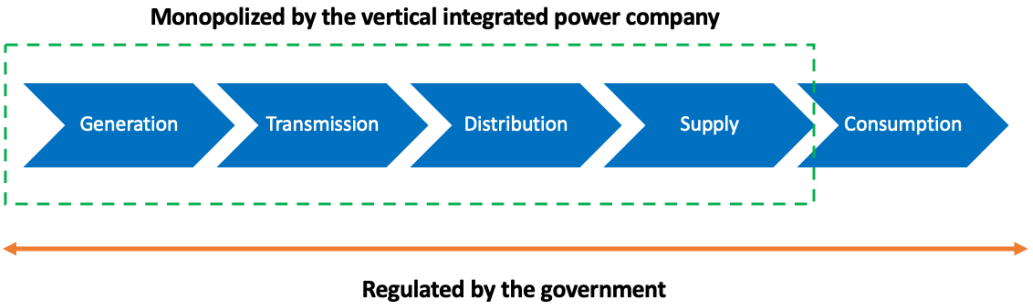

Figure 4 Model of the regulated electricity market

2.2.2 Deregulated electricity market

In comparison to the regulated market, the role of the government has changed from a market regulators to a market supervisors. The deregulated market does not set entry limitations to the generation sector, allowing the existence of multiple power generation companies other than a single power utility company. In this situation, power generation companies can sell electricity into the wholesale market, and electricity retailers are able to purchase electricity to sell it to the general electricity users in the retail market (Figure 5). For the reason of energy security, power transmission and power distribution sectors (T&D) still remain monopolized by the state utility. Market competition activities take place in the generation sector and the retail sector, so customers can compare electricity rates and services between suppliers with different contracts. The operation of a fully liberalized energy market works differently from the monopolized energy market in many aspects. For the liberalized market, the market affair mainly relies on the price mechanism to reach the balance and the government has less influence to interfere in the liberalized market. Moreover, the deregulated electricity market offers a broader ranges of market activities, providing an option of renewable energy for customers who are volunteering or obligated to use green electricity. In comparison to the conventional energy, renewable energy can be considered as the innovative product in the energy market. Because of the flexibility in the market, renewable energy developers can either participate in the market competition either in the generation sector or the retail sector to supply green electricity to the customers.

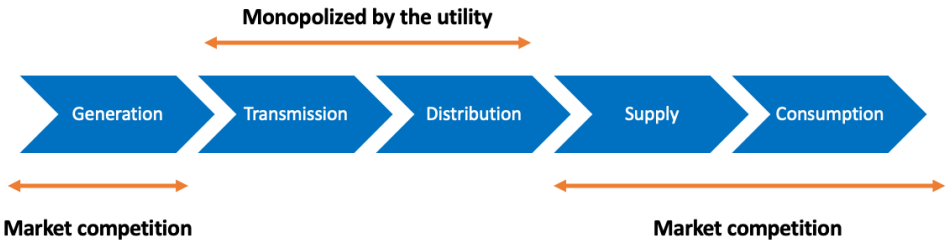

Figure 5 Model of the deregulated electricity market

Based on the extent of deregulation, competition models in the electricity market can be classified as “Wholesale competition” (Figure 6) and “Retail competition” (Figure 7). Generally, wholesale competition happens in the early stage of deregulation. Most of the countries would face numerous obstacles from market legislation when they divided the power utility company. In this stage the power utility company would only be partly separated and the retail sectors would remain regulated. Currently, the goal of the Taiwanese government is to transform the competition type into wholesale competition in the electricity market and create a market environment that is conducive to renewable energy development.

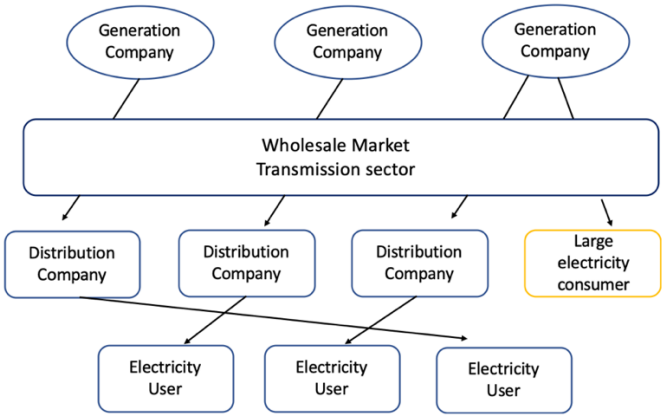

Figure 6 Model of wholesale competition

When an electricity market has been developed for a period of time and has a highly competitive wholesale market, the market would further deregulate and transform into retail competition. In the retail competition model, electricity customers can freely choose electricity retailer whom they like to purchase electricity from, even directly from the generation company, so electricity price would be more transparent in this model. Therefore, the retail competition model is regarded as the ultimate goal of electricity deregulation, and can be an index to determine the degree of maturity in the liberalized electricity market (Wang, 2018). The operation flow in the mature electricity market in Europe, North America, Japan, etc. are based on the retail competition, while there may have some diversity according to each country’s policy and characteristics.

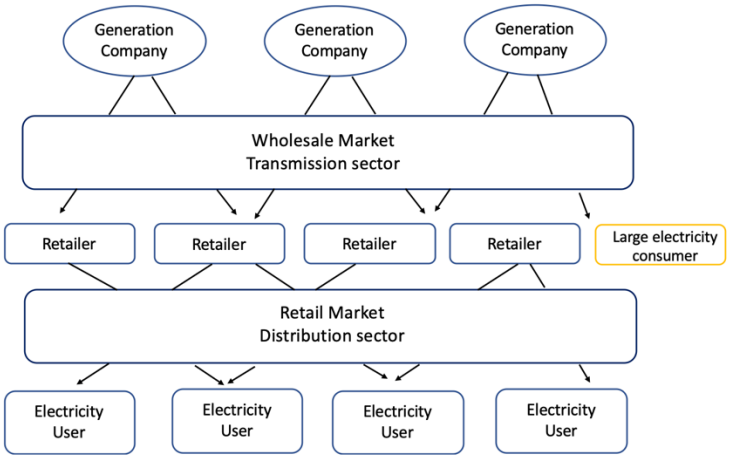

Figure 7 Model of retail competition

2.3 The economic competitiveness of green electricity

This research defined competitiveness as the ability of green electricity to compete in the electricity market. If the competition between the renewable energy industry and the conventional energy industry in the electricity market is competitive, then we can say the "competitiveness of green electricity" is the mechanism that has the potential to provide a better position for green electricity, because the economic incentives would encourage renewable developers to introduce more green electricity to the market. The degree of competitiveness can be determined by numerous variables (i.e. function in the market, market power, market concentration, etc.), so this section provides general knowledge of competitiveness from a theoretical perspective for the later evaluation in the case of Taiwan.

2.3.1 The marketing function in the electricity market

Market power is an observed objects to evaluate the materiality and competition in the market. It refers to the relative ability of suppliers to manipulate the price of the product, decreasing the competitive level and economic efficiency in the marketplace for a sufficient period of time (Ennis, S. et al., 2017). During the energy transition, the existence of market power in the electricity market decreases the competitiveness and the quality of energy supply generated from renewables, also hampers the deployment and investment in renewable technologies. Currently, there is no single method that can estimate the market power precisely, because each method has it limitation when it is applied in practice (Louis Kaplow, 2015). Still, the market share test can provide an initial assessment as an index to understand the performance of a product. Therefore, this study adopts the method of using the market share of green electricity as the input to evaluate the extent of its competitiveness in the market.

2.3.2 The evaluation of competitiveness in the market

Evaluation of the market share and the market concentration are preliminary and straightforward indicators to understand the product performance in the marketplace. To quantify market share and market concentration, the Herfindahl–Hirschman Index (HHI) is the generally accepted index to detect the market concentration (David & Wen, 2001). The assumption of HHI is that the market competitiveness is in inverse proportion to the degree of the market concentration[3]. The HHI is computed by squaring the market share[4] of each firm and summing the result of squared shares. The degree of market concentration through the HHI value is interpreted by guidelines from the U.S. Department of Justice and the Federal Trade Commission, markets are regarded as highly concentrated if the HHI value is in excess of 2,500 points, and markets with the HHI value between 1,500 and 2,000 are considered moderated concentrated. Even though HHI has been criticized when applied in the energy market since it neglects the demand elasticity (S.Borenstein et al., 1995) and does not reflect the true competitive position of suppliers (J.C. Dalton, 1997). However, David & Wen (2001) and Alvarado (1998) asserted that electricity market is a dynamic environment, the market concentration is more appropriate to assess the probability of market concentration instead of the preciseness. Thus, for the purpose to evaluate the market competitiveness preliminarily, the HHI index is still considered as a useful tool to provide information for the study.

In addition to the market structure, internal factors and external factors in the energy market also has the extent to determine the market performance. Internal factors in the market include product innovation, supply & demand side cost efficiency, and productivity (EU, 2017). In this case, green electricity can be considered the product innovation in the electricity market since the presence of renewable technologies enable a new type of energy source to compete with conventional energy. On the other hand, external factors refer to the factors outside from the market itself but can affect the operation in the marketplace (EU, 2017). For instance, FiT and green certificate trading are two supportive instruments to foster the energy transition and renewables expansion (Lipp, 2007). Nevertheless, both of them do not belong to the normal mechanism in the electricity market, instead, they are regarded as the external factor for the government to intervene competition in the electricity market. Thus, market performance and green electricity competitiveness driven by external factors are the other aspects that need to be considered during the analysis.

[3] Market concentration is measured when a company or firm accounts for a large percentage in the market (The Economic Times). If market concentration is low in the market, then the market is considered to be highly competitive. Contrary, if market concentration is high in the market, it means the market is monopolistic and the market is less competitive.

[4] Market share means the percentage of a company or entity accounts for in the market

2.3.3 The effect of market function on the renewables promotion

The Taiwanese government postulates that fierce competition between green electricity suppliers and grey electricity[5] suppliers in the market could create a virtuous cycle to bring up the share of renewable energy in the market. Due to the improvement of renewable technologies, the capital cost of renewables continues to decrease and makes it becomes cost-effective to compete with conventional fuels in the electricity market. Aside from the economic competitiveness of green electricity, the function of the electricity market is to play a pivotal role to determine whether it can provide enough incentive to renewable developers to bring additional wind and solar capacity into the market (Stevenson, 2018; Frankel et al., 2019).

2.4 The influence of policies on the competition in the market

As mentioned in the last section, policies that intervene in the market are external factors that have the potential to affect operation and competition in the market. Therefore, this section introduces a tool for policymakers to check if the current system over-regulates the market or not. Evaluation principles in Section 5.3 are followed by the CAT, and the design of interview questions for the case in Taiwan are based on the Competition Checklist. The origin version of the Competition Checklist from the OECD can be found in Appendix A.

2.4.1 The introduction of the Competition Assessment Toolkit (CAT)

A competitive market is conducive to improving a country's economic performance, which can encourage market innovation and provide business opportunities for investors. This further increases market efficiency, which benefits the entire economy. Nevertheless, the presence of regulations and laws are sometimes redundant, and those that only restrict the competition between business result in adverse consequences for the marketplace. To prevent an over-regulated situation, the CAT is a useful tool for a government to scrutinize drafts of new or existing regulations for the purpose of reducing excessive restrictions to commercial activities. This is done by asking a series of questions based on the "Competition Checklist" in order to identify excessive restrictions that have the potential to hamper market functions (OECD, 2019).

2.4.2 The application of the CAT in the study

It is possible for local or central governments to take the place of market participants because they may have international pressures or political purpose that make them to approach the renewable goal. In this case, governments tend to intervene in the operation of the electricity market in order to speed up the energy transition (Mulder, 2017). In Taiwan, the Electricity

[5] Electricity that is generated from fossil fuels

Act and the Renewable Energy Development Act (REDA) are two main legislations that regulate the electricity market and the expansion of renewable energy. Due to this, "amendments to the Electricity Act" and REDA are chosen to be assessed if they correspond to anti-competitive principles in the Competition Checklist from the CAT. Although both legislations has been revised in 2016 and 2019, respectively, several articles in the content restrain the ability of private market participants to compete with the state-owned electric power company. Therefore, the purpose of applying CAT in this research is to diagnose if the current renewable energy regulations in Taiwan have possible anti-competitive impacts in the electricity market.

There are six steps to exercise the CAT, while due to the research scope, this paper only conducts the first two steps of CAT, which are *Identify policies to assess* and *Apply the checklist.*

1. ***Identify policies to assess*:**
   In this study, regulations in the amendments to the Electricity Act and the REDA are targets for the assessment. Especially focus on articles that have a tendency to increase market power and lead to a monopoly in the electricity generation sector.

2. ***Apply the checklist:***
   After collecting information through the literature review and the evaluation, the next step is to check if the current policy or regulation correspond to principles of "Limits on the range of electricity suppliers", "Limits on the ability of electricity suppliers to compete in the electricity market", "Reduction in investment incentives", and "Limits the choices for electricity consumers" in the checklist.

2.5 System integration of renewables in the energy market

In addition to the renewable energy promotion mechanisms previously mentioned, the position of renewable energy in the market also highly depends on the phase of renewable energy integration in a country. The IEA has categorized six different phases to integrate renewable energy based on the level of RE deployment, operational and market design, regulation and fundamentals of supply and demand, etc.(IEA, 2020). According to the category from the IEA, the energy market in Taiwan is in phase 1, which indicates that the development of renewable energy is in an early stage and the share of renewables in the market is relatively low (only with a few percent). On the other hand, the energy market in Europe has already progressed to a further phase and requires a more advanced method to integrate renewable energy into the market. (i.e. additional investment in power system flexibility). The classification is helpful for policymakers to review renewable energy

deployment in the country and determine what could be the suitable strategy to support the system integration at the current stage.

