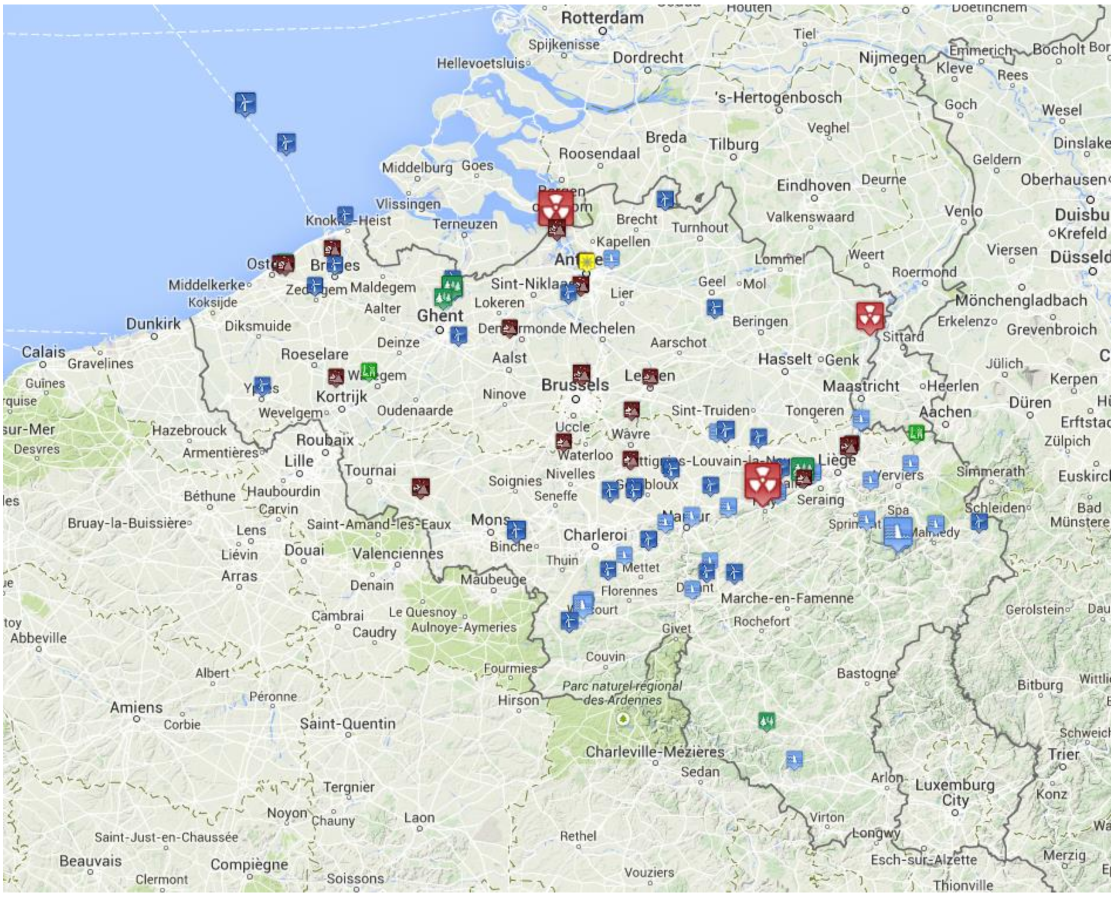
A case study of Belgium: improving the promotion systems for electricity generation from renewable energy sources

Yingyao Wang



Engineering and Policy Analysis

Faculty of Technology Policy Management

Delft University of Technology

A case study of Belgium: improving the promotion systems for electricity generation from renewable energy sources

Yingyao Wang

Supervisors

Prof. R.W. Künneke *Section of Economics of Technology and Innovation*

Chair

Dr. D.J. Scholten *Section of Economics of Technology and Innovation*

First supervisor

Dr. L.J. de Vries *Section of Energy and Industry*

Second supervisor

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Section of Economics of Technology and Innovation
Master in Engineering and Policy Analysis
Faculty of Technology Policy and Management
Delft University of Technology

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Summary

In the aftermath of the Fukushima Daiichi nuclear disaster in 2011, several countries have decided to rethink their energy policies and subjected their nuclear reactors to stress tests. According to national law drafted in 2003, Belgium must have phased out all seven nuclear reactors by 2015-2025. However, to date Belgium still has not presented a clear plan how to replace their nuclear power climate-friendly and securely while maintaining an acceptable electricity price. According to the Belgian energy development plan, renewable energy sources will play an important role in power generation in the coming decade, but the uncertain investment environment undermines the confidence of energy investors. Belgium will not reach its 2020 EU target and even suffer from power shortages if it maintains the status quo.

This paper aims to give new insights into the assessment of RES-E policy instruments and provide possible solutions to improve the RES-E promotion system in Belgium. To realize these objectives, the paper mainly uses the multi-system framework, neoclassical economics and new institution economics throughout the study. To be specific, the research firstly uses the multi-system framework to clarify the RES-E investment environment, and then based on economics theories and existing experiences, defines six policy assessment criteria to evaluate the policy instruments. In the case study of Belgium, the current Belgian power market situation is presented following an adapted multi-system scheme. Furthermore, the history of Belgian RES-E policy instruments are shown as well. With six defined policy assessment criteria, this paper evaluates policy performances of four main RES-E policy schemes in the case of Belgium. Based on the evaluation results, we find that Belgium is most in need of improving the policy performances on cost effectiveness, transaction and administration cost efficiency and compatibility. To improve this situation, three policy options have been listed for Belgium, two of which are recommended in light of the specific characteristics of the Belgian case. Specifically, we suggest Belgium improve its current TGC system and investment subsidies on the one side, and try to implement a tendering scheme on the other side.

In the research, some scientific contribution and practical contribution is recognized as follows. Firstly, an adapted multi-system framework for power generation is established, which could simplify the investment environment and make it possible to get a quick overview of one country's power sector. Secondly, applying new institutional economics in the study is a meaningful step in the field of policy assessment. Most existing studies evaluate the policy scheme only on effectiveness and cost efficiency, but this paper not only summarize and define six policy assessment criteria but also make explanation on each of them based on economic theories and practical experiences. Finally, other countries besides Belgium could also evaluate their RES-E policy schemes in a more comprehensive and accurate manner with six policy assessment criteria and find the right improving direction for the RES-E promotion system.

It is certain that there are limitations in this research. For instance, there might be other investment determinants which I have ignored; the policy assessment criteria are defined only based on certain theories and limited experiences; this paper only focuses on four main RES-E policy instruments and one case study, etc. All of these should be improved by future studies.

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1. Introduction

1.1 Overview

In recent years, significant energy events have taken place, the Deepwater Horizon oil spill off the Gulf of Mexico, the Fukushima nuclear accident in Japan, the Arab Spring which led to oil supply disruptions in North Africa, the rapid deployment of photovoltaics, and the events in Ukraine which resulted in the reduction of natural gas supplies from Russia to European countries (IEA, 2012). All of these put the issues of environmental protection, economic development and energy security on under the global spotlight. At the same time, renewable energy is becoming an increasingly important issue in global energy trends and national energy strategies.

Firstly, greenhouse gas emissions, especially CO_2 emissions, are at an historic high, and this has severe impacts on global warming. According to Matthews's findings, if people want to restrict global warming to no more than 2 degrees, we must restrict total carbon emissions – from now until forever – to little more than half a trillion tonnes of carbon, or about as much again as we have emitted since the beginning of the industrial revolution (Matthews, Gillett, Stott, & Zickfeld, 2009). As 11 gigatonnes (Ragwitz et al.) of CO_2 were emitted by power plants in 2008, electricity production in the energy sector is considered to be the largest source of carbon dioxide until 2050 (Table 1.1). Therefore, the European Union and many are advocating a change from fossil-fuel-based power generation towards a carbon free sector.

World	2005	2020	2035	2050
CO_2 Emissions	27.1	38.3	48.1	55.2
By sector				
Industry	5.1	7.2	8.4	8.1
Transport	6.3	8.0	10.9	15.9
Residential/Commercial	3.4	4.0	4.5	4.7
Electricity production	9.9	15.5	19.7	21.1
Other (including bunkers)	2.4	3.7	4.6	5.3

Table 1.1 Reference case emissions by sector (Eurelectric, 2011)

Secondly, as a critical energy sector, electricity generation is necessary to ensure the security of supply in order to guarantee national economic growth and peoples' living standards. However, most European countries have a high dependency on imported energy, and EU-27 hard coal and natural gas dependency rates respectively reached 62.2% and 64.2% in 2009 (Eurelectric, 2011). This means that the fossil fuels for power generation in all these countries except the Czech Republic and Poland, with high production of hard coal, and the Netherlands and Denmark, with high production of natural gas, are largely supplied by other countries, mainly Russia. In other words, Russia and other energy-rich countries to some extent influence the power supply in many European countries. To decrease the energy dependency, by exploiting renewable energy and develop RES-sourced power plants could be a possibility for some countries.

Nuclear was a good option for future power generation since it is characterized by carbon-free energy. However, the Fukushima nuclear disaster which occurred in 2011 put the nuclear safety issue squarely under the spotlight, and under pressure from several anti-nuclear energy movements, some countries have decided to rethink their energy policies and implement stress tests for their nuclear reactors. For instance, the German government declared the closure of all nuclear reactors by 2022 and strives to develop renewable energy and Italy has banned nuclear power (IEA, 2012). In contrast, renewable energies such as biomass, wind, solar, hydro and geothermal are trusted by public. Since these carbon free energies come from resources which are naturally replenished on a human timescale, it is undisputable that renewable energy plays an important role to mitigate climate change and reduce energy dependency. It can be said that even before the debate about nuclear power has clear results, RES-sourced power generation will be the most promising option for achieving national climate and energy targets in the coming decade.

For the above reasons, the European Union (EU) puts a high priority on the promotion of electricity from renewable energy sources and issued Directive 2001/77/EC which sets a target of 22.1% of gross inland electricity consumption to come from renewables for EU-15 by 2010. This directive was amended twice and finally repealed by Directive 2009/28/EC which sets an overall '20-20-20' goal for the European community. Under the new directive, the member states are granted more rights and obligations. On the one hand, they can accomplish national targets through cooperation mechanisms, but on the other hand, they must establish renewable energy national action plans which not only include indicative targets for renewable sources consumed in electricity, heating and transport and RES support schemes but also cover issues like access to and operation of electricity networks and administrative procedures (European Commission).

The advantages of renewable energy are intuitively clear, and reaching the national RES-E target is obligatory, so each member state is taking efforts to promote electricity generation from renewable energy sources. Compared with conventional technologies, RE technologies are less mature and commercialized (Falconett & Nagasaka, 2010). Therefore, although they save carbon emission costs and fuel costs, renewable energy projects are often capital-intensive and risky. In neoclassical economics theory, investors pursue profit maximization, and consequently more profits are supposed to attract more investments. However, the policy performance of RES-E support schemes gives a different result. According to the study, the countries with highest support levels -Belgium and Italy- are among those with the lowest deployment, while the Spain and Germany with not particularly high support level have great success in RES-E installations (Haas, Panzer, et al., 2011). The fact makes an important point: the investment behavior in renewable energy projects cannot be explained only by neoclassical economics theory.

To make the RE technologies competitive with conventional technologies, two categories of economic promotion strategies, price-driven and quantity-driven ones, are created. By definition, each kind of support scheme has pros and cons, but a debate on which one can achieve optimal results occurs as different schemes are widely used in the world. Even though the current experiences show that FIT schemes are generally more efficient and effective than TGC schemes (Haas, Resch, et al., 2011), some other results and viewpoints are worth thinking about. Firstly, compared with the FIT scheme, the TGC scheme is less mature and adopted by fewer countries, which slows the improvement process of the support instrument to some extent, so it is too early to say which one is better. This is justified by the recent improving effectiveness of quota-based TGC systems, where support is applied technology-specifically via banding (Haas, Resch, et al., 2011). Secondly, the success of renewable energy development depends on the specific design and implementation of the policy instrument rather than the policy type selected. This can be confirmed by the fact that France applies the FITs system but gets little development of wind energy while on the contrary the TGC system in Sweden presents a quite high policy effectiveness and efficiency (Fagiani, Barquín, & Hakvoort, 2013; Held, Ragwitz, Merkel, Rathmann, & Klessmann, 2010a). Lastly, these support schemes are applied in the real world instead of an ideal institution setting environment, which indicates that the investment in renewable energy projects must be influenced by other regulatory and social factors besides the economic barrier (Beck & Martinot, 2004; Rademaekers, 2010). In other words, the most used policy assessment indicators (effectiveness and efficiency) are not sufficient to evaluate the RES-E support schemes since the deployment of RES-sourced power plants is the result of multi-influence factors, not merely a support instrument.

In conclusion, electricity generation from renewable energy sources should be actively promoted to change the global climate and energy picture. In Europe, the European Commission mentioned that the member states shall introduce support schemes and measures and design them effectively in order to ensure the share of energy from renewable sources equal or exceed expectations in the indicative trajectory. In light of experiences and existing studies, the performances of many instruments in practice are very different from their theoretical expectations since the investment behavior is determined by various factors. Therefore, the biggest challenge for each country at this moment is how to choose a proper and effective support instrument.

1.2 Problem description

As a member, Belgium is working towards the EU climate and energy objectives. Renewable energy seems even more important for Belgium in power supply and emission reduction in the future. In Belgium, more than half of power is generated from nuclear (Commision, 2011), so the Fukushima Daiichi nuclear disaster presented policy makers with a difficult situation. Considering the few domestic fossil fuels and the aging of power capacity (Figure 1.1), no matter whether the Belgian government decides to phase out or extend the operational life of nuclear reactors, the energy mix for power generation will change to a large extent in next decade and renewable energy will take the dominant role in the process, especially so wind and biomass energy (Devogelaer & Gusbin, 2011).

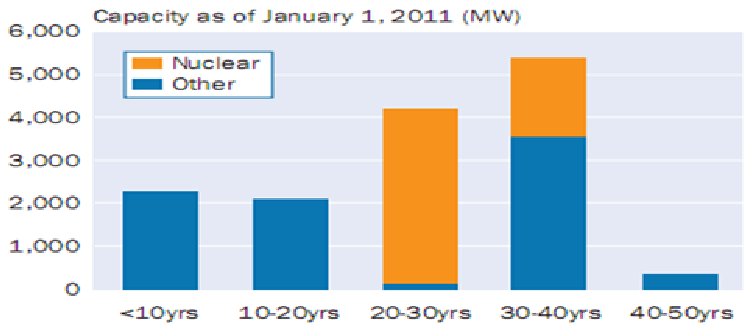

Figure 1.1 Age of Belgium's power capacity (Edwardes-Evans, 2011)

EU Directive 2009/28/EC on renewable energy sets targets for each Member State. The overall target for the share of energy from renewable energy sources for Belgium is 13%. In the national renewable energy action plan, Belgium indicates as a 2020 national target that 20.9% of the gross electricity consumption should be from renewable energy sources (Peeters, Simon, & Hannequart, 2010). Several studies have discussed Belgian energy scenarios and the development trajectories of renewable-sourced electricity regarding the climate and energy targets (Bossier, Devogelaer, Gusbin, & Thiéry, 2011; Commission, 2010; D'haeseleer, 2007; Devogelaer & Gusbin, 2011; Peeters et al., 2010), but few technology-specific targets are stated by federal and regional governments.

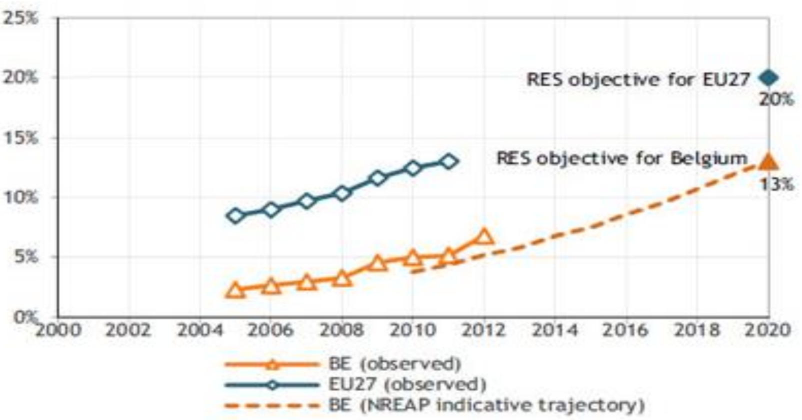

Figure 1.2 Share of renewables in gross final energy consumption in Belgium (Eurostat: observed trajectories; National renewable energy action plan of Belgium: indicative trajectory)

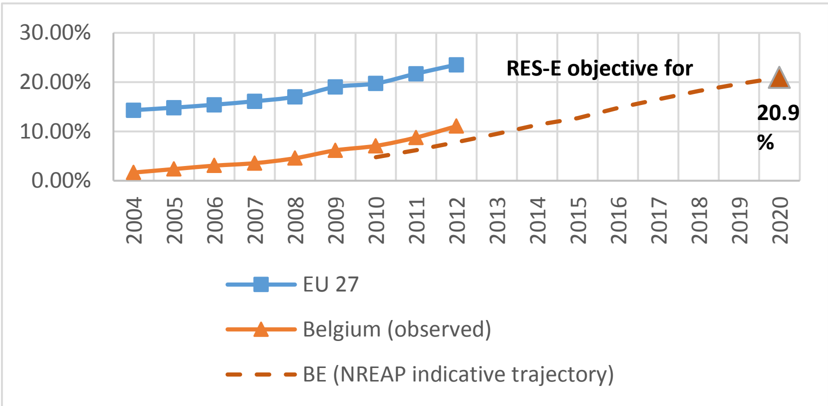

Figure 1.3 Share of renewables in gross final electricity consumption in Belgium (Eurostat: observed trajectories; National renewable energy action plan of Belgium: indicative trajectory)