2.6 Summary

From the preliminary information above we can understand that the success and the effectiveness of renewables promotion highly rely on the mechanisms behind the strategy. Nevertheless, the RE promotion policy is not the only mechanism that has an influence on the promotion of renewables. Alagappan et al (2011) pointed out that the influence of other external factors, such as the difference in market structure, also needs to be included before judging the efficiency of the renewables promotion. Market concentration and competitiveness in the electricity market are market-oriented factors that have an indirect influence on renewable energy development since they can determine developers' willingness to the investment in renewables. All in all, to answer the sub-question 1, we can say that three mechanisms ("Deregulating the electricity market", "Enhancing the competitiveness of green electricity in the electricity market" , and "Conducting supportive instruments within RE promotion policy") can provide direct or indirect support to the expansion of renewable energy, and introducing more renewable energy to the market means that more electricity would be generated from renewable sources (green electricity).

Chapter 3 Research design

This chapter provides methods and materials to show readers how the research approaches to its objective. Research framework, research strategies, data collection, and data analysis are presented in the following sections.

3.1 Research framework

The objective of this research is to evaluate the influence of two renewable energy promotion strategies, which are the "renewable energy promotion policy" and the "deregulation of the electricity market", on the promotion of green electricity in Taiwan. As previously mentioned, materials in Chapter 2 are the foundation for the evaluation of a case in Taiwan, preliminary research and a group of literature reviews are conducted to let the readers have a clear understanding of what are the mechanisms behind renewable energy promotion strategies. After acquiring the background information, the research moves forward to the single case study. According to the current status in Taiwan, two strategies are analyzed and discussed of what influence do they bring on the promotion of renewables. Subsequently, the research conducts an in-depth evaluation through the interviews with stakeholders in Taiwan's renewable energy industry field and the document review to explore the explanation behind the current renewable energy status in Taiwan. Lastly, the conclusion is drawn to achieve the objective of this research.

Thus, the study is inclined towards evaluative and explorative forms of research, which relies on the desk research to collect information as sources to understand the current situation in Taiwan, and the primary research conducts interviews to find out the influence of RE policy from the stakeholders' perspective, which is conducive for the research to bridge the gap between actual strategies implementation and the anticipated results. Figure 8 shows the research framework in this study.

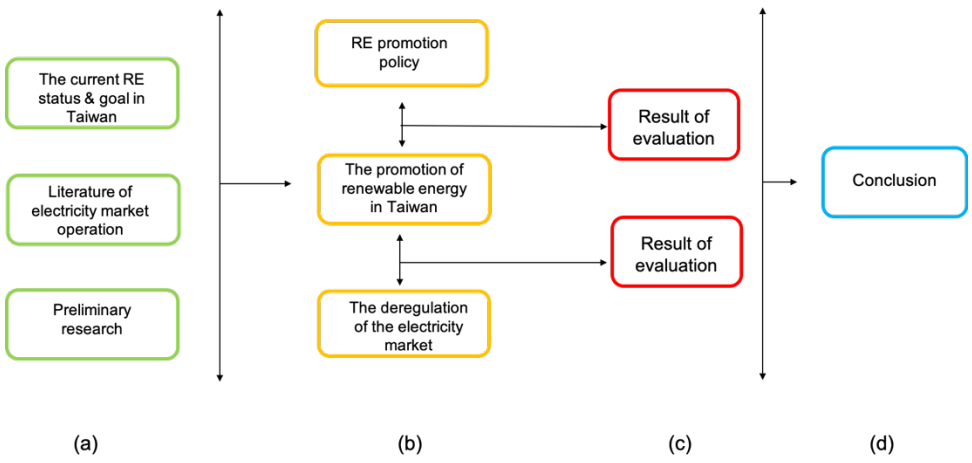

Figure 8 Research framework (own elaborated)

3.2 Research strategy

The research strategy in this thesis is composed of two parts. The first part is the desk research that is able to answer Sub-question 1, Sub-question 2, and Sub-question 3. The second part is the primary research by applying the qualitative method of data analysis and evaluation to study the case in Taiwan for the preparation to answer Sub-question 4 and the main research question.

3.2.1 Desk research

Desk research in this study mainly relies on the secondary data collection and further provides preliminary knowledge for the assessment in the later chapters. In this stage, literature and document review focus on the information collection from:

- National renewable energy development reports & policies in Taiwan
- The renewable energy supportive instruments
- The operation in the electricity market

3.2.2 Primary research

The purpose to conduct interviews in the primary research is to collect empirical information from target stakeholders, which enables the researcher to have an in-depth perspective to evaluate the status of renewables promotion in Taiwan. To evaluate the influence of two strategies that the Taiwanese government is currently applied to the promotion of renewable energy, data and information for the study is collected from in-depth interviews with stakeholders who are involved in the trading of green electricity in Taiwan's electricity market. The design of interview questions is based on the CAT Checklist guideline (Appendix A) that is developed by the OECD and with a part of open discussion for the case analysis. The purpose of applied CAT in this research is to diagnose possible anti-competitive impacts in the electricity market, therefore, only the first two steps of CAT, which are Identify policies to assess and Apply the checklist are conducted. Interview questions can be found in Appendix B to D.

Organizations involved in this study is constituted by:

- Bureau of Energy, Ministry of Economic Affairs
- National Renewable Energy Certification Center (NRECC)
- Energy industry investor
- Energy cooperative
- Industry (with contract capacity less than 5000KW)

The list of interviewees is presented in Table 1.

Table 1 Research interviews

Interviewee	Organization	Method of interviewing
Administration side		
Mr. Chun-Li, Chang	Bureau of Energy	Skype meeting
Mr. Chih-Wen, Huang	NRECC	Skype meeting
Renewable energy supply side		
Mr. David Lo	YUSHAN ENERGY CO., LTD.	Skype meeting
Mr. Tung-Pai, Yen	Sunnyfounder energy cooperative	Skype meeting
Renewable energy demand side		
Ms. Vicky Lai	YUNG CHI INDUSTRY CO., LTD	Skype meeting

3.3 Data collection

The collection of data and information for this research is based on the requirement to answer the set of sub-questions, which is shown in Table 2.

Table 2 Information required for the research sub-questions

Research sub-questions	*Information required*
How do specific policy mechanisms within RE promotion strategies relate to the increase of green electricity in a country of similar characteristics as Taiwan?	● General concept of regulated/deregulated electricity market ● Supportive instrument within RE promotion strategy ● General concept of the competitiveness in the market
What are the policy instruments within RE promotion policy and what is the electricity market structure in Taiwan?	● Renewable energy strategy in Taiwan ● The electricity market structure in Taiwan
What is Taiwan's current progress in reaching it green electricity goals?	● The green electricity goal in Taiwan ● Energy mix in Taiwan
To what extent can the achievement of the green electricity goals in Taiwan be explained by specific policy instruments within RE promotion policy and the functioning of the conditional deregulated electricity market?	● In-depth research to the current RE status in Taiwan ● The current functioning in Taiwan's electricity market ● The performance of supportive instruments

Sources and method of data collection is presented in Table 3.

Table 3 Required information & method of data collection

Required information	***Sources***	***Accessing methods***
General concept of regulated/deregulated electricity market	Scientific literature, Related textbooks	Search method
Supportive instrument within RE promotion strategy	Scientific literature, Past reports	Content analysis, Search method
General concept of the competitiveness in the market	Scientific literature, Related textbooks	Content analysis, Search method
Renewable energy strategy, The electricity market structure, The green electricity goal, and Energy mix in Taiwan	Governmental documents, Past reports, Internet resources	Content analysis, Search method
In-depth research to the current RE status in Taiwan	Interview, Data collection, Past reports	Content analysis, Interviewing, Search method
The current functioning in Taiwan's electricity market	Interview, Data collection, Past reports	Content analysis, Interviewing
The performance of supportive instruments in Taiwan	Interview, Data collection, Past reports	Content analysis, Interviewing, Observation

3.4 Data analysis

3.4.1 Method of data analysis

In this research, both qualitative and quantitative methods of data analysis were applied according to the type of data. For instance, RE supportive instruments and the type of electricity market are data that required information from diverse aspects as the source, thus, data in this category was conducted with the quantitative method. On the other hand, data related to the RE status in Taiwan has been analyzed qualitatively in order to evaluate the case in Taiwan.

3.4.2 Analytical Framework

The analytical framework of this master thesis is shown in Figure 9.

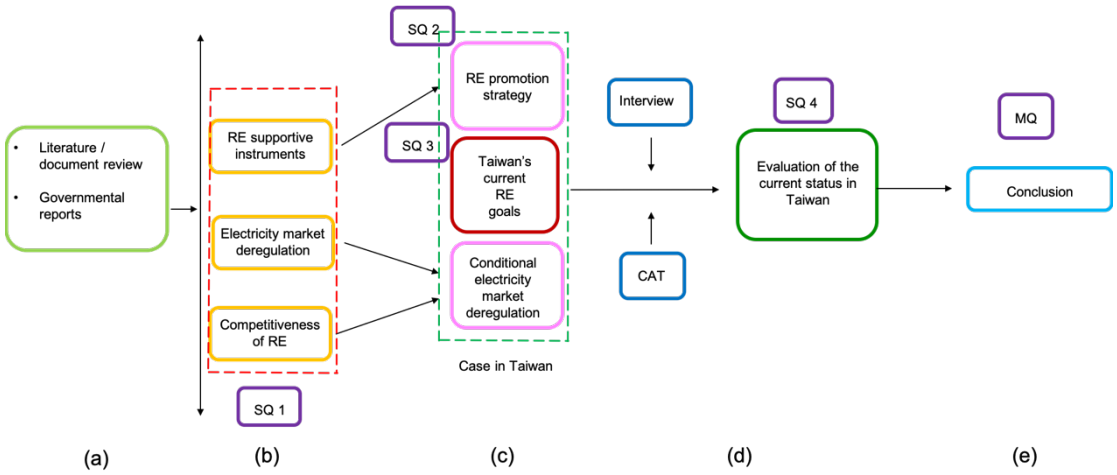

Figure 9 Analytical framework

Data analysis is approached with the following sequences:

(a) The first step is the collection of data and information, especially focuses on 1) The functioning and structure of the electricity market. 2) RE promotion strategy and supportive instruments. 3) The concept of competitiveness in the market. The literature and document review in this phase are prepared for preliminary information to answer sub-questions in this study.

(b) With the information collected from the first step, the second step has chosen three mechanisms that have the potential to promote renewable energy from both theoretical and empirical perspectives, which will be later applied to the case in Taiwan. Also, this stage discusses the relation between three mechanisms and the share of green electricity to answer sub-question 1.

(c) Stage 3 begins the case study in Taiwan. This stage introduces the current RE goal and two strategies (RE promotion strategy, Conditional deregulation to the electricity market) to achieve the target. Information in this stage is able to answer sub-question 2 & 3.

(d) Based on information collected from interviews, this stage provides a further explanation to the mid-term result from the last stage, also conducts CAT and Checklist to evaluate the functioning in the conditional deregulated electricity market to answer sub-question 4.

(e) The effectiveness and performance of two renewable energy promotion strategies that the Taiwanese government conducted are concluded in this step.

3.5 Ethical statement

Based on the Bryman and Bell (2007) & the Ethic procedures from the University of Twente stated in the Research Ethics Policy (2019), ethical consideration related to the data collection and the prevention of violation to interviewees are followed in this research.

- Ensure the privacy of research participants
- Any data or information collection for the research will be conducted only if the permission from the interviewee is obtained.
- Any deception or counterfeit of data or information will be avoided in the research.
- Ensure the anonymity of participants and organizations.
- Ensure adequate classification of the data and information from interviewees
- Offensive, discriminated questions will be avoided in the interview.

Chapter 4 The current renewables status in Taiwan

This chapter demonstrates the on-going RE promotion strategy in Taiwan's electricity market during the energy transition to give a more extensive insight into current energy status and renewable energy goal in Taiwan. Moreover, sub-question 2 (*What are the policy instruments within RE promotion strategy and what is the electricity market structure in Taiwan?*) and sub-question 3 (*What is Taiwan's current progress in reaching it green electricity goals?*) are answered through the mid-term evaluation in the summary of this Chapter.

4.1 The energy transition and the goals in Taiwan

4.1.1 The evolution of the energy transition in Taiwan

The issue of energy transition in Taiwan has been debated for decades and is full of controversies. The attitude of indecisiveness and contradiction toward the energy policy between two main political parties drag out the transition progress. In the 1970s, Taiwan's industrial structure was mainly composed of heavy industries and petrochemical industries, which had high energy demands especially in the areas of oil refining and steel production. Cheap energy derived from the fossil fuels has long been regarded as the ideal energy source on which Taiwan's economic foundation was built. Even though a big portion of highly polluting and energy consuming industries were gradually replaced by the electronics industry after the 1980s, electricity demand kept growing annually, and the average electricity growth rate over the last five years (2015~2019) was about 1.3% (Figure 10).