The development of renewable energy in Belgium is on track: the share of gross final energy consumption from renewable energy sources increased steadily from 2.3% to 6.8% over the period 2005-2012 (Figure 1.2) and the share of renewable energy in electricity consumption reached 11.1% in 2010 (Figure 1.3). This means the development progress has been faster than indicated in Belgium's national renewable energy action plan, which provides an indicative path towards the target. However, how to maintain such positive trends effectively and efficiently in the next couple of years becomes a great issue. According to studies from the Federal Planning Bureau, realizing the energy transition and achieving the 2020 targets are technically feasible, but the transition process will not be so simple from an economic perspective. It is a huge challenge for any power market to secure a high level of additional investments, and harder still to secure investment in renewable energy projects. An energy 'revolution' will not happen spontaneously. It requires strong policy signals and appropriate schemes to encourage investments.

During the last few years, there an amount of nuclear debates have taken place among different Belgian political parties, industries, energy companies and scholars. In particular, a comprehensive study by the Commission for the Analysis of the Belgian Energy Policy towards 2030 came to the conclusion that the government should reconsider its 2003 law because the nuclear phase-out would lead to higher electricity prices and endanger Belgium's energy security and ability to meet its climate change targets (IEA, 2009). On the contrary, some other studies conclude that it is possible for Belgium to reach its EU targets even if the nuclear phase-out policy were maintained (Devogelaer & Gusbin, 2011). After the Fukushima disaster, Belgian authorities took a long period to discuss the issue, which makes the future energy mix unclear and increases the uncertainties of renewable energy development. Actually it has undermined the confidence of investors. For instance, Electrabel has claimed that it will not invest in new power plants in Belgium and will shut down some power plants soon (Sayles, 2012). E.ON is waiting for the new support scheme for biomass power in order to make a final investment decision. Nuon has gotten all necessary permits for 450 MW CCGT at Walloon, but has not started construction of the new plant. In a word, most of energy producers take a wait-and-see attitude. All of these events to some extent imply that the investment climate in the Belgian power generation market is indeed not good and so more efforts should be taken to improve the situation, especially for stimulating renewable energy projects.

This problem description shows that on one side Belgium has shown good performance in deploying renewable sources of power in recent years and stayed on the right track towards the 2020 RES-E target by 2013 while on the other side the current RES-E support is called into question by studies and different actors. In light of the future energy mix, Belgium faces a big challenge to ensure a rapid growth of investment in renewable-sourced power plants. Now, there are only six years left towards the 2020 targets, thus a number of problems must be urgently clarified and resolved. Why did a positive trend occur in the growth of electricity produced from renewable energy in recent years? What is the problem with the current RES-E support system and is it appropriate for Belgium? What can be changed to improve the investment climate for power generation from renewable sources? Given the situation the main research question can be formed as follows:

How can the renewable energy support system be improved to stimulate the investment in power generation from renewable energy sources in Belgium?

1.3 Research objectives, questions and boundary

Research objectives

As stated before in the overview, the investment behavior in renewable energy projects cannot be explained by neoclassical economics theory alone and the performances of many instruments are in practice very different from their theoretical expectations. Therefore the first objective of this research is to figure out the reasons for these inconsistent results and to explain the investment behavior with a more appropriate theory. Based on the theoretical discussion and empirical analysis, we expect to formulate some new criteria in order to better choose policy instrument.

The second objective of this research is to evaluate the renewable energy support instruments in Belgium and use the appropriate theory to demonstrate the current situation. Since the investment in power generation is determined by multi-factors, besides the RES-E support schemes a few non-economic factors must be taken into account, for instance the administrative procedures, information transparency and sufficiency, and grid connection and use. This will help policy makers better understand the investment climate in terms of renewable energy and improve the RES-E support system accordingly and properly.

The final objective is to make policy recommendations based on the Belgian situation and criteria for policy selection. The expected results will be like replacing the TGC system with FIT scheme or improving the current TGC system. Certainly, the advices on removing non-economic barriers will be stated as well, to facilitate the investment in renewable energy projects.

Research questions

According to the research objectives and main questions, several sub-questions are formulated to help reach the final answer step by step:

Part I Choosing the proper policy

1. How does the electricity sector work? What kind of factors influence the investment in renewable power generation?
2. What are renewable energy support schemes and how do they work from neoclassical economic perspective?
3. What is the role of institution environment?
4. What are the successes and failures of the policy instruments from practical experiences?
5. What are the criteria to evaluate these policy instruments?

Part II Explaining the current situation in Belgium

6. What is the status of RES-E and the power sector in Belgium?
7. What is the history of Belgian RES-E policy instruments?
8. How is the investment environment of renewable-sourced electricity?

Part III What should be done by policy makers

9. Is the current RES-E support system suitable for Belgium and what can be improved?
10. What should be done in other areas to stimulate the investment in renewable electricity?

Research boundary

Both the energy issue and policy issue are rather complicated in real life. They are connected to many industries, restricted by many factors, and discussed by various actors. Therefore, even on the same topic, researchers might draw different conclusions according to different study fields or study perspectives. To make the study proceed smoothly and help readers better understand the paper, it is necessary to define a research boundary before we start the research.

Policy support for investments in renewable energy projects is an issue of concern for many kinds of actors, such as policy makers, energy investors and end consumers. Policy makers are in charge of the policy design, energy producers consider the policy support as an important factor when making investment decisions, and the extra costs of developing renewable electricity are always finally paid by end consumers. For the main research question 'How can the renewable energy support system be improved to stimulate the investment in power generation from renewable energy sources in Belgium', we will study and answer this question from a government perspective since the RES-E support system is mostly changed by policy makers who are on behalf of government. Therefore, the government is regarded as the problem owner in this research. However, the interests of energy investors and end consumers cannot be neglected, since the policy support should offer sufficient incentive to investors on one side and also pass on affordable costs to end consumer on the other side.

The time scope is taken into account when drawing lessons from practical experiences of different countries and evaluating the development of renewable electricity in Belgium. Since most of the member states have established a systematic RES-E support system not long, we could get new insights to the policy selection criteria only from their policy success and failures in the last decade. For the case study of Belgium, we will examine the development of renewable electricity and the support schemes in the time period of 2003-2011, especially after 2008 when most renewable energy sources started a rapid growth in power generation (Figure 1.4). 2003 is set as the start year since starting that year federal authority and two primary regions (Flanders and Walloon) all had adopted TGC as the main support scheme, and 2011 is set as the end year due to data limitations.

Even though policy and regulation to encourage RE is multiple and varied, and the 2020 climate and energy targets in Belgium might be realized through some other means, like improved ETS (emission trading scheme), enhanced energy efficiency, and increased cooperative projects, due to time limitation this paper is only concerned with the growth of renewable electricity and focuses on the analysis of four renewable energy support schemes in stimulating the investment in the renewable-sourced power generation. Given that these policy schemes are a kind of direct government intervention, providing incentives for investors/entities installing RE, with no doubt 'how to improve the current Belgian renewable energy support system' becomes the key issue to be resolved in this research.

1.4 Research design

After the problem description and the formulation of research questions, it is essential to establish a conceptual framework to guide the entire study. To start with, some theory and theoretical framework is introduced and these will be applied in order to help get the answers to several sub-questions. Next, research methods will be presented. Lastly, a conceptual framework with clear research structure, research methodology and research methods will be created.

Research methodology

Multi-system framework

A multi-(discipline, level and actor) system scheme created by J. Groenewegen (Groenewegen, 2005) is used for market introductions when the system has different interrelated domains. This scheme contains three main domains, technology, economics and institutions, which influence each other. The actor is placed in the middle of the triangle structure. Since the market liberalization which started in the mid-1990s, the electricity sector has gradually changed to a socio-technical system1. It can be seen from the investment behavior in power generation. In this regard, the success of a technology currently depends on a number of conditions: the technology itself must evolve and become cost-competitive; policies and regulations must enable development and deployment; markets must develop sufficient scale to support uptake; and the public must embrace new technologies and learn attendant new behavior. However, in the past, before the market liberalization, the power sector was operated as public monopoly and the government centrally controlled the infrastructure planning, so investment at that moment was characterized by an engineering culture with a focus on a cost-efficient, reliable and robust service provision and without market influence. As described above, it is possible to use the multi-system scheme to present an overview of the electricity market and explain the investment determinants in renewable-sourced power generation.