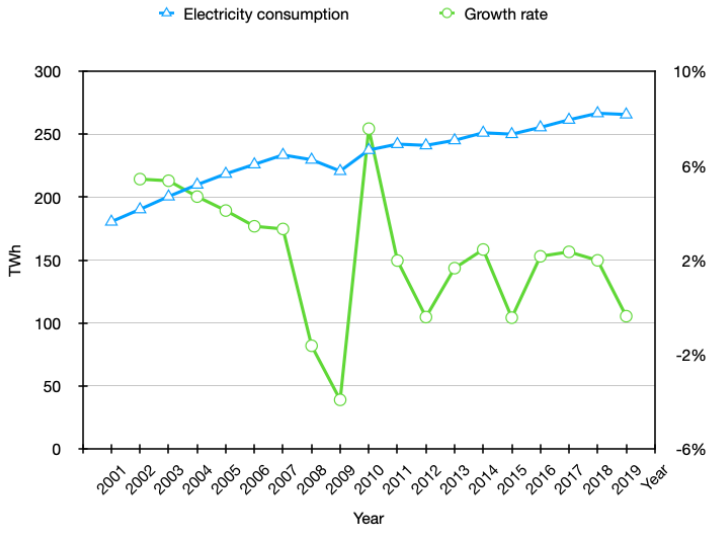

Figure 10 Annual electricity consumption and electricity growth rate in Taiwan

(Data: Bureau of Energy)

Persistent high electricity consumption for industries and high reliance on imported primary energy became two energy insecurities for the Taiwanese government, causing it to rethink its energy strategy and open a window for the energy transition. There is a consensus between

the two main political parties that coal-derived energy should be curtailed in order to alleviate air pollution from coal-fired power plants. However, the question is: What will the alternative energy sources to compensate for the energy gap from coal be? Aside from the supplement from natural gas, nuclear energy and renewable energy are two possible options for Taiwan. Both alternative energy options have their own champion, the diverse attitude toward the nuclear power between two political parties not only make the energy issue more complicated and make it become a political affair instead of professional based on scientific and economic arguments. In addition, it also abate the strength of energy transition since the energy policies are forced to start over again when every time changes in governments happen. The debate between nuclear power and renewable energy have prolonged the progress of energy transition until 2011. The lesson from the Fukushima nuclear accident in 2011 urged the Taiwanese government to positively promote the renewable energy and gradually phase out nuclear power plants on the island, for the reason of converting the current brown economy into the green economy, also ensuring the energy security for the next generation.

In addition to the reason for promoting energy independence, global trends toward renewable electricity is another factor to prompt the energy transition in Taiwan. RE100 is the global corporate renewable energy initiative that invites ambitious businesses committed to 100% green electricity (RE100.com). Today, Taiwan is a leading global supply chain for numerous RE100 member cooperatives, inevitably more and more companies in Taiwan are required to utilize green electricity during manufacturing processes by their upstream clients. It is predicable that the demand for green electricity will become higher in the following years. Although amendments to energy law expedited the establishment of a conditional deregulated energy market and the trading of the green certificate, energy industry in Taiwan is still in the learning stage, the policy effectiveness to accelerate the energy transition is full of uncertainty and many challenges need to be overcome in the future.

4.1.2 The energy transition goal in Taiwan by 2025

The ultimate energy transition goal in Taiwan, as stated by the MOEA is that "*20% of the electricity generation needs to be derived from renewable energy, also achieve the nuclear-free homeland by 2025*, *at the same time augment the energy independence and dwindle the reliance on imported fuels*" (MOEA, 2019). The policy tree of the energy transition goal is presented in Figure 11 and details of sector goals are described as follows:

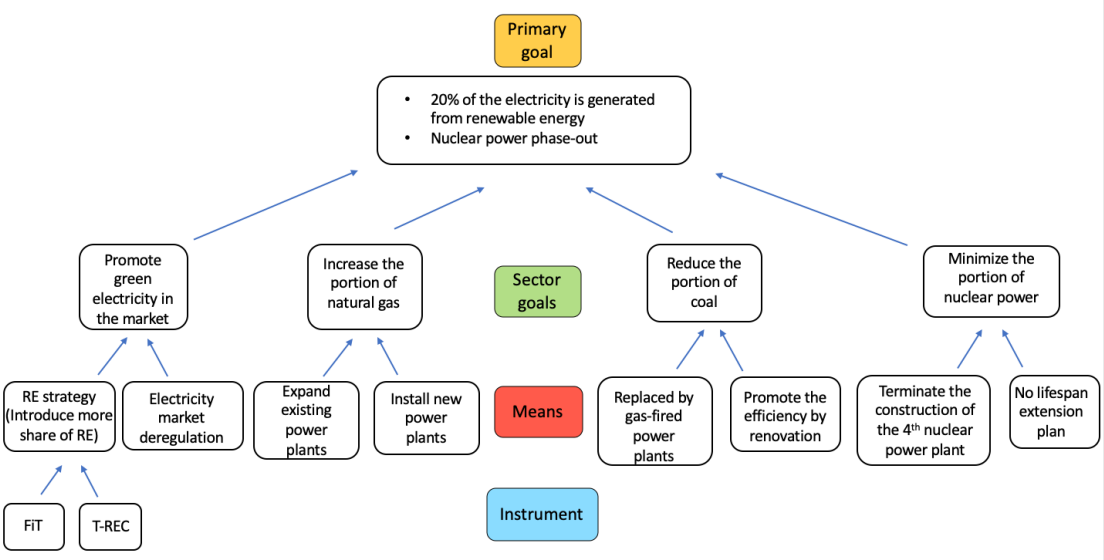

Figure 11 The policy tree of energy transition in Taiwan

I. Promote green electricity in the market

Expand the deployment of renewable technology and facilities, particularly the installation of PV and offshore wind farms in the western coast. Also, provide a liberalized and well-functioning electricity market to enhance the competitiveness of green electricity.

II. Increase the portion of natural gas:

To mitigate air pollution and enhance energy security, natural gas plays an important role in Taiwan's energy transition since it has to compensate the power gap from coal-fired power plants and nuclear power plants. By 2025, gas-fired power plants will generate 50% of the total electricity.

III. Reduce the portion of coal:

With the characteristics of low price and stable supply, coal can be regarded as the pillar that supported Taiwan's economic prosperity over the last few decades. However; it is also criticized for the air pollution and excessive CO_2 emissions produced during power generation. To prevent the exacerbation of air pollution, the portion of electricity generated from coal will reduce to 30% by 2025.

IV. Minimize the portion of nuclear power

Considering Taiwan is located at the Circum-Pacific belt, nuclear power cannot be the optimal energy option for the next generation due to the difficulty of storing nuclear waste. Furthermore, compared to the falling prices of renewables, the cost of nuclear power also needs to take the decommissioning fees into account. Thus, transitioning to

nuclear power is a costly option. The Executive Yuan has announced the schedule of nuclear decommissioning, expecting to reduce power generation from nuclear energy and complete the nuclear power phase-out target by 2025.

This chapter is focusing on the discussion of the first sector goal: *promoting green electricity in the market.*

4.2 The current strategies to achieve the energy transition goal

The energy policies in Taiwan can be traced back to 1973, and the attention of these former policies mainly focused on how to enhance the stability of energy security without hampering the economic development. There was less concern at the time for environmental protection or sustainability. Not until the 2000s did the Taiwanese government begin forming the draft of renewables-related policies endeavoring for sustainability for the next generation. Thus, the blueprint and goal of the energy transition in Taiwan became explicit in the late 2000s, and following this, two on-going strategies have been implemented to propel the advancement of the energy transition (Chou et al., 2019).

4.2.1 RE promotion policy

Two revolutionary modifications to Taiwan's energy legislation are considered as the locomotives of the energy transition. One is the redistribution of the power generation mix. Due to the characteristics of isolation and land limitation of the islands, Taiwan will continue to rely on fossil fuels. Additionally, the portion of nuclear power is expected to be phased out and part of the resulting power gap will be compensated by renewable energy, mainly from solar PV and offshore wind energy. However, it is challenging to boost the share of renewable energy from 4.7% to 20% within a few years, so the Taiwan Executive Yuan approved the second stage of the "Two-Year Solar PV Promotion Project." This stage installed an additional 1.5 GW of PV capacity in 2019 and aims to expand the total solar PV installed capacity to 6.5 GW by the end of 2020. The "Two-Year Solar PV Promotion Project" can be regarded as an ancillary policy that is conducive to fulfill the solar PV 20 GW installed capacity goal by 2025 (Executive Yuan, 2019). At the same time, the Ministry of Economic Affairs (MOEA) has been promoting "Four-Year Wind Energy Promotion Project" since 2016. This project has a mid-term goal of reaching an installed capacity of 1334 MW (onshore: 814MW, offshore: 520MW) by 2020, and an ultimate goal of 4.2GW (onshore: 1.2GW, offshore: 3GW) by 2025[6] (MOEA, 2016). Moreover, under the consideration of domestic industrial upgrading, the Industrial Development Bureau (IDB) ambitiously expects

[6] In the second stage of offshore wind power development plan, MOEA has allocated a total of 5.5 GW to different offshore wind developers in 2018, which means the total offshore wind target has increased to 5.7GW (including demonstration wind farm) by 2025.

to facilitate a localization of the offshore wind industry and build the industry supply chain on the island. Taiwan is aiming to become the hub for the Asia Pacific wind market through the current offshore wind project (IDB, 2018).

The potential of offshore wind energy in Taiwan Strait has attracted global offshore wind developers, such as Ørsted, CIP, and Yushan, to engage in the offshore wind farm development projects in the western coast. To ensure the stable growth of the offshore wind industry in Taiwan, offshore wind power development plan is divided into three stages: 1) Demonstration, 2) Zones of Potentials, and 3) Zonal Development. The Demonstration stage was initially consisted of three projects (Formosa 1, Taipower, and Fuhai), with the installed capacity of 358MW by the end of 2020. The second stage planned to allocate 5.5GW through two different procedure, namely "Selection Procedure" (3.5GW) and "Competitive Bidding Procedure" (2GW). The "Selection Procedure" meant any offshore wind developers who were interested in the developing project needed to be evaluated with some specific criteria (i.e. technology, finance, local content consideration, etc.) by the MOEA, and only for those who met the requirements were qualified with the establishment permit. Differently, the only considering factor in the "Competitive Bidding Procedure" was the tariff; developers with the lowest tariff won the project. The third stage is the zonal development after 2026, which aims to install 1GW annually and expand a total of 10GW by the end of 2035.

4.2.2 The deregulation of the electricity market

Another way Taiwan has sought to promote renewable energy is by amending the Electricity Act in 2016, through which it intended to liberalize the electricity market in two stages. Before the deregulation of the Electricity Act, Taipower Company was the only state-owned utility and had monopolized the energy market for fifty years. Even now, Taipower Company is still the only public utility in Taiwan. To enhance energy security and assure a steady energy supply to energy consumers, the MOEA deregulated the limitation of independent power producers (IPP) in 1995 and permitted the power trading between IPPs and the Taipower Company to elevate the capacity of reserve margin. In 2009, the Taipower Company introduced the FiT to purchase electricity generated from renewable energy. After the first-stage conditional liberalization of the electricity market in 2016, with the regulation of "Green Electricity Comes First," RE generation companies are allowed to sell green electricity to electricity customers. At the same time, the Taipower Company is required to transform into a holding company and be divided into power sector, T&D and retail sector after the amendments. To popularize green electricity in the market, the MOEA established the Taiwan Renewable Energy Certificate (T-REC) in 2017. The electricity market Power generators who produce 1000 kWh by renewable energy will be issued a certificate. The establishment of the T-REC can label the origin of green electricity so consumers are able to

provide the certificate to meet the standard under the regulation. The second stage of the liberalization will open grey energy to the electricity market and an electricity trading platform will be founded. Both are expected to be conducted in 6 to 9 years after the first-stage deregulation, which will be around the year 2024.

Before the revision of the Electricity Act, Taiwan's electricity market was classified as a monopsony market, which meant there were several electricity suppliers and only one buyer (Taipower company) in the market (Figure 12). In this situation, the electricity price was regulated by the public utility, and most of the electricity trading was done by PPA or FiT instead of relying on free market competition.

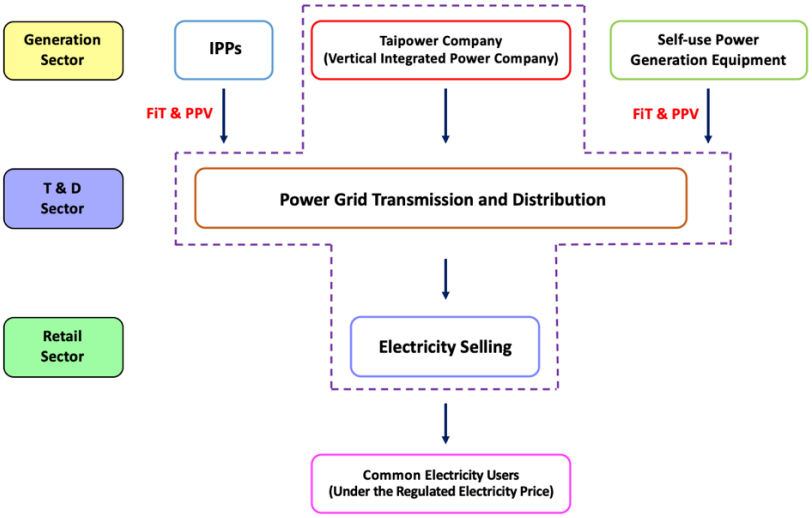

Figure 12 Electricity market structure in Taiwan before the amendments

The monopsony electricity structure may restrict the innovation and competition of electricity products and also limit the expansion of renewable energy in the market. Therefore, the idea behind the amendments to the Electricity Act is the deregulation of the monopsony electricity market. This means Taipower company needs to be divided into different sectors and no longer monopolizes power generation, T&D, and retail business in the electricity market. The amendments to the Electricity Act has proposed a new framework for the electricity market, however; in the first stage of the deregulation it only allows the trading of green electricity which can be sold in the way of wholesale, wheeling, and direct supply. Conventional energy is excluded in this scheme (Figure 13).