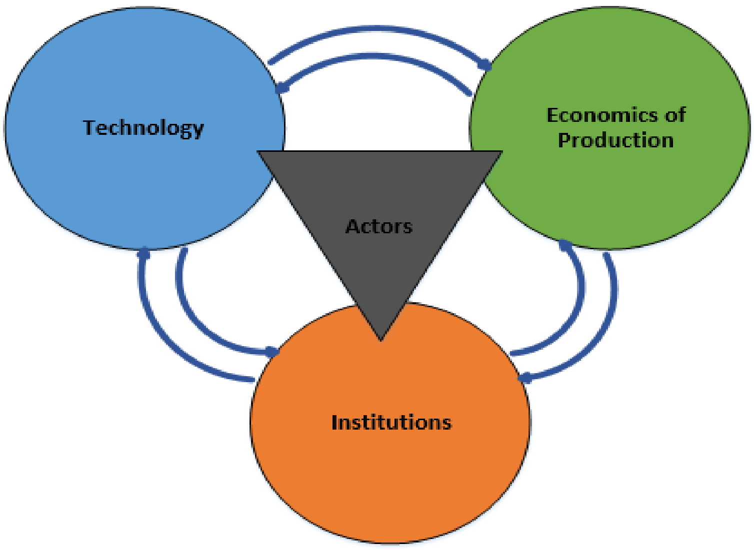

Figure 1.4 Simplified multi-system framework from J. Groenewegen[2] (Groenewegen, 2005)

[1] Socio-technical system refers to the interaction between society's complex infrastructures and human behavior, and pertains to theory regarding the social aspects of people and society and technical aspects of organizational structure and processes (Wikipedia).

[2] The original system covers multi disciplines, multi levels and multi actors. In this paper, we adopt a simplified system only to introduce the investment determinants for power generation in a systematic and comprehensive way.

An amount of studies have discussed the investment factors and risks in electricity generation (Blyth, 2009; Gross, Heptonstall, & Blyth, 2007; J. de Joode & Boots, 2005; Pierre, 2004), and in general the factors can be categorized into economic, technology and regulatory groups, which fits the three domains in the multi-system framework (Figure 1.4) well. In next chapter, we will elaborate these investment determinants following an adapted multi-system scheme.

Since the different domains are interrelated and interacted, and the government could only directly control the institution domain, it is a feasible path to influence the technology and economic aspects through policy improvements. In this research, it can be understood in this way that we are searching for the possibilities to reform the renewable energy support system in order to improve the multi-aspect (technology, economic and institution) involved investment climate of renewable energy in power generation. In other words, the whole research is centered around one issue: how do institutions incentivize actors and shape activities in the RES-E investment?

Neoclassical economics

Neoclassical economics has gained widespread acceptance by contemporary economists and it is variously used for approaches to economics focusing on the determination of prices, outputs, and income distributions in markets through supply and demand (Wikipedia, 2014). "It provides a framework for identifying market imperfections and failures, and allows for designing a desired end state or equilibrium of a market" (Scholten, Künneke, Correljé, & Groenewegen, 2014). For the energy industry, neoclassical economics once considered the manmade greenhouse gases as an externality, the costs of which are not borne by polluters themselves (Gross et al., 2012). However, as the problem of climate change occurred, the advantage of renewable energy over conventional energy in environment received a lot of attention and the environmental impacts were suggested to internalize. Generally, two ways are available to internalize the environmental costs and make the RES competitive with fossil fuels in power generation: add extra taxes or costs (e.g. carbon cost) on conventional electricity or offer extra support (e.g. subsidies) to renewable-sourced power. These two ways are both designed by changing the costs or revenues of power generation to achieve a new desired equilibrium of the electricity market, but this paper focuses on the latter option.

Although neoclassical economics dominates microeconomics today, there have been many critiques on it. Since neoclassical economics rests on several assumptions, like rational preference of people, hypothesized maximization of utility by income-constrained individuals and of profits by cost-constrained firms, and availability of full information, studies always criticize that it ignores important aspects of human behavior, focuses on describing a "utopia" in which Pareto optimality applies, and relies too heavily on complex mathematical models without enough regard to whether these actually describe the real economy (Wikipedia, 2014). Therefore, neoclassical economics theory can illustrate how the RES-E support instruments are designed to realize the theoretical output, but it cannot explain why the performance of policy schemes in practice are different from the expectation from NCE textbooks.

New institutional economics

Institutions are the humanly devised constraints that structure political, economic and social interaction (North, 1991). Institutional economics focuses on the role of institutions in shaping economic behavior based on the fundamental premise that neoclassicists oppose: that economics cannot be separated from the political and social system within which it is embedded (Wikipedia, 2014). However, the new institutional economics is considered as complementary to the neoclassical economics instead of as a substitute (Hazeu, 2000). Specifically, the NIE tempers the unrealistic assumptions of neoclassical economics such as perfect information, zero transaction costs and full rationality, but the assumptions of self-seeking individuals attempting to maximize an objective function subject to constraints still holds (Herath, 2005). In conclusion, we characterize the NIE as a better economics theory to explain social phenomena, since in reality the society works with institutions and the people never behave under the unrealistic assumptions. Since renewable energy policy instruments are applied under different institutional settings in the real world, the policy performance/investment behavior should be explained by other theories besides neoclassical economics. As one study (Scholten et al., 2014) mentions, institutional economics could help understand what the effects of certain regulation is on the market outcome by employing a more qualitative research agenda in the context surrounding markets and actors, this paper expects that the NIE theory could give a more comprehensive and reasonable explanation of the effects of RES-E policy instruments on the investment behavior in RES-E in practice. The NIE analysis covers many aspects such as transaction costs, asset specificity, property rights, etc. In this paper, we think primarily about the transaction costs caused by the implementation of RES-E policy instruments.

Research methods

With the purpose of reaching the final conclusion, research methods also need to be clarified here in addition to research questions and methodologies. Literature review and case study are the two main research methods applied in the paper. The former enables people to be familiar with the current knowledge including substantive findings as well as theoretical contributions to a particular topic (Wikipedia, 2014). In this research, it is used to collect information about the investment determinants, the function and design of policy instruments, and the successes and failures of support schemes. The latter, case study, is defined as a research strategy, an empirical inquire that investigates a phenomenon within its real-life context. The analyses of events or policies fit the objective of evaluating the renewable energy support instruments in Belgium, so it is considered as an appropriate method to figure out the current situation and then come to conclusions based on the defined criteria for policy assessment.

The information and data mentioned in this research are mainly gathered from journal articles, books, and EU research reports, while especially most of the numerical data is derived from the Eurostat and IEA databases. On top of this, national policy reviews, annual reports and surveys from energy-related institutions and companies, and interviews are another source of information. Even though they do not include much theoretical analysis, specific descriptions of figures and events and different opinions (e.g. opposition from the public on nuclear power) are all beneficial to understanding the real situation better.

Research conceptual framework

To sum up all the information above, a research conceptual framework is formulated as shown in figure 1.5. It provides the guidance needed to proceed, step by step, with the study.

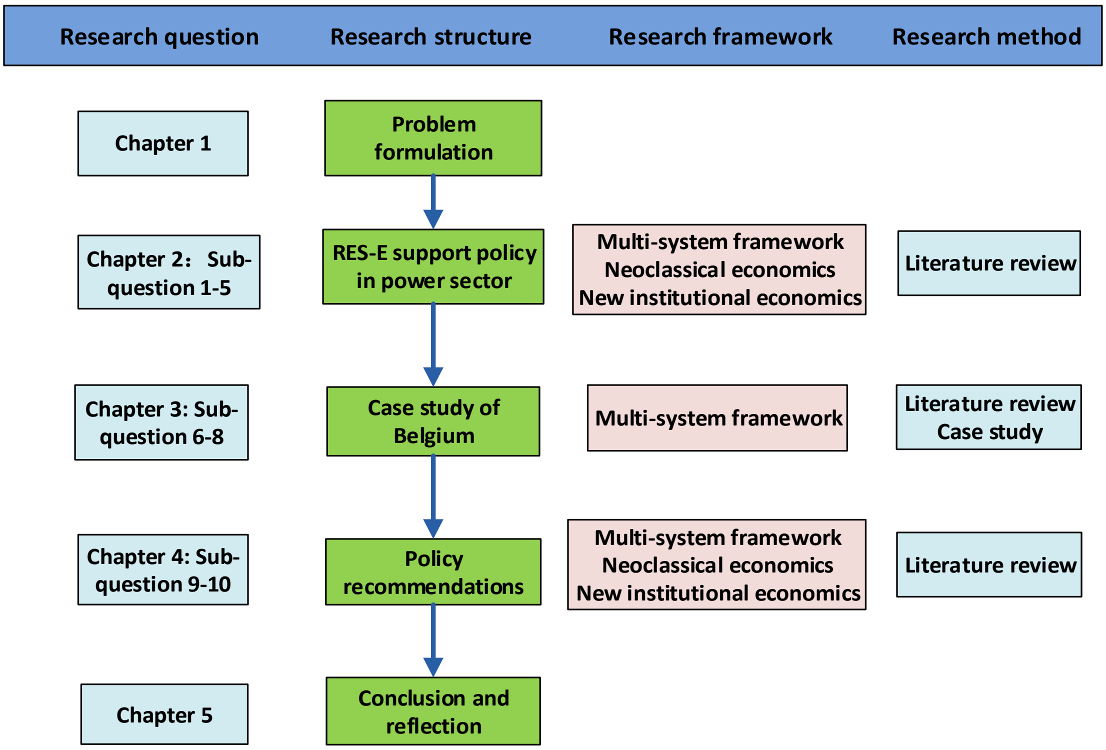

Figure 1.5 Research conceptual framework

1.5 Structure of the report

In terms of the research framework, the thesis is organized as follows. Chapter 1 introduces the background and research questions of this paper. Information about power generation investment, renewable energy policy instruments and practical experience is summarized in Chapter 2. And based on the literature review, the criteria of policy assessment are created. Chapter 3 introduces the case study of Belgium, including the status of renewables-sourced power, the overview of Belgian electricity sector, the history of its policy instruments, and the analysis of the current situation. According to the defined criteria, policy shortcomings will be found and policy recommendations will be made in Chapter 4. Finally, the thesis ends with conclusions and reflections in chapter 5.

2. Renewable energy support policy in the power sector

To stimulate the investment in renewable-sourced power generation, we first need to know which factors determine the investment in power generation. Therefore, section 2.1 present an overview of investment determinants in power generation based on multi-system scheme. After that it comes to the question of how to increase the RES-E investment from government perspective. Since the paper focuses on the study of selecting renewable energy support instruments, four common policy schemes will be introduced as key point in section 2.2. In order to possess an overall understanding of RES-E policy instruments, the paper will elaborate the schemes based on neoclassical economics theory, new institutional economics theory and practical experiences, respectively. All of these will contribute to know how the policy instruments work in theory and what are their failures or shortcomings in reality. Lastly, policy assessment is an essential step for policy selection. It can be understood that the RES-E policy instrument will be only appropriate when it meets certain criteria. So some criteria are created based on the existing knowledge, in order to lay the foundations for evaluating the policy performance and correctly choosing the policy instrument in the case study of Belgium.

2.1 Overview of investment determinants in power generation

Although the starting time, scale and reasons for proceeding with market liberalization vary among countries, a common objective of this liberalization in developed countries is to improve the economic efficiency in production and resource allocation by changing the investment models (Shih, 2007). Before an electricity market is liberalized, investment decisions in power generation are usually based on integrated planning and cost-minimization. The evolution of the entire power system is centrally controlled by a regulated monopoly company[3] with the objective of minimizing electricity costs for final consumers. Therefore the levelized cost is considered a critical parameter which determines the technology choice during that period. After the liberalization of the power sector, investment choice is left to a competitive market where power generators try to increase their own profits, so current project investment is evaluated by private companies on a profit-maximization base (Fagiani et al., 2013). This means that besides the levelized costs, revenue risks should be taken into consideration, since the factors like electricity price and renewable support schemes are uncertain. In addition, a few technical, economic, institutional, political, social and environmental barriers have to be overcome to facilitate a breakthrough for renewable electricity (Haas, Panzer, et al., 2011).

As described above, the investment in renewable electricity can be understood as the result of the interaction of multi-factors in the technology, economics and institution domains. So we will elaborate the investment determinants in power generation based on existing studies (Gross et al., 2007; J. de Joode & Boots, 2005; Pierre, 2004) by following the simplified multi-system framework as follows.

2.1.1 Technology domain

[3] State-controlled company

Technology development phase: the fast development of technologies provides countries with many options for power generation. Considering the local conditions and relevant support policy schemes, the development state of various energy technologies varies in the EU member states (Table 2.1). Currently the fossil fuel for power generation is totally commercialized, but as for renewable energy, some types of technology are still at the pilot or demonstration phase (Klessmann, 2012). Investors take fewer risks on commercialized technology investments since it is already widely accepted in market and investment capital is relatively low. As for the pilot technology, it needs to spend an amount of R&D investment and takes a long time to realize marketization. To some extent, it increases the uncertainty of the return on power generation investment.

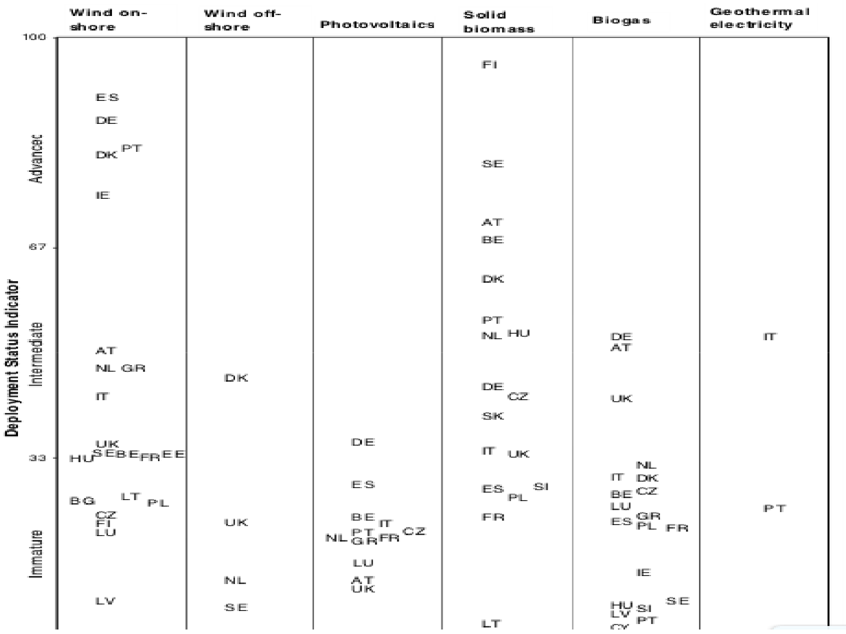

Table 2.1 Development state of RES-E technologies in the EU-27 member states (Klessmann, 2012)

Generation technical and economic characteristics: the technical and economic characteristics are of importance to determine power generation investment since these features can directly influence power production and the return on investment. As seen in table 2.2 and 2.3, different technologies are compared based on several technical factors, such as unit size, lead time, and CO2 emissions. In summary, gas-fired technology is increasingly popular among the fossil fuel power plants since it has short lead time which means investors can operate the plant and get their returns soon, and less CO2 emission is emitted compared to coal-fired ones, but it comes with the significant risk of volatile gas prices obviously increasing the cost of power generation. Nuclear power plants can provide large-scale electricity production with very low net CO2 emissions over the plant lifecycle, but it is subject to a long lead time and is its safety issues are always questioned, especially after the occurrence of nuclear power disasters. Compared with other types of renewable energy, biomass is the only one which emits GHG emissions when generating power although still much less than compared to power generated from fossil fuels. Wind and solar power both own many attractive characteristics, short lead time, no fuel costs, no emissions and low operating costs, but the intermittent power production is a shortcoming. Compared with wind power plants, solar PV does not produce noise and is more convenient to install by households, so it has become widely used all over the world in recent years as the cost of PV decreases. Hydro power is produced from the movement of massive flows of water such as a river, canal or stream, and the technology has a long lead time but no CO2 emission, and it could earn a high energy payback. However, whether the dam building influences the geological framework and climate is often a subject of debate regarding the installation of hydropower stations. It is worth to note that the development of renewable energy is restricted by natural and geographical conditions, so sufficient energy potential (wind, solar or water) is the premise of investment in power generation by these renewable energy sources.

Technology	Unit Size	Lead Time	Capital Cost/kW	Operating Cost	Fuel Cost	Co_2 Emissions	Regulatory Risk
CCGT	Medium	Short	Low	Low	High	Medium	Low
Coal	Large	Long	High	Medium	Medium	High	High
Nuclear	Very large	Long	High	Medium	Low	Nil	High
Hydro	Very large	Long	Very high	Very low	Nil	Nil	High
Wind	Small	Short	High	Very low	Nil	Nil	Medium
Recip. Engine	Small	Very short	Low	Low	High	Medium	Medium
Fuel Cells	Small	Very short	Very high	Medium	High	Medium	Low
Photovoltaics	Very small	Very short	Very high	Very low	Nil	Nil	Low

Notes: distributed generation technologies are shaded. CO_2 emissions refer to emissions during combustion/reformation only.