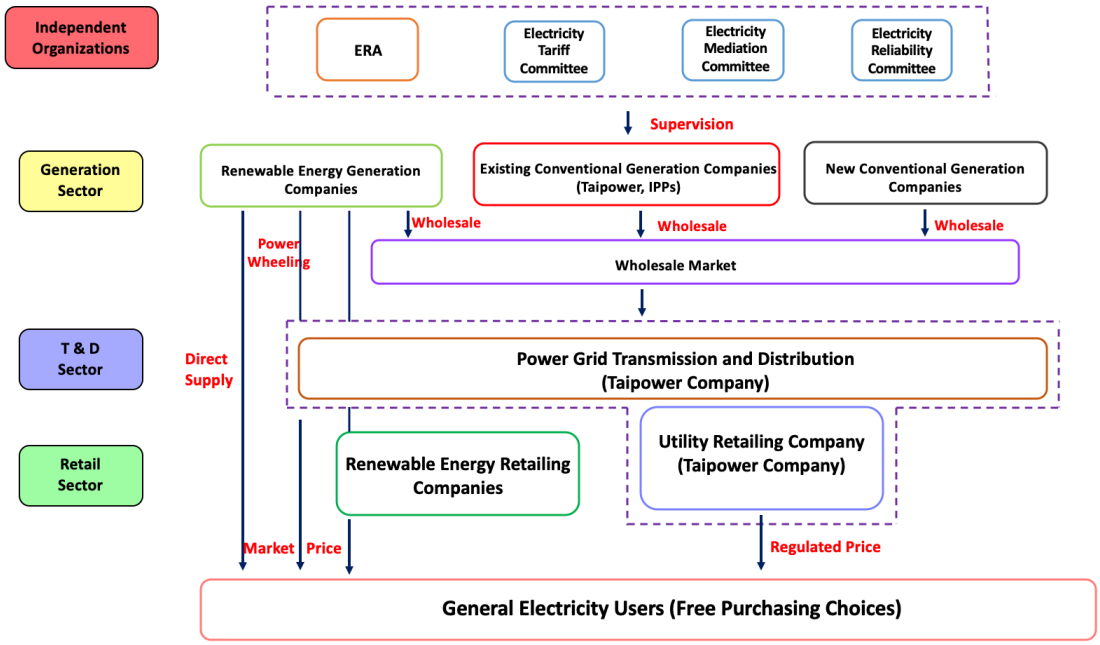

Figure 13 Ideal electricity market structure in Taiwan after the amendments

(Revised from the Bureau of Energy, 2017)

Considering energy security, the business of electricity transmission and distribution is still monopolized by Taipower Company's grid sector according to the regulation (Amendments to the Electricity Act, 2017). At the same time, Taipower Company is responsible for the establishment of an electricity trading platform. Taipower Company has formed the "Electricity Trading Platform Commission" in 2018, with the responsibilities of designing the trading platform, negotiating with stakeholders, and conducting the financial analysis of the market (TEPA, 2019). The initial design includes three different markets, which are: the Capacity Market, Day-Ahead Market, and Real-Time Market. According to the MOEA and the Taipower Company, the testing of the Day-Ahead Market and the Capacity Market will take place in the first quarter and the fourth quarter of 2021, respectively (MOEA, 2020).

Figure 14 presents market actors in Taiwan's current electricity market that are involved in the study.

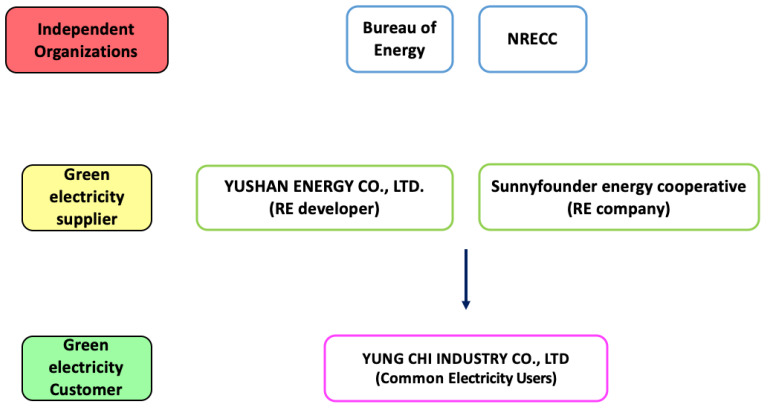

Figure 14 Market actors in the current electricity market

4.3 Supportive instruments within the current RE promotion strategy in Taiwan

4.3.1 Feed-in Tariff (FiT)

The electricity market in Taiwan has not yet been fully deregulated and the design of the market structure is still in the early stage. Although the legislation has already approved that green electricity suppliers who own a retailing license can sell electricity through the transmission, without the establishment of an electricity trading sector. However, the attitude from green electricity suppliers seem to be more conservative, and they tend to sign the FiT contract with the Taipower company to secure revenue. Therefore, most of the green electricity trading so far in the market were completed through PPA or FiT instead of auction or tender process, which means the current electricity market structure in Taiwan is still far from a free competition.

From the perspective of renewable energy suppliers, the MOEA did not fully take market and technology-varying conditions into consideration when it set the annual FiT rate (Wang, 2012). Therefore, the uncertainty towards the FiT rate may dissuade offshore industries from funding more potential wind farms. Moreover, it intensifies business pressure on small scale energy cooperatives, especially on those who highly rely on revenue from the FiT.

4.3.2 Taiwan Renewable Energy Certificate (T-REC)

Amendments to the Electricity Act provides an opportunity for electricity customers to purchase green electricity or green certificates to meet their demand, especially for international companies like Google and RE100 members who are more likely to utilize green electricity during the manufacturing process due to their self-regulated sustainable policy and obligation to meet the local requirement. The MOEA expected that the huge demand for green energy would bring prosperous commerce of T-REC in the electricity market as well, however; the real performance of the T-REC was opposite as it was predicted.

This phenomenon could be interpreted by the following reasons. The first reason was that the online certificate trading platform was still testing, which resulted in that both certificate sellers and buyers did not have a proper platform to negotiate the contract and finish the dealing, inconveniences from the above status did decrease the incentive to engage in the certificate trading. The second reason resulted from the first reason, because currently there was no certificate trading platform, companies who generate renewable energy by themselves tend to keep certificates to meet their own requirement instead of selling them to the market. The last reason was that most of green electricity, especially generated from solar PV, were bought by the Taipower Company. After the amendments, renewable energy suppliers are allowed to sell electricity to buyers other than the Taipower Company. However, renewable energy generation companies were not allowed to terminate the contract with the Taipower Company because of the PPA agreement, so green electricity from the previous renewable energy generation companies could neither be sold on the energy market nor provide T-REC certificates. Therefore, these shortcomings explained why the market dealing rate of the T-REC remained low over these years.

To improve the dilemma, the Legislative Yuan passed the revision draft of the "Renewable Energy Development Act" (REDA) in 2019, which allows the termination of PPA between renewable energy generation companies and the Taipower Company. Another spotlight of the REDA amendments is the regulations for large electricity consumers (Large Electricity Consumers Regulation). According to the amendments, large electricity consumers who exceed the capacity of 5000kW are obligated to install 10% of the renewable energy power generation and facilities, or purchase a certain amount of renewable energy and certificates (REDA, 2020). In other words, the trading of green energy and T-REC for large electricity consumers needs to be sold at the same time and not allow to be divided, which is known as the **bundling sale**. However, some of the green energy suppliers and consumers hold different perspectives from the government and assert that unbundling sale is a more effective way to prosper the sale of T-REC. Since the Bureau of Energy has not gotten the consensus with industry representatives and considers the impact COVID-19 brings, the implementation of the "Large Electricity Consumers Regulation" would be deferred to 2021 (Bureau of Energy, 2020).

4.4 The mid-term review of Taiwan's energy transition goals

Although the deadline to meet Taiwan's energy transition goals is set to 2025, it is crucial to do a mid-term review to evaluate the performance of the on-going policies' implementation. Due to the research scope, only the first sub-goal is discussed in this section.

I. Promote Renewable Energy:

- **The renewable installed capacity has grown compared to the last year (2018), and most of the increased capacity is derived from the PV.**

  According to the "Two-Year Solar PV Promotion Project", another extra 1.5 GW capacity of solar PV should be installed in 2019. Based on the data from the Bureau of Energy, the PV installed capacity in 2019 was 1779 MW, with 1491 MW from roof-top PV and 288 MW from land-based PV. This has exceeded the anticipated target goal (Bureau of Energy, 2020). The success of this PV expansion may partly contribute to smoother cooperation between the central government and local municipalities. Firstly, the biggest obstacle to installing land-based PV is that it is difficult to find suitable land for large scale PV installation. Therefore, the local municipality has found potential sites (e.g. non-arable land, closed landfill site, detention basin) for land-based PV installation and has successfully promoted land-use efficiency for sustainable purposes. Secondly, considering the effective land usage and the prior goal achievement of 3 GW of roof-top PV (the installed capacity of roof-top PV reached 3.02 GW in 2018), the Bureau of Energy has redefined their PV installed capacity goals. The land-based PV capacity goal has been reduced from 17 GW to 14 GW, and the roof-top PV capacity goal has been increased from 3 GW to 6 GW by 2025. However, many residential houses in Taiwan have the problem of illegal rooftop constructions, which prohibit the installation of roof-top PV. To increase the installation potential of roof-top PV, both the central government and local municipalities have adjusted construction regulations to allow them only on rooftops that meet the safety standard. At the same time, MOEA and the Council of Agriculture have examined the feasibility of applying agrophotovoltaics (APV) in the southern part of Taiwan. Thirdly, the MOEA has authorized local municipalities to install small scale PV (under 500 kW) in order to avoid bureaucratic processes. To date (05. 2020), the total installed capacity of solar PV that has been connected to the grid is 4.6 GW, and this number will continue to grow.

  On the other hand, the first offshore wind farm (Formosa 1) was fully commissioned at the end of 2019. With the extra 128 MW installed capacity from this offshore wind farm, the total installed wind capacity has reached 852.4 MW. Although this number is still far away from the expected goal (1334 MW, onshore: 814MW, offshore: 520MW), three offshore wind farms (Taipower demonstration wind farm, Formosa 2 and wpd Taiwan) will start construction in 2020 and are expected to enter operation by 2021. These three wind farms are able to provide a total 1128 MW (110 MW, 378 MW, and 640 MW) of installed capacity,

increasing the total offshore wind capacity to 1256 MW by 2021 (Chiang, 2019; wpd Taiwan, 2020).

- **The portion of electricity generated from the renewables has increased, yet does not meet the anticipated goals.**

  Compared to 2018, the percentage of electricity generated from renewables has increased from 4.6% (2018) to 5.6% (2019), and renewable power generation has grown 20.1% from 12.7 TWh in 2018 to 15.3 TWh in 2019 (Bureau of Energy, 2020). Solar PV has the most significant power generation growth, from 2.7 TWh in 2018 to 4.1 TWh in 2019. The percentage of the total installed capacity from solar PV and wind energy reached 2.2% in 2019 (Bureau of Energy, 2020).

  Even though renewables sharing and renewables power generation has increased annually, a gap still exists between actual achievement and expected goals. According to research from the National Taiwan University Risk Society and Policy Research Center (RSPRC) and data from the Bureau of Energy, the renewables power generation in 2019 was 15.3 TWh, with energy sharing of 5.56%. However, in the National Electricity Resources Report (2017) the renewables power generation target for 2019 was 18.1 TWh with 7% energy sharing (Bureau of Energy, 2017). This means the actual performance of renewables power generation is 15% below the original target (RSPRC, 2020). Furthermore, in accordance with the statistic calculation, the total installed PV capacity in 2019 (1779 MW) was not fully connected to the grid. Only a capacity of 1.4 GW has been connected to Taipower's electricity grid system, which can explain a part of energy difference between installed capacity and its actual power generation output (RSPRC, 2020; Bureau of Energy, 2020).

  Examining the progress of the current wind energy deployment, both onshore and offshore wind projects have lagged behind mid-term targets. As of May 2020, the installed capacity of offshore wind power is 128MW (Fuhai wind farm failed to pass the EIA), which is still far from its mid-term target of 520 MW. The current wind energy capacity is mainly generated by onshore wind turbines, with an installed capacity of 724.4 MW. However; this capacity is still about 90 MW short of the mid-term goal (Bureau of Energy, 2020). Another factor that brings uncertainty to onshore wind energy targets is that the "Four-Year Wind Energy Promotion Project" does not formulate a specific plan for producing onshore wind energy after 2020. Additionally, it would be more difficult to develop onshore turbines due to the limited land resources. Both uncertainties need to be addressed

properly to ensure that wind energy targets can be achieved by 2025 (RSPRC, 2020).

4.5 Summary

The introduction of supportive instruments and electricity market structure in this chapter provides information for reader to understand the current renewable status in Taiwan to answer sub-question 2. Currently, FiT and T-REC are two instruments within the RE promotion strategy, and the electricity market in Taiwan is conditional deregulated, which means the operation in the market has not yet been fully liberalized. Taiwan's current electricity market structure will be more fully explained in the next chapter. After solving sub-question 2, Table 4 summarizes the mid-term review of Taiwan's energy transition goals, which is helpful in understanding the answer to sub-question 3.

Table 4 The comparison between current energy progress and the target

	Actual performance (2019)		Expected target (2020)		Ultimate target (2025)	
	Power generation (TWh)	Energy mix	Power generation (TWh)	Energy mix	Power generation (TWh)	Energy mix
RE	15.3	5.6%	24.9	9%	61.7	20%
Gas	91.1	33.3%	93.2	33%	158.0	50%
Coal	126.4	46.1%	126.3	45%	85.1	27%
Nuclear	32.3	11.2%	29.5	10%	2.9	1%
Other	9.0	3.8%	8.2	3%	5.4	2%
Total	274.1	100%	282.0	100%	313.2	100%

Note: Power generation from the Expected & Ultimate target is estimated by the Bureau of Energy (Bureau of Energy, 2018)

Chapter 5 The explanation behind the current RE status in Taiwan

As mentioned in Chapter 2, RE promotion policy and the deregulated electricity market are two strategies that relate to the promotion of renewable energy and green electricity in Taiwan. Later in Chapter 4, we have a general scope of Taiwan's energy transition goals and what policies the Taiwanese government conducts in pursuit of its ultimate target. Content in this chapter focuses on the assessment of the first sector goal (Promoting green electricity in the market) and evaluates the relationship between the sector goal and strategies that the government has currently implemented (introducing more shares of RE and deregulating the electricity market). Figure 15 shows the scheme of this chapter to let the readers understand the result of the evaluation in each section. This chapter will evaluate the result of applying these two strategies in Taiwan and assess if they produce the results that the Taiwanese government expected. Also, this chapter answers sub-question 4 (***To what extent can the achievement of the green electricity goals in Taiwan be explained by specific policy instruments within RE promotion policy and the functioning of the conditional deregulated electricity market?***).

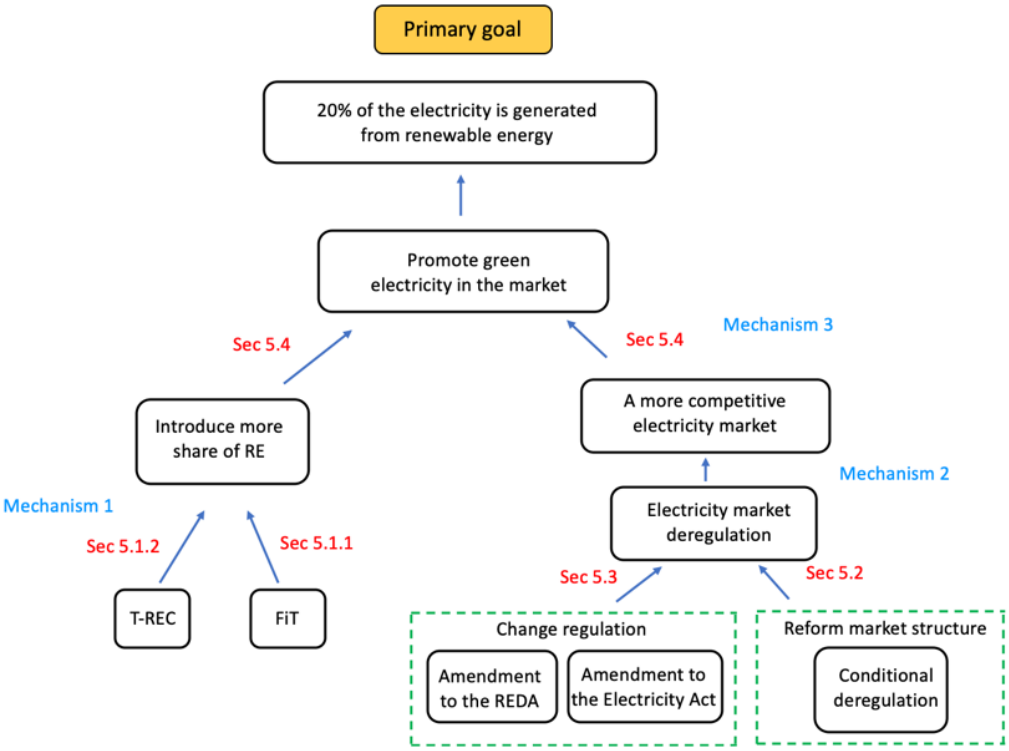

Figure 15 Scheme in Chapter 5

5.1 The influence of supportive instruments on the promotion of renewable energy

5.1.1 FiT

The FiT is the primary instrument to support renewable developers in supplying green electricity and propelling Taiwan's energy transition movement. Unlike the case in Germany (Sec 2.1.3.1), whose FiT scheme has been applied since the 1990s, Taiwan is only halfway through the first round 20-year FiT. Even with only ten years of practice and without experience from the past, however; statistics from the last ten years have suggested that the current FiT policy in Taiwan is the right way forward. It has received a positive result in promoting the share of green electricity in the electricity market.

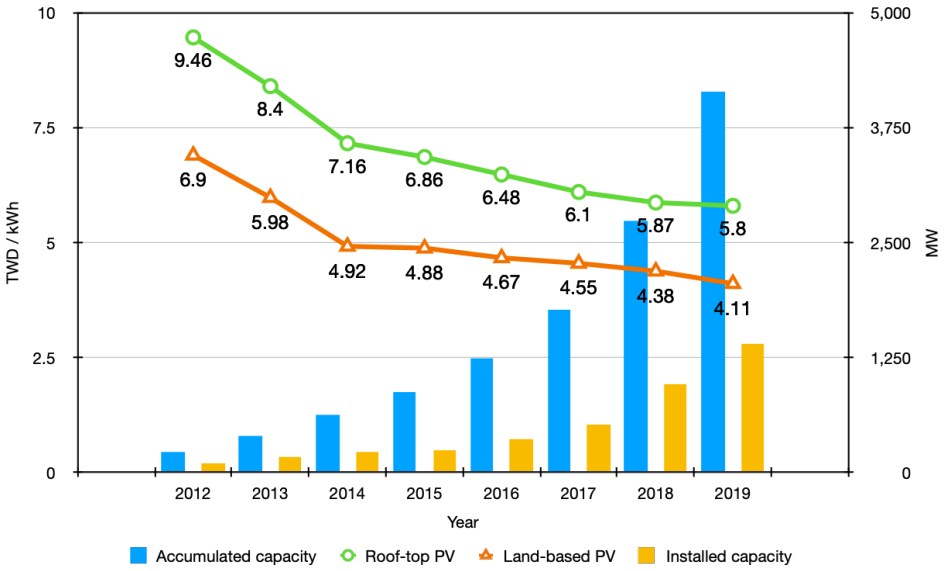

Figure 16 Annual FiT rate and installed capacity of solar PV (Data: Bureau of Energy)

The expansion of solar PV can be regarded as the main share of renewables in the last few years. Figure 16 presents the annual FiT rate and the annual installed capacity of the PV. The FiT rate of PV is steadily decreasing annually, however it seems that it does not cause a significant impact on the expansion of PV, and the installed capacity continues growing every year. Even with the lowest FiT rate compared to the last few years, the installed capacity in 2019 singly has successfully reached 1.5 GW and has met the target set by the Bureau of Energy. This phenomenon reflects the fact that though the FiT rate is decreasing annually, the reduction is still acceptable to solar PV developers and does not dissuade their willingness to invest.

According to the ordinance in the REDA, MOEA is the authority responsible for setting the annual FiT rate. Every year MOEA will arrange an audit committee to take several factors (i.e. initial construction fee, 20 years maintenance fee, reasonable revenue, etc.) into account and formulate a draft FiT rate before the convention. Renewable developers can provide their

suggestions and opinions to the committee in the convention if they think the draft rate does not reflect their investment cost. The audit committee would then collect feedback from the industry to scrutinize if it is necessary to do any adjustments before the next convention. After a few rounds of discussion and revision, the final version of the FiT rate for the next year will be approved as long as the consensus is made between the audit committee and renewable developers (Interviewee 2). The amount of the FiT rate is determined by four variables: Initial construction cost, 20 years maintenance fee, Capitalization factor, and Annual electricity sales volume (Figure 17).

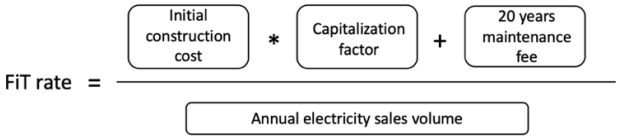

Figure 17 The formula of the FiT rate in Taiwan

The annual reduction of the FiT rate is predicable since the cost of renewable technologies has decreased annually. However; some solar developers have suggested the reduction of the FiT rate should not exceed the global average (4.25%) because the rising of U.S. 10 Year Treasury Yield has increased the uncertainty to the capitalization factor (Meeting minutes, MOEA 2020). The reduction of the FiT rate has a greater impact on the smaller-scale developer, especially for the energy cooperatives who rely on the power generation from roof-top solar PV. This is because the business model of the energy cooperative in Taiwan is based on crowdfunding, and they are required to provide the internal rate of return (IRR) to their clients. A drastic reduction of the FiT rate may diminish the IRR and clients' incentive and also limit the innovation influence on the energy cooperative in the future (Interviewee 3). However, the solar PV technology is more mature today, making the construction of solar PV cheaper and able to compensate for the impact brought about by the capitalization factor. Furthermore, no matter what the FiT rate from roof-top PV or land-based PV is, the solar business is still lucrative for large scale developers in comparison to the current electricity price (2.62 TWD / kWh)[7]. This explains the reason why the annual reduction of the solar FiT rate neither created a fierce backlash from solar developers nor affected the expansion of the solar PV.

[7] Household electricity

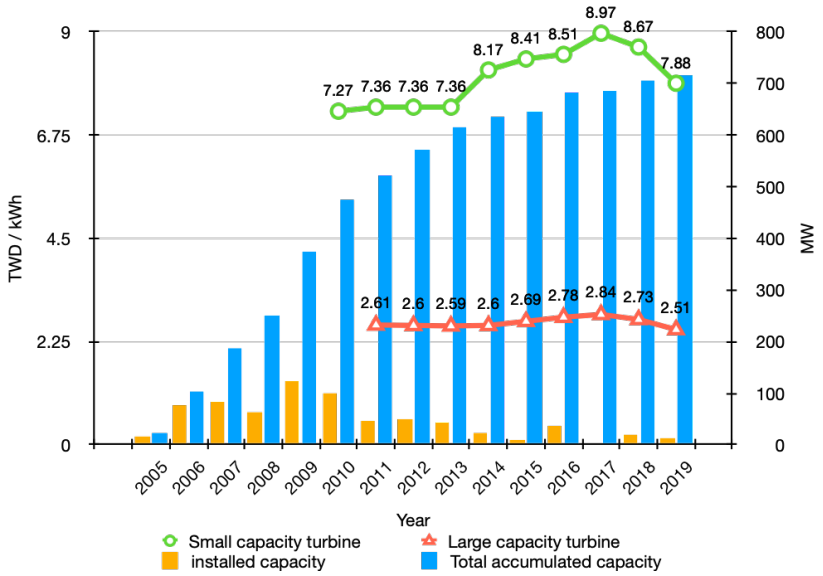

Figure 18 Annual FiT rate and installed capacity of onshore wind (Data: Bureau of Energy)

On the other hand, the relationship between the FiT rate of onshore wind and its installation seems to be more volatile when compared to the case of solar PV. The deployment of onshore wind can be traced back to 2000. Before the legislation of REDA, the development of onshore wind energy tended to be a demonstration of the political ambition for renewable energy instead of a development based on commercial consideration. Therefore the budget of onshore wind projects was mostly supported by the governmental subsidies. However, the government withdrew these subsidies in 2004, and after this, electricity generated from onshore wind turbine was purchased with a fixed price (2 TWD / kWh) by the Taipower Company until the introduction of the FiT in 2010 (Yuan magazine, Taipower Company 2012). In the FiT era, the rate of the large capacity onshore turbines ranges between 2.51~2.84 TWD / kWh and has not had a significant price fluctuation in the past 10 years. Although the average FiT rate of the onshore wind turbine is more favorable compared to the fixed price period, however; statistics in the last 10 years show that the higher FiT rate does not stimulate the higher onshore turbine installation (Figure 18). This phenomenon may contribute to the saturation of onshore capacity in Taiwan since the development of onshore turbines in Taiwan was concentrated in the first decade of the 2000s and most of the suitable sites have already been occupied. It is now more difficult to find potential sites for onshore turbines today. In addition to the limitation of land resources, negative impacts (shadowing, noise nuisance, environmental consideration, etc.) that onshore turbine bring, hinder the more recent expansion of onshore turbine. Therefore, the FiT rate is not the only variable that determines the installation progress of onshore wind turbines.