Table 2.2 Qualitative comparison of generation technology by risk characteristics (IEA, 2003)

Energy source	Power generation technology		Production Cost of Electricity (COE): State-of-the-art 2007 ($€_{2005}$/MWh)	Projection for 2020 ($€_{2005}$/MWh)	Projection for 2030 ($€_{2005}$/MWh)	Net efficiency 2007	Lifecycle GHG emissions: Direct (stack) emissions (kg CO_2/MWh)	Indirect emissions (kg CO_2(eq)/MWh)	Lifecycle emissions (kg CO_2(eq)/MWh)	Fuel price sensitivity
Natural gas	Open Cycle Gas Turbine (GT)	-	65 ÷ 75 (b)	90 ÷ 95 (b)	90 ÷ 100 (b)	38%	530	110	640	Very high
	Combined Cycle Gas Turbine (CCGT)	-	50 ÷ 60	65 ÷ 75	70 ÷ 80	58%	350	70	420	Very high
		CCS	n/a	85 ÷ 95	80 ÷ 90	49% (c)	60	85	145	Very high
Oil	Internal Combustion Diesel Engine	-	100 ÷ 125 (b)	140 ÷ 165 (b)	140 ÷ 160 (b)	45%	595	95	690	Very high
	Combined Cycle Oil-fired Turbine (CC)	-	95 ÷ 105 (b)	125 ÷ 135 (b)	125 ÷ 135 (b)	53%	505	80	585	Very high
Coal	Pulverised Coal Combustion (PCC)	-	40 ÷ 50	65 ÷ 80	65 ÷ 80	47%	725	95	820	Medium
		CCS	n/a	80 ÷ 105	75 ÷ 100	35% (c)	145	125	270	Medium
	Circulating Fluidised Bed Combustion (CFBC)	-	45 ÷ 55	75 ÷ 85	75 ÷ 85	40%	850	110	960	Medium
	Integrated Gasification Combined Cycle (IGCC)	-	45 ÷ 55	70 ÷ 80	70 ÷ 80	45%	755	100	855	Medium
		CCS	n/a	75 ÷ 90	65 ÷ 85	35% (c)	145	125	270	Medium
Nuclear	Nuclear fission	-	50 ÷ 85	45 ÷ 80	45 ÷ 80	35%	0	15	15	Low
Biomass	Solid biomass	-	80 ÷ 195	85 ÷ 200	85 ÷ 205	24% ÷ 29%	6	15 ÷ 36	21 ÷ 42	Medium
	Biogas	-	55 ÷ 215	50 ÷ 200	50 ÷ 190	31% ÷ 34%	5	1 ÷ 240	6 ÷ 245	Medium
Wind	On-shore farm	-	75 ÷ 110	55 ÷ 90	50 ÷ 85	-	0	11	11	nil
	Off-shore farm	-	85 ÷ 140	65 ÷ 115	50 ÷ 95	-	0	14	14	
Hydro	Large	-	35 ÷ 145	30 ÷ 140	30 ÷ 130	-	0	6	6	nil
	Small	-	60 ÷ 185	55 ÷ 160	50 ÷ 145	-	0	6	6	
Solar	Photovoltaic	-	520 ÷ 880	270 ÷ 460	170 ÷ 300	-	0	45	45	nil
	Concentrating Solar Power (CSP)	-	170 ÷ 250 (d)	110 ÷ 160 (d)	100 ÷ 140 (d)	-	120 (d)	15	135 (d)	Low

Table 2.3 Energy technologies for power generation (European Commission, 2008)

From the economic perspective, the cost structure of different technologies is different. The costs of coal and gas plants can vary substantially from country to country since they largely depend on the local fuel price. With the increasing focus on CO2 reduction, the carbon cost plays an important part for coal and gas plants. In regard to nuclear power, three main factors contribute to its direct costs: construction costs, O&M and fuel costs, and waste management and decommissioning costs. The costs of renewables differ between technologies and they are often highly site-specific. Costs are influenced by natural resource (e.g. wind speeds, lighting conditions, and availability of biomass), the scale of the power plant, commodity prices (e.g. steel, silicon), etc. Bioenergy electricity generation facilities vary in size as well as in technologies used and it is the only renewable energy source which is not free (IEA, 2010). Compared with onshore wind power, the electricity production could be increased on the sea due to higher wind speeds for longer periods despite the high cost. Solar PV costs consist of the costs of modules and inverters and cabling which are dependent on the price of commodities such as silicon.

To show the comparison of the economic characteristics of different technologies, levelized cost of electricity in Belgium is used as an example below (Figure 2.1). This economic criterion is rather pivotal for the investment decision and technology selection. The investment cost in the graph equals to levelized capital cost which is normally considered the sunk cost of a new power plant. No matter whether offshore or onshore, wind power has the highest capital cost, followed by nuclear. Compared with coal-fired power, gas-fired power holds relatively lower investment costs. Biomass power has a slightly lower capital cost but higher operation and maintenance (O&M) costs among the renewables. Offshore ranks highest in O&M cost, followed by onshore power. Coal, gas and nuclear power share almost the same O&M cost. It is worth mentioning that unreasonable costs of grid connection (part of O&M cost) might cause problems which influences the investment decision. These is no doubt that uncertain fuel costs carry substantial risks for project developers. Among all these technologies, the gas power faces the most unstable fuel cost. Coal is a little more expensive than nuclear power in fuel costs, while wind power use its fuel for free. Coal, gas and biomass energy are subject to an additional charge, carbon cost. Coal-fired power usually pays most due to its higher CO2 emissions. In general, coal-fired power generation costs are lowest, than gas-fired power, followed by onshore wind power, and the offshore wind power is most expensive. However, the levelized cost of each technology is unstable owning to the changes in fuel price, carbon value, and even investment costs.

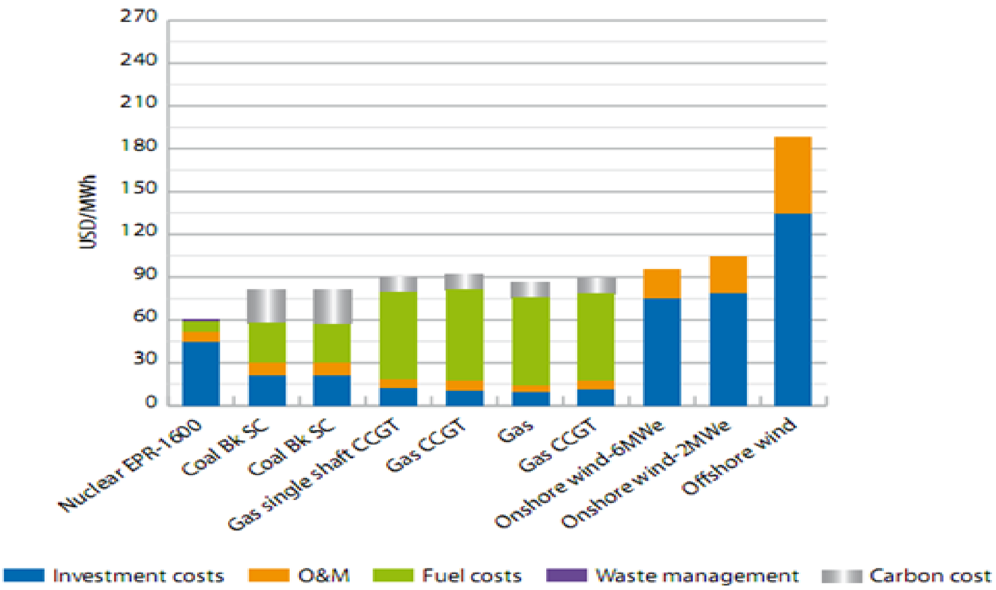

Figure 2.1 Belgium – levelized costs of electricity at 5% discount rate (IEA, 2010)

Operation and environment determinants: these determinants contain the grid connection and access, location selection, and environmental impacts. From the technical perspective, sufficient and well-planned transmission lines are necessary to avoid system congestion and ensure the projected investment final payback. Also, non-discriminatory grid connection and access could guarantee fair competition to energy producers to some extent. The location of power plant is determined by several factors: geographic conditions, natural resource, land use, transportation conditions for electricity and raw materials, local demand and public acceptance. Onshore wind has the highest land use per unit of produced electricity, whereas solar PV uses less land and is usually installed on roofs (Figure 2.2). Since most wind resources are located far from load centers, the significant investment on new transmission lines cannot be neglected (Fürsch et al., 2013). Besides carbon dioxide, a number of other air pollutants, such as methane, sulphur dioxide (SO2), nitrous oxides (NOX), mercury, lead and ammonia negatively affect human health and the environment (müller, Brown, & Ölz, 2011). Figure 2.3 shows that even though biomass is a type of renewable energy, in some cases the pollutant emissions (SO2 and NOX) from biomass power plant exceed even those from coal-fired plants, since these emissions from biomass combustion strongly depend on the composition of the biomass. Water is required at various stages of producing and converting fuels, and particularly important for cooling. However, even if water is abundant, local regulatory limits on the usage and the high cost of acquiring water may become a limitation for new plant establishment. Most RE technologies, especially solar PV and wind power, consume less water than fossil fuel and nuclear plants (Figure 2.4).