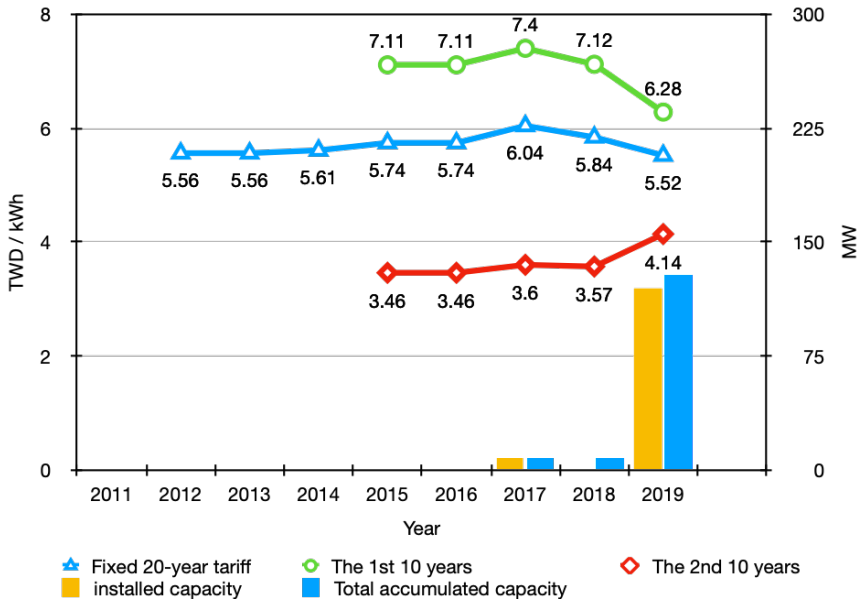

Figure 19 Annual FiT rate and installed capacity of offshore wind (Data: Bureau of Energy)

Similarly, statistics collected so far do not reflect an obvious relation between FiT rate and the installed capacity in the case of offshore wind energy (Figure 19). This is because instrument to promote the expansion of offshore wind energy in Taiwan do not merely depend on the FiT, it also includes the mechanism of "Selection Procedure" and "Competitive Bidding Procedure" (See Section 4.2.1) that makes the development plan more complicated compared to other renewables. Furthermore, the offshore wind power plan has a stronger connection to government's political ambition (i.e. wind farm demonstration, localization of the wind industry), which means all of the offshore wind development proposals should adhere to the principles of MOEA's offshore wind project design (3 phases development plan) otherwise they cannot acquire the establishment permit (Interviewee 4). Although there is not enough evidence to prove the relationship between FiT rate and the annual installed wind power capacity, however; the FiT rate is able to determine the time schedule of the installation process to some degree. This is because the drastic reduction of the FiT rate in the last few years has prolonged consultations between MOEA and offshore wind developers, which has resulted in the postponement of the government's original construction plan.

5.1.2 T-REC

Unlike FiT, which has a more direct influence on the deployment of renewables, the potential of renewables promotion from the T-REC seems to be more ancillary and moderate. The main purpose of the T-REC is to multiply added value on green electricity by providing extra revenue as incentives to favor renewables suppliers. Furthermore, it popularizes the trading of green electricity at reasonable price and extends accessibility for potential consumers. By formulating a benign credit cycle between supply and demand sides through the market

mechanism, the operation of the T-REC can be regarded as a catalyst to speed up energy transition procedures (Interviewee 1).

Although T-REC was only introduced in 2017, NRECC is optimistic about the prosperous selling of T-REC in the following few years. Figure 20 shows the issued certificates in the past three years, and the number of certificates in 2020 is significant. Issued certificates in the first half of 2020 have already surpassed the numbers in 2019. The growing number of certificates in 2020 can be explained by several factors. Firstly, after months of testing, the online certificate trading platform was officially launched in June this year (2020). The platform not only provides a "public version of PPA contract template" as a reference for seller and buyer to shorten the negotiation procedures, but also introduces auction mechanism to diversify certificate trading forms. Secondly, the current based price of the certificate is 1,400 TWD/certificate, which means the sale of a certificate can grant at least an additional 1.4 TWD/kWh for green electricity suppliers. The extra revenue boosts renewables suppliers' willingness to apply T-REC from the NRECC to enter the market (NRECC, 2020; Interviewee 1). Thirdly, Under the "Large Electricity Consumers Regulation," more companies have begun to fulfill their renewable obligation this year. Lately, the largest semiconductor manufacturing company in Taiwan, TSMC, has completed the first green electricity trading through power wheeling[8]. It has purchased about 10,000 certificates from renewables suppliers on the certificate platform (NRECC, 2020). This successful trading case represents a big first step for green electricity and certificate trading in the market. No matter if the intention to purchase green electricity and T-REC is to meet an obligation or to fulfill a social responsibility, it is predictable that more companies will follow suit in the next two years.

To some degree, the promising development of the T-REC has a positive influence on the expansion of renewable energy and the ability to introduce more green electricity into the electricity market.

[8] Power wheeling is a type of electricity transportation within an electricity grid from power generation sectors to end users

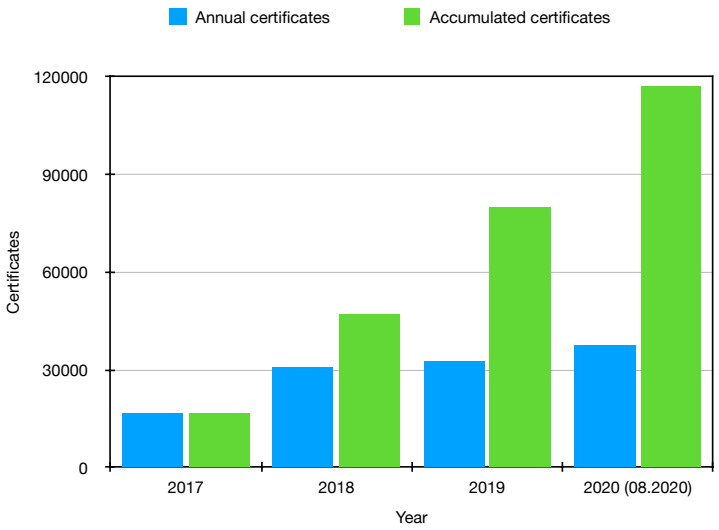

Figure 20 Issued certificates in the past three years

5.2 The influence of the market reformation on the function in the electricity market

5.2.1 The current electricity market concentration in Taiwan

To understand the influence of the deregulated electricity market on the promotion of green electricity, we need to first evaluate the market concentration as a premier index to determine the market performance under the current market structure. Table 5 presents the market share between different power generators and the annual HHI value. The result shows that all of the HHI values have exceeded 6000 in the past five years, and the market concentration shows no difference even after the conditional deregulation (2017). This means Taiwan's electricity market remains highly concentrated today, and there is no competition in the market since Taipower Company dominates over 3/4 of the total power supply. The conditional deregulation neither makes the market more competitive nor increases the competitiveness of green electricity in the market.

Table 5 Market share and HHI in Taiwan's electricity market (Data: Taipower)

Generation sector	2015	2016	2017[b]	2018	2019
	Market share (%)[a]				
Taipower	77.2	77.1	78.1	78.3	77.6
IPP (Coal)	9.7	9.5	9.1	8.4	8.3
IPP (Gas)	8.1	8.4	8.4	8.2	8.6
RE	2.2	2.4	2.6	3.0	3.7
Cogeneration	2.8	2.6	1.8	2.0	1.8
HHI	**6132.22**	**6117.74**	**6262.98**	**6281.69**	**6181.54**

Note: [a] Market share is based on annual power purchase from the Taipower Company [b] The first year after conditional liberalization

5.2.2 Renewables development under the current market structure

Inherited the result from the last section, Taipower Company is still the largest electricity provider in the market, pointing out the fact that the amended Electricity Act fails to mitigate the problems of market power and monopoly in the electricity market as the government anticipated. The result can be ascribed to indecisiveness and compromise content in the amendments to the Electricity Act when it was launched in 2017. The spirit of amendments to the Electricity Act was meant to terminate the long-term monopolization from the Taipower Company and to demonstrate the spirit of energy democracy to the general public, however; the amendments itself could be the main reason that exacerbated the existing problems. Numbers of controversies in amendments could interpret why the Taipower Company today still predominates the electricity market even after the market reformation. Details of how articles in the amendments to the Electricity Act resulted in the problem of monopoly will be discussed in the next section (Section 5.3).

Aside from the problem of monopoly, it is also on the debate that whether amendments to the Electricity Act are truly conducive to promote renewables and increase the share of green electricity in the market. Although the amendments were expected to promote the diffusion of green electricity, however; in contradiction that some articles in amendments may have opposite effects to the achievement of its original purpose. Firstly, the amendments did not relieve the investment risk for renewables generation companies. Contrary, it created more financial burden for renewable energy developers to compete with the Taipower Company. For instance, for those renewable generators or retailers who like to provide green electricity through direct supply or power wheeling are required to prepare a level of electricity reserve capacity before engaging in the market (Article 27). In other words, any renewable companies have to spend extra cost (by self-generation or purchase from other generation companies) to meet the requirement of reserve capacity, otherwise they cannot sell green electricity to their clients. Furthermore, renewable generation companies and retailers will be charged for "transmission fee" and "distribution fee" by the Taipower Company if they sell green electricity through the grid system from the Taipower Company. However, the tricky thing is that if renewable companies decide to sell their green electricity to the Taipower company rather than sell on their own, then they neither have to meet the requirement of reserve capacity nor have to pay for the extra charging. Therefore, given cost-benefit balance, there would be a big chance that renewable energy companies are more willing to sell their electricity to the Taipower Company to reduce investment costs.

In short, under the structure of a highly concentrated market and with the imperfection of the amendments, the current market environment is unfriendly for renewable energy companies to survive independently, especially for smaller developers with limited capital. To some

degree, the frustration of the current market state may hinder the goal achievement of Taiwan's renewable energy target since irrational regulations in the amendments have already affected renewable energy developers' willingness and confidence to invest.

5.3 The influence of the regulation changes on the function in the electricity market

From the last section, we have seen that amendments to the Electricity Act set barriers for renewable energy generation companies to compete in the market. In this section, we will more precisely point out how amendments to the Electricity Act and REDA affect electricity market competition based on the Competition Checklist that is previously mentioned in Section 2.4 (Table 6).

Table 6 Competition check list (Revised from Checklist)

Checklist	Restriction in the electricity market
Limits on the range of electricity suppliers	◆ Limits IPPs generated from conventional energy to provide electricity to consumers ◆ License requirement for energy cooperatives
Limits on the ability of electricity suppliers to compete in the electricity market	◆ Raises the cost of production for green electricity suppliers relative to the Taipower Company
Reduction in investment incentives	◆ Favors the Taipower Company with some articles in the Electricity Law
Limits the choices for electricity consumers	◆ Limited choices for consumers to decide from whom they purchase electricity ◆ Lack of information to the electricity market ◆ Bundled sale requirement for the large electricity consumers

5.3.1 Limits on the range of electricity suppliers

◆ **Limits IPPs generated from conventional energy to provide electricity to consumers**

The article of "Green Electricity Comes First" in the first deregulation stage has violated the principle of the market liberalization since it has restrained the ability of conventional energy IPPs to participate and compete in the generation sector. Without the deregulation of conventional energy, IPPs generated with conventional energy can only sell their electricity to the Taipower Company as it was before. Since the scale of

renewable generation companies is relatively small in comparison to the Taipower Company, the Taipower Company can easily take over 90%[9] of the market share in the wholesale market. This drives the market away from free competition. Although the amendments allows free purchasing choices for general users, in the current situation consumers can only choose between "green electricity" or "electricity sold by the Taipower Company" because there is no access for consumers to purchase electricity from IPPs. This explains why the Taipower Company can keep its market position even after the amendments.

- **License requirement for energy cooperatives**

  Although the government has ambitions to replicate the successful experience of energy cooperatives from Germany, under the current regulation in the amendments, energy cooperatives can only sell their electricity to the Taipower Company with the FiT rate. The crux of the problem is that the legislative status of energy cooperatives belongs to the self-usage renewable power generation industry (with installed capacity < 500kW) instead of proper RE generation companies. This means that RE companies are not allowed to directly participate in commercial activity in the electricity market (REDA, 2018). Power wheeling and direct supply are two ways to do this. If energy cooperatives want to sell their electricity through power wheeling or direct supply to their clients, they have to apply for another selling license. Currently, energy sources for energy cooperatives are mostly derived from roof-top PV with smaller capacity (10~20kW). Under this economic consideration, the profit in the free market has not yet been a persuasive incentive for them to terminate the FiT contract with the Taipower Company. Furthermore, this additional regulation discourages the participation of citizen-led renewable generators to compete in the market. Based on information from the interviewee, the procedure of license transfer is bureaucratic and full of obstacles, which has reduced their willingness to switch their current license (Interviewee 3). It can be said that the current market structure is not amiable for small scale generation companies, however; the presence of this license regulation has added to the already high threshold for entering the electricity market.

[9] Even though IPPs have about 20% of the market share in the generation sector, however; at this moment IPPs can only sell their electricity to the Taipower Company. Therefore, the generation portion from the IPPs should be included in the portion from the Taipower Company, which makes the market share of Taipower Company can reach 90% in the wholesale market.

5.3.2 Limits on the ability of electricity suppliers to compete in the electricity market

- **Raises the cost of production for green electricity suppliers relative to the Taipower Company**

  As mentioned in Section 5.2.2, the amendments did not bring any cost advantages or ancillary support to renewable generation companies at their embryonic stage. To the contrary, regulations in the amendments raised the threshold for renewable developers to enter the market. Firstly, amendments to the Electricity Act impose several external costs (i.e. transmission fee, distribution fee, preparation for reserve capacity, etc.) to private renewable generation companies that did not exist before. Even though the REDA has allowed the termination of PPA contracts between renewable generation companies and the Taipower Company, if private generation companies terminate the contract, they have to pay for liquidated damages to the Taipower Company. The regulation is criticized by the renewable generation industry because it increases the production cost of green electricity and benefits the Taipower Company in the end. Secondly, if renewable generation companies do not want to use Taipwer Company's grid system to transmit and distribute electricity they generated, the only way for them to sell electricity is to build the grid system themselves to directly supply electricity to their clients. However, the price to build a grid system is costly and the government does not budget subsidies for developers. This is the reason why "direct supply" has never been an option for renewable generation companies to transmit and distribute electricity. As a result, new regulations increase capital risk and financial burden for newly founded companies. Since most of the smaller scale renewable generation companies are formed by citizen-led initiatives, an increase in production costs will make it more difficult for these companies to borrow capital from banks and will create barriers to entering the electricity market.