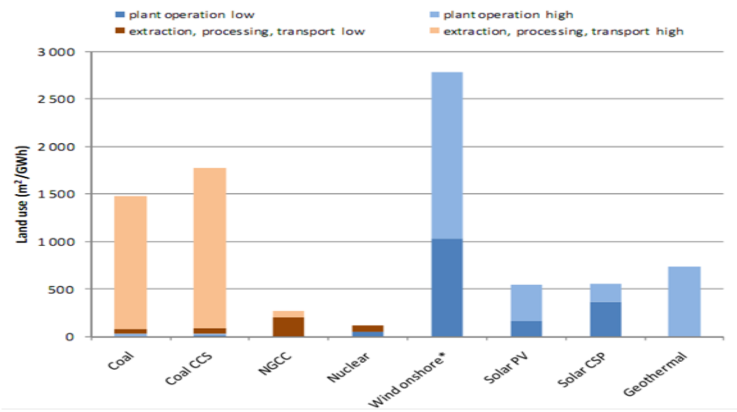

Figure 2.2 Land use requirements of power generation technologies (müller et al., 2011)

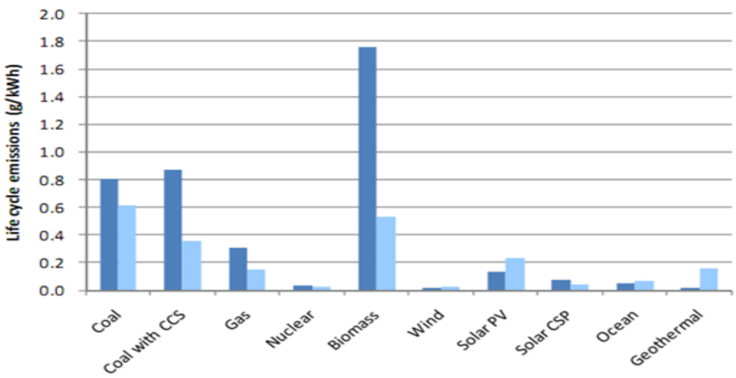

Figure 2.3 Recent life-cycle SO2 and NOx emissions of power generating technologies (müller et al., 2011)

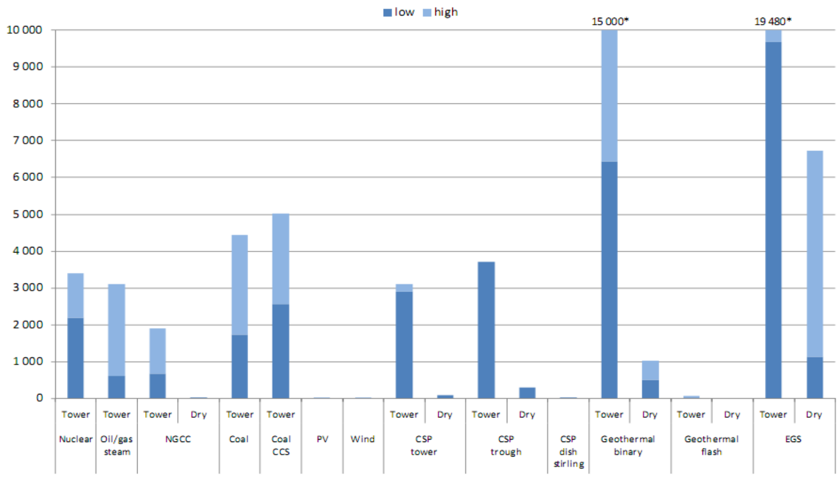

Figure 2.4 Water consumption of power generation technologies during operation, litres per MWh (müller et al., 2011)

2.1.2 Economic domain

Investment cycle: In the power generation market, there is an investment cycle but it is not as obvious as in other industries due to its long lead-time. It is inevitable that only when average electricity price rise sufficiently, investors could ensure their return on investment and then start to consider other investment determinants. But in some cases, they may suffer from the significant investment cycles, since a high power price induces increasingly investments until excess capacity is created and the price falls again (Figure 2.5). This means that the return on some ongoing projects will be cut down, in which case some investors prefer to postpone or cancel projects (Pierre, 2004).

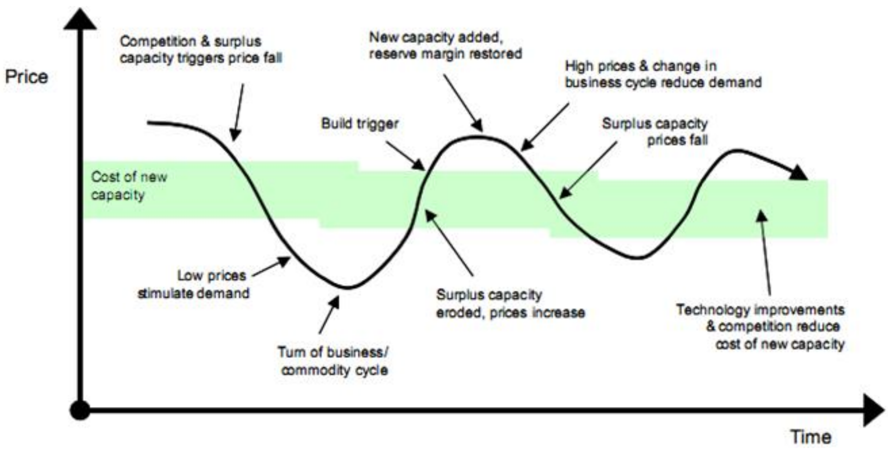

Figure 2.5 Business cycle of power generation (Pierre, 2004)

Demand and supply: power price is without a doubt the direct signal for investors, but the investment opportunity is easier to estimate if future power demand and supply is known. Project developers should be free to access information about social development, government preference, and short/long term energy plans, all of which could help predict the power deficit.

Market power: market power is the ability of a firm to profitably raise the market price of a good or service over marginal cost (Wikipedia). In a perfectly competitive market, market participants have no market power. In reality, with only twenty years' experience of electricity market liberalization, no such competitive market has been developed yet. Producers with market power have the ability to lower the power prices and increase barriers to entrants. These firms usually control a large market share and have significantly more experience and resources. When developers consider investing in power generation, market power of incumbents cannot be neglected.

Power price: the power price is a strong signal for investors when considering a new power plant since it means all revenues for power producers except policy support. In the electricity wholesale market, the spot price is one important index indicating the market status. The system-marginal plant as price maker sets the spot price of electricity for that particular time of day and all other plants in the system are price takers. Generally speaking, for most power markets, marginal plants are usually gas-fired ones, which means that volatile gas price has an impact on the electricity price.

2.1.3 Institution domain

Administration procedure: administration procedure directly effects the schedule of power plant projects. Normally it takes investors quite a long time before they really start the construction of a power plant, since the permits should be approved by different organizations and the processing time is uncertain. What is more, if a country has diverse regulations in different areas, investors should spend more time to come to know the local rules about electricity generation investment, which to some extent hinders the liquidity of power generation investment.

Information transparency and sufficiency: sufficient, transparent and accurate information is the basic condition for making a correct investment decision. To be specific, besides prices (e.g. power price) and tariffs (e.g. grid connection, policy support level), the information about other aspects should be also clarified and accessible. For instance, available sites for new power plants, guidance on administrative procedures, and clear rules for granting policy support. From a governmental perspective, sufficient and transparent information could facilitate the liberalization process of the electricity market and help create a more competitive investment climate.

Regulatory policy: governments influence the power industry in different ways. As for the economic aspect: firstly, to increase the competition among energy producers and realize market liberalization, some authorities provide direct support for new entrants or limit the market share of incumbents; secondly, governments can pay much attention to the revenues from power generation. For instance, in some cases a regulator is established to monitor the power price and a price cap is set. Furthermore, RES-E support policies deserve utmost concern under the current situation that it is appealing the entire world to widely apply renewables to alleviate energy and climate problems. Lastly, additional taxes or levies on fossil-fuel power is also a way to promote renewable electricity. For the technical domain: the operation of technology is better regulated by certain rules, such as the regular submission of network development plans or grid connection and access priority. The policy itself could also influence the investment decision due to its uncertainties. For example, unclear policies on nuclear power increases the risks for project developers. Of course, policy could be applied to influence other investment determinants, like public acceptance. All in all, governmental preference and regulatory policy determine the investment orientation of energy producers.

2.1.4 Other determinants

Here two factors related to different actors are listed. These are extra important issues which also determine the investment decision of power generators.