5.3.3 Reduction in investment incentives

- **Favors the Taipower Company with articles in the Electricity Law**

  Dividing the Taipower Company was supposed to be a critical step in breaking their monopoly in the electricity market. Nevertheless, articles in the amendments left some ambiguity in the exact definition of the division. The division was meant to mitigate the vertical market power of the Taipower Company in order to increase market competition, but the amendments neglected the fact that the Taipower Company has been the one and only power utility in the past fifty years. It has significant horizontal market power as it owns a large number of power generators on the market. Today, Taipower Company controls 63.3% of power generators in the generation sector (Bureau of Energy, 2020), and without a horizontal division of the Taipower Company, it is difficult for other private generation companies to compete.

Furthermore, the government regarded the price of electricity as a political issue and insisted on preserving the integrity of the Taipower Company in the amendments. This left the possibility for the government to intervene in market activities when imbalances occur. That is why the amendments has been criticized by the public; the existence of these articles neither solved the problem of monopoly in the market nor supported newly-founded renewable energy companies.

Thirdly, it would be unfair to private renewable generation companies if the Taipower Company could participate in the market competition without any quantity restrictions, since it is a state-owned enterprise supported by the government. Lately, the Taipower Company has announced that it will release 800 GWh of green electricity to the market when the trading platform is launched at the end of 2020 (MOEA, 2020; Taipower Company, 2020). The manipulation from the Taipower Company initiated a debate among private generation companies. A group of companies argued that the Taipower Company should not be involved in the free market competition because of its ability to determine the price of green electricity with its market power (Interviewee 3). In addition, the production costs of green electricity from the Taipower Company could be lower because of its scale advantage, which will burden private generation competition. Meanwhile, other groups of developers held an optimistic attitude because the present demand for green electricity from industries is still higher than what the generation sector can supply. The participation of the Taipower Company can stimulate market liquidity and make green electricity prices more transparent on the platform (Interviewee 4).

While it is still too early to assess the influence of Taipower Company on free market competition, it is undeniable that the role of the Taipower Company in the future will be an important variable for private generation companies to consider before entering the market.

5.3.4 Limits the choices for electricity consumers

- **Limits the choices for consumers to decide from whom they purchase electricity**
  Because the electricity liberalization at the current stage does not include the deregulation of conventional energy, therefore, customers do not have an access to directly purchase electricity from conventional IPPs. (See 5.3.1 "*Limits IPPs generated from conventional energy to provide electricity to consumers*")

- **Lack of information to the electricity market**

  With the deregulation of the electricity market, Taipower Company was no longer the only choice for consumers to purchase electricity. Even though it has been three years after the partly deregulation in the electricity market, and the general public today are more willing to support sustainable development by purchasing green electricity, however; with the lack of policy announcement and the establishment of the trading platform, electricity customers are still unfamiliar to the market structure after the amendments and have no experience of how do the reformed market work. That is why the attitude from electricity customers tend to be conservative and remain the old practice to purchase electricity from the Taipower Company instead of other private electricity suppliers (Interviewee 5).

- **Bundled sale requirement for the large electricity consumers**

  After a few rounds of revisions, the Legislative Yuan has retained its decision for a "bundled sale" requirement for large electricity consumers in the amendments to the REDA. This means green electricity and T-REC cannot be sold separately. Although the bundled sale has its shortcomings in promoting certificate liquidity in the market, NRECC has explained why it would currently be more suitable to regulate large electricity consumers through the bundled sale. Firstly, the practice of granting certificates is an innovative trading strategy that has never been conducted in Taiwan's market before. NRECC claims that bundled sale would be a better starting option for companies to get familiar with the mechanism behind the certificate trading. Secondly, because the T-REC can be used as documented proof for different environmental purposes (i.e. the credit for "CSR declaration" and "CO_2 emission inspection"), bundled sale can verify the "zero-emission" behind the certificate[10]. Therefore, under the regulation in the REDA and to make T-REC more acceptable by other administrations, the bundled sale could be a better choice than the unbundling sale because it can prevent the confusion for companies in the environmental inspection.

  Since the certificate trading platform was launched in June 2020 and is still in the experimental stage, it is comprehensible that the the NRECC would be more prudent than hasty. It has kept an open-mind to allowing unbundled sales for large electricity consumers, but only if certificate trading remains on track in the future.

[10] The problem with unbundling sales is that becomes difficult to determine whether certificates can be used to prove that companies who hold them actually reduced CO_2 emissions. For instance, a company that uses grey electricity in their manufacturing process can purchase T-REC on the trading platform for purposes other than the CO2 emissions inspection This is because the "zero-emission" behind the certificate does not have a direct connection to a company's emissions. In other words, this company would not contribute to the "zero-emission" behind the certificate, and this is the main reason why the EPA does not accept certificates outside of a bundled sale.

5.4 Summary in this chapter

This chapter provides a comprehensive explanation of the relations between supportive instruments, the conditional deregulated electricity market, and their performance on the promotion of renewable energy. Content in section 5.2 and section 5.3 can be elaborated by Figure 21, which reflects the current status of the electricity market in Taiwan. When in comparison to the ideal electricity market structure that the government expected (Figure 14), we can see a gap exists between reality and anticipated results. Firstly, IPPs can only sell electricity to the Taipower Company due to the current regulation, which is the same as it was before the amendments. Secondly, the wholesale market is not ready yet. Without a trading platform, only with a small portion of renewable energy companies attempt to sell electricity through power wheeling to their big client. In addition, as mentioned in Section 5.3.2, the "direct supply" is unlikely to happen in the market in the following few years. It is not a cost-effective way to sell electricity under the current market status. Therefore, nearly all of the renewable generation companies tend to retain their previous selling strategy, which is selling electricity to the Taipower company to ensure a steady profit. Thirdly, the Taipower Company has not yet been separated and still controls the operation of electricity service flows.

Even though the current electricity market in Taiwan is only partly deregulated and cannot be fully compared with the ideal electricity market that the government expected, it still carries significant problems. The Taiwanese government may need to revise some current policies before moving forward, otherwise it may become even more difficult to achieve anticipated results.

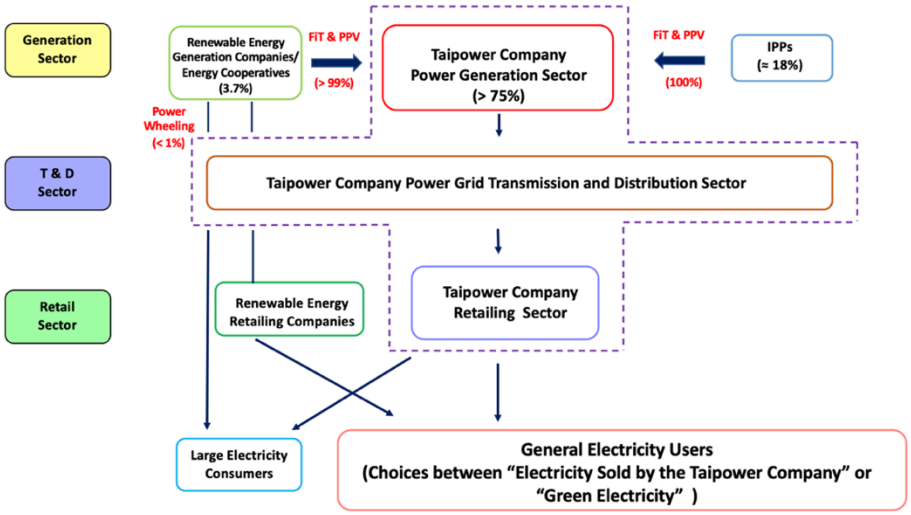

Figure 21 The current electricity market structure in Taiwan after the amendments

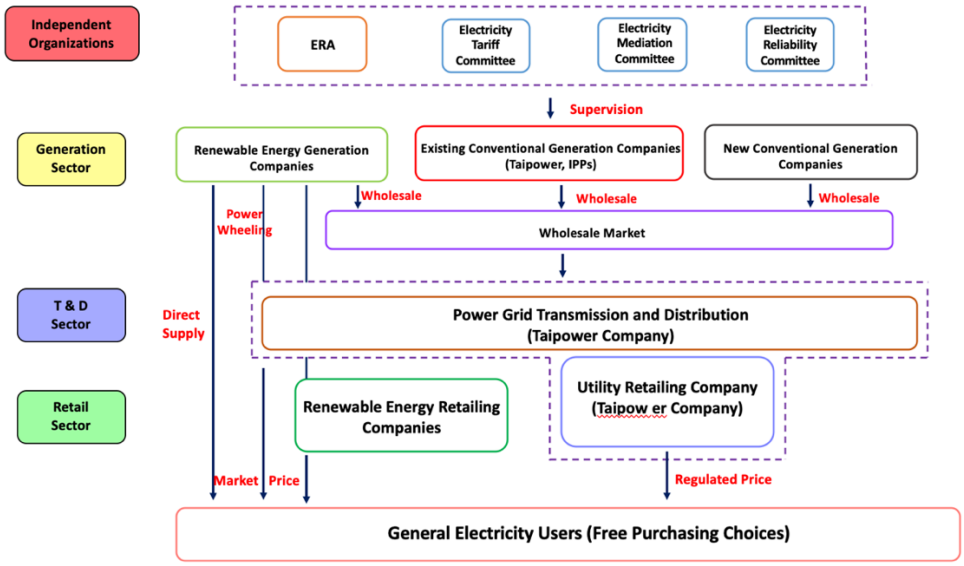

Figure 13 Ideal electricity market structure in Taiwan after the amendments

All in all, this chapter provides a further explanation of strategies the Taiwanese government is applying and evaluates if they are helpful to the promotion of green electricity in the market. The results in Chapter 5 can be explained in Figure 22. To briefly answer sub-question 4, supportive instruments do introduce more green electricity to the market. These instruments can be regarded as an effective strategy of achieving energy transition goals. On the other hand, the current, partly deregulated market fails to provide incentives to renewable energy developers to supply more green electricity. Therefore, the current strategy of deregulating the electricity market may not be an effective method to meet Taiwan's green electricity goals.

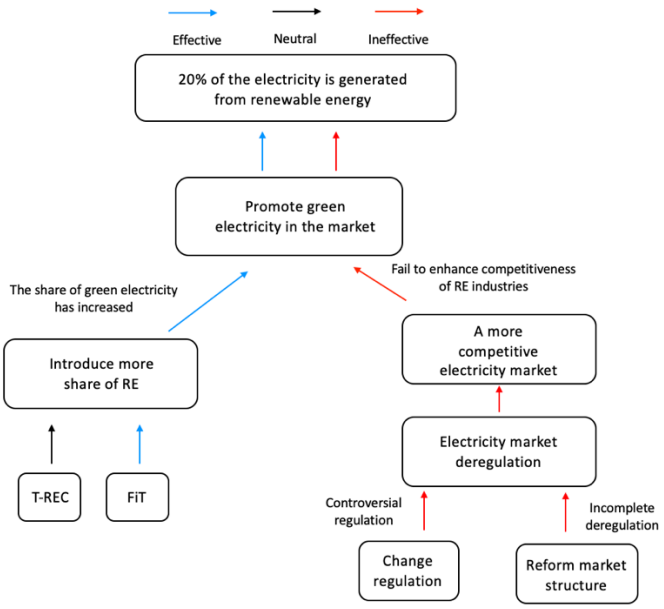

Figure 22 The result of evaluation in Chapter 5

Chapter 6 Conclusion

This chapter systematically concludes the thesis by answering the main question and four sub-questions. The objective of this research is to evaluate the relation of different mechanisms towards the promotion of renewable energy. Relying on the finding in the research, this chapter offers a series of explanations to assess the RE situation in Taiwan. Research limitations are also presented at the end of this chapter.

6.1 Conclusion

The following is the answer to each of the sub-questions in this research.

1. ***How do specific policy mechanisms within RE promotion strategies relate to the increase of green electricity in a country of similar characteristics as Taiwan?***

In Chapter 2 we selected three mechanisms, based on the situation in Taiwan, as theory factors that relate to the position of green electricity. The first mechanism (supportive instruments) is an instrument behind the RE promotion policy. Because the formation of RE promotion policy in a country is purposeful and follows the specific goal it is set to achieve, supportive instruments can be regarded as tools that offer the most straightforward assistance towards reaching a government's policy targets. Therefore, from the theoretical perspective of this research, the "Supportive instruments" mechanism has a direct influence on the promotion of green electricity.

On the other hand, the effects of the other two mechanisms (Electricity market deregulation and Enhancing the competitiveness of RE in the market) in promoting the share of green electricity is more veiled in comparison to the first mechanism. This is because from the theoretical perspective the main purpose of the above two mechanisms is not solely the expansion of renewable energy. Towards this end, the role that these two mechanisms play is more indirect. Therefore, this research has classified "Electricity market deregulation" and "Enhancing the competitiveness of RE in the market" as potential instruments in promoting the share of green electricity.

2. ***What are the policy instruments within RE promotion strategy and what is the electricity market structure in Taiwan?***

From the information in Chapter 5, the Taiwanese government has applied two supportive instruments to facilitate the expansion of renewable energy. The main instrument is the FiT, which has provided direct support to solar PV and wind power developers since 2010. The secondary instrument is the T-REC. T-REC is a form of certificate trading based on the principle of the RPS policy, and it has only recently been introduced to the market in 2017.

Therefore, the operation of T-REC is still in an early stage, and the relevant regulation and trading system have not yet been fully established.

In 2017, the Taiwanese government passed the amendments to the Electricity Act and deregulated the electricity market. However, the current electricity market in Taiwan is in the first-stage of liberalization and is only partly deregulated. This first-stage deregulation only permits renewable energy companies to participate in market activities in the generation and retail sectors. The electricity market will be fully deregulated around 2024 in the second stage of liberalization. Therefore, it can be said that the current operation and structure in Taiwan's electricity market is in between a "regulated market" and a "deregulated market", which can be explained by Figure 21 in Chapter 5.

3. What is Taiwan's current progress in reaching it green electricity goals?

Taiwan is gradually attaining its sustainable electricity goals, nevertheless, the statistics in Chapter 4 show that the transition progress is not fast enough. This is particularly due to the promotion of renewables, which still require an extra 9.6 TWh to meet the mid-term target by 2020. Aside from the steady growth of solar PV, which is on track to achieve the installed capacity target by the end of 2020, the inadequate and delayed expansion of offshore wind energy could be the main reason that results don't meet expectations. In addition to the expansion of the renewables facilities, another aspect which should be considered is the renovation of the current power grid and the increase of renewables infrastructure (e.g. electrical substation). The integration of green electricity and utility grid systems also plays a pivotal role in determining whether the sustainable electricity goal can be achieved by 2025. The outcome of the mid-term review indicates that the Taiwanese government should not be satisfied with current progress because it is far from the anticipated goal. Instead, the government's attitude should be more progressive, especially in overcoming hindrance factors between offshore wind developers and governmental departments in the next five years. All in all, it is challenging for Taiwan to achieve its energy transition goal by 2025, particularly in renewable energy.

4. To what extent can the achievement of the green electricity goals in Taiwan be explained by specific policy instruments within RE promotion strategy and the functioning of the conditional deregulated electricity market?

The evaluation in Chapter 5 explains the relationship between the promotion of green electricity and two strategies that the Taiwanese government is now applying. The first relation is the effect of RE promotion policy on the promotion of green electricity. Statistics in Chapter 5 have shown that supportive instruments, particularly the FiT, behind the current renewable energy policies are conducive to the development of renewable energy in Taiwan

and effective to the promotion of green electricity in the electricity market. On the other hand, the instruments did not bring any significant assistance to the promotion of green electricity. This is because 1) the electricity market in the current status is not fully deregulated and unable to work as expected, and 2) some of the controversial articles in the amendments to the Electricity Act have abated the effectiveness of market reformation and have built up a tougher threshold for smaller renewable energy developers to survive independently in the market. As a result, the current electricity market does not attract newly founded or small scale renewable energy companies to compete and engage in the free market. Most of the RE companies would rather sign a FiT contract with the Taipower Company. Nor has the competitiveness of the RE industries been enhanced to give green electricity a better position in the electricity market. Therefore, the second strategy the Taiwanese government is conducting seems to be an ineffective way to promote the share of green electricity at the current stage.

The explanation above provides sufficient information to answer the main question below:

To what extent do renewable energy strategies and the electricity market deregulation affect the promotion of green electricity, particular to the case in Taiwan?

Based on the current situation in Taiwan, "conducting RE promotion strategy" and "deregulating the electricity market" are two primary strategies for the Taiwanese government to achieve its sustainable electricity goal that 20% of electricity is to be generated from renewable sources by 2025. The research shows that the implementation of supportive instruments has a positive and significant influence on the development of renewable energy, while the deregulation of the electricity market at the current stage is less relevant and less effective to the promotion of green electricity in the market.

To conclude, supportive instruments that the Taiwanese government is now applying, such as FiT and T-REC, can be considered useful tools that stimulate the development of renewable energy. However, as mentioned in the Section 2.5, RE integration in Taiwan is in a very early phase, which is quite different from the situation in renewables forerunner countries. This means that the application of the same instrument in different regions may lead to diverse outcomes due to the innate characteristics of different countries. Experiences from renewable energy forerunner countries in Europe have shown that although supportive instruments are effective in expanding renewable energy, they may also come with economic problems (i.e. financial burden for the government). Therefore, during its own policy implementation, the Taiwanese government should also take the side effects of supportive instruments into

account. It should also make a periodic policy review to adjust the supportive instruments according to specific situations.

Furthermore, empirical findings from mature electricity markets show that a fully deregulated and well-functioning electricity market is a precondition to the development of a renewable energy industry. If the Taiwanese government is to achieve its renewable energy targets, several obstacles in its energy market, such as the dominance of the Taipower Company and the existence of controversial regulations, need to first be overcome.

6.2 Limitation of the research

Initially, this research was meant to conduct another interview with a large international cooperative in Taiwan, in order to understand the influence of REDA from "large electricity consumers' perspective. However, due to the pandemic of COVID-19, it became more difficult to contact the cooperative and arranged interview with them. Therefore, this research can only provide data collected from a medium-scale company as the input for the evaluation. Besides, the promotion of renewable energy is a broad and complicated issue, strategies to increase the share of renewables may diverse depend on countries' renewables status. Due to the time limit, this research only focusing on the discussion of the unique case in Taiwan instead of providing a comprehensive evaluation for the general case.

Aside from external limitations, the research scope is also limited because this thesis only selected Taiwan as the only case to study. Besides, the main reason behind the energy transition in Taiwan (environmental consideration, energy security) is different from Germany or the UK in Europe (Paris Agreement). This characteristic makes Taiwan become an atypical case, which is difficult to find a country with a similar situation to compare with. Since the policy implementation is a dynamic process, further study is required to make the evaluation of the case in Taiwan more comprehensive.

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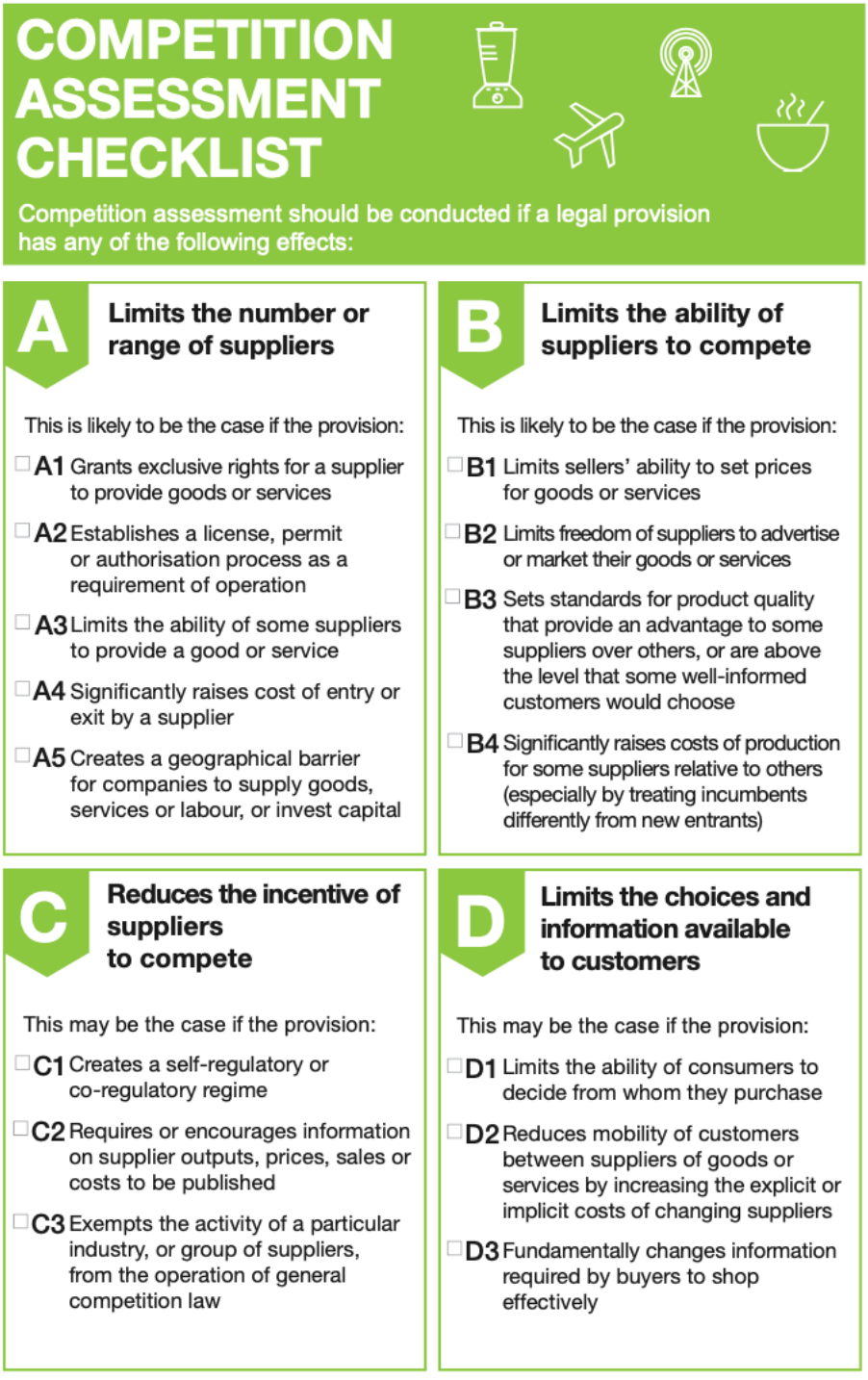
Appendix A – Competition Assessment Checklist (OECD)



Appendix B – Interview Question (Administration Side)

- Why the green certificate trading system in Taiwan adopted bundling sales instead of unbundling sales to regulate the large electricity consumers?
- Currently is there any competent authority responsible for the supervision in the energy market?
- Without the energy trading platform, at present how do you ensure the functioning and the transparence of the green electricity trading in the energy market?
- In the Renewable Energy Development draft, the definition of large energy consumers are those who exceed 800KW in their contract capacity, while in the Renewable Energy Development Act the threshold extend to 5000KW. Why there is the difference and what is your consideration?
- Even though there is a highly demand of green electricity in the market due to the regulation, yet the trading of green certificate still remain lower than expected since the system was founded in 2017. What is the reason for that?
- Why the energy prosumer are obligated to keep 10% of energy they generated for their own use?
- Under the regulation of bundling sales, energy suppliers need to change their selling strategies when they face different kind of energy consumers. Do you think it will interfere investors' willingness to the investment of renewable energy?
- What is the criteria to determine the annual FiT rate?
- Have you made the conference with renewable energy suppliers or put their opinion into consideration before adjusting the FiT rate?
- What is the trend of FiT program in the future? Is there any plan for the exit strategy for the FiT or the conversion of FiT to FiP?
- What is your opinion to the current policies implementation? Do you think they are conducive and effective to promote the green electricity competitiveness in the market?
- What is the energy market plan in the next five years? Under the current circumstance do you think the renewable energy sharing goal by 2025 is achievable and what is the challenge?

Appendix C – Interview Question (Renewable Energy Supply Side)

- Currently your selling strategy mainly relies on the FiT or the trading in the energy market?
- After passing the Renewable Energy Development Act, what is the influence on your selling strategy?
- What is your opinion to the bundling sales regulation? Do you agree in the embryonic stage the bundling strategy is the best way to promote the certificate trading in the market?
- The rate of FiT is decreasing annually, what is the influence on your business and what is your opinion?
- It is allow to terminate the FiT contract after the passing of the Renewable Energy Development Act, do you tend to keep the contract or terminate the contract and sell your green electricity in the energy market?
- What factors or hindrance interfere your willingness to terminate your FiT contract?
- Currently Taipower Company is the biggest renewable supplier in the wholesale market. Do you consider this phenomenon as a threat which has significant influence on the competition in the energy market?
- Without the foundation of energy trading platform, what is the your opinion to the fairness and transparency of green electricity trading in the market?
- Compared to the energy market oversea, what does the energy market in Taiwan lack off?
- In your opinion, do you have any suggestion to current renewable policies?

Appendix D – Interview Question (Renewable Energy Demand Side)

- Does your company has any budget to the renewable energy development?
- Do you have any renewable energy strategy and target in your company policy?
- Do you utilize green electricity during the manufacturing process?
- Have you installed any renewables facility in your company? If you do, do you think it is cost-benefit way compared to the trading in the market?
- Have you meet your obligated green electricity capacity? If not, what is your plan to fill the energy gap?
- If you do not have budget or space to install renewables facility by yourself, what is your alternative options?
- Without the foundation of energy trading platform, what is the your opinion to the fairness and transparency of green electricity trading in the market?
- If you need to purchase green electricity, do you prefer to sign the selling contract with the Taipower Company or other suppliers?
- Is your company qualified as the “Large energy consumer”? What is your opinion to the “Large energy consumer” policy in the Renewable Energy Development Act?
- What is your opinion to the bundling sales in the energy market?
- What do you think about the current energy market strategy in Taiwan? Do you think the policies are able to promote the trading of green electricity and green certificate in the market?
- In your opinion, do you have any suggestion to current renewable policies?