Public acceptance: barriers in public acceptance cover insufficient public awareness of new power generation technologies, as well as the NIMBY (not in my backyard) effect, which might be caused by high population density or local culture and customs. In some cases, public acceptance must be achieved to get the required construction permits for a power plant. This means that public opinion determines the fate of power plant projects no matter how much profit it could make in theory.

Political issue: politics is quite complex, involving an amount of relationships and interests. Energy issues always incur serious debate among different political parties, especially in periods of administration shifts, and the uncertain outcome of the argument will definitely increase the investment risk. What's more, some politicians abuse their power for their own interest or regions. All of these make the electricity market more risky and makes it unattractive for energy producers to invest in new power plants.

Based on the information above, we enrich the simplified multi-system framework and make it adapt to power generation investment (Figure 2.6). The framework gives the guidance to evaluate the overall investment environment in power generation in a more systematic and comprehensive way. We will apply it in the following case study of Belgium.

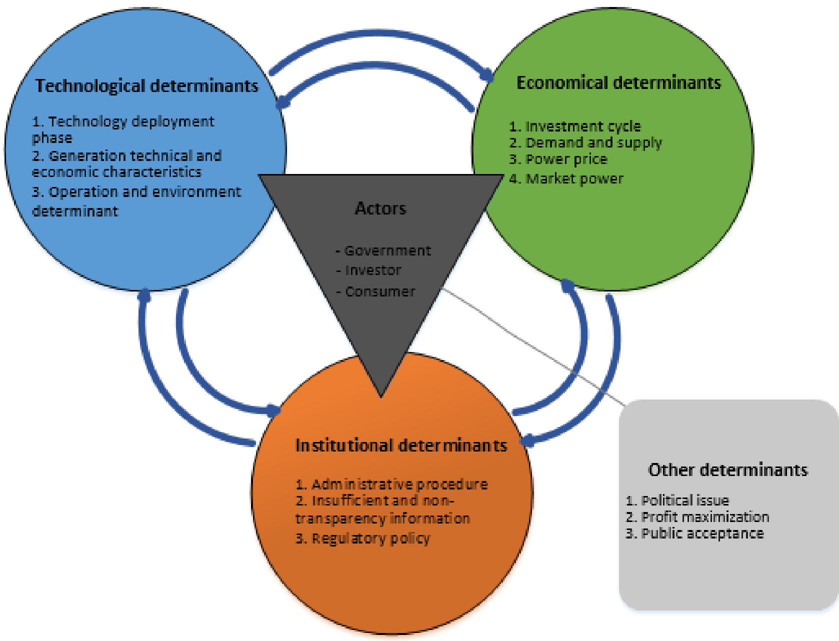

Figure 2.6 Multi-system framework adapted to power generation investment (own creation)

2.2 Renewable energy support schemes

Considering how to internalize the environmental costs and make RES competitive with fossil fuels in power generation, a number of regulatory policies have been mentioned in section 2.1.3. Currently, many promoting strategies are available for renewable energy development. As shown in Table 2.4, a fundamental distinction is discovered between direct and indirect policy schemes. Direct policy instruments are designed to stimulate RES-E immediately, whereas indirect instruments focus on improving the long-term framework such as by simplifying administrative procedures. Voluntary instruments are a kind of promotion strategy which differ from regulatory ones, and it is based on consumers' acceptance of premium payment for green electricity (Haas, Panzer, et al., 2011). Since we aim to give Belgian government advices which could have direct effects under regulation, this paper will focus on four direct regulatory strategies which are most commonly used and can be further classified into price-driven instruments (feed-in tariffs and investment subsidies) and quantity-driven instruments (renewable portfolio standard/quota obligation and tendering).

		Direct		Indirect
		Price-driven	Quantity-driven	
Regulatory	Investment focused	Investment incentives Tax credits Low interest/soft loans	Tendering system for investment grant	Environmental taxes Simplification of authorisation procedures Connexion charges, balancing costs
	Generation based	(Fixed) Feed-in tariffs Fixed premium system	Tendering system for long term contracts Tradable green certificate system	
Voluntary	Investment focused	Shareholder programs Contribution programs		Voluntary agreements
	Generation based	Green tariffs		

Table 2.4 Fundamental types of promotion strategies (Haas, Panzer, et al., 2011)

2.2.1 RES-E policy instruments

2.2.1.1 Price-driven instruments

Price-driven strategies have no established quantity goals or targets. RES-E electricity producers could receive financial support in terms of a subsidy per kW of capacity installed or a payment per kWh produced (Haas, Panzer, et al., 2011). There are a number of variations on this price-driven scheme such as:

Feed-in tariffs (FITs): is a generation-based instrument, widely used in the electricity sector. A utility, supplier or grid operator is legally obligated to pay a certain price for electricity from RES-E producers, and the price per unit of electricity (tariff rate) is determined by a federal (or provincial) government. It usually takes the form of either a fixed amount of money paid for RES-E production, or an additional premium on top of the electricity market price paid to RES-E producers (Haas, Panzer, et al., 2011). Due to the volatile electricity price, the total revenue per kWh (electricity price plus the premium) received by RES-E producer under feed-in premium scheme seems less predictable than that under a fixed FITs system.

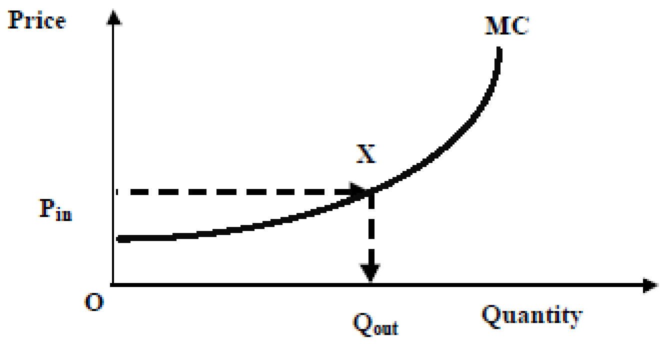

Figure 2.7 Feed-in tariffs (Menanteau, Finon, & Lamy, 2003)

The feed-in tariff system operates as a subsidy allocated to producers of renewable electricity. Figure 2.7 shows its function by means of the marginal cost curve of RE technologies from neoclassical economics perspective. Without policy support, no investment is expected in RE technologies since usually the cost of RES-E generation is higher than the electricity price. The producers are encouraged to exploit all available generating sites until the marginal cost of producing RES power equalises the proposed feed-in tariff Pin: the amount generated then corresponds to Qout (Figure 2.7). All RES-E projects benefit from the tariff Pin, including those whose marginal production costs are considerably lower than the proposed tariff (Menanteau et al., 2003). Therefore the overall cost of supporting the production of RES-E is given by the area Pin*Qout.

Technology	Minimum price per certificate (euro / MWh)		
	Installation service for 01/01/2010	Installation service from 01/01/2010	Installation service from 01/01/2012
Onshore wind, biomass (organic-biological substances) and biogas from organic-organic substances	€ 80	€ 90	€ 90
Organic-organic portion of garbage, landfill gas (fermentation from organic materials in landfills) and biogas from wastewater sludge or sewage sludge	€ 80	€ 60	€ 60
Biogas mainly from the fermentation of manure and / or agriculture-related flows (agricultural streams) digestion with biogas from organic waste composting	€ 100	€ 100	€ 110 (no premium ecology) € 100 (ecology premium received)
Hydro, tidal and wave energy, geothermal	€ 95	€ 90	€ 90
Other techniques	€ 0	€ 60	€ 60

Table 2.5 Minimum price per certificate for each technology in Flemish (Source: VREG)

Looking into the specific design of the FITs system, several main elements are summarized and illustrated here (del Río, 2010; del Río & Bleda, 2012; Doherty & O'Malley, 2011; Gonzalez, 2008). First of all, a fixed price is set in law, regulation or decision. There are many different approaches to the setting of a support value by governments. Usually the guaranteed price is set at a level linked to avoided costs of the power generation of the same kWh from non-renewable power plants. FITs and Fixed premium schemes are obviously different in this regard as mentioned above. Based on these two systems, some variations are created to guarantee a proper support level, likely a cap-and-floor price element (Doherty & O'Malley, 2011; Gonzalez, 2008). The second design element is technology specification which means the support level for diverse technologies is different. This is quite important since it allows the support level to be better adapted to the costs of different technologies, reducing the total cost of policy support and the chance that the cheapest technologies will receive windfall profits (del Río & Bleda, 2012). In some countries, regional governments design their own support principles and even show tariff differentiation within the same technology based on site, plant size or conditions that affect the yield (Table 2.5). In contrast, the same support would be granted to different technologies if a flat FITs scheme is applied. Besides the support value, guaranteed duration of support and tariffs degression and revision (reductions of support levels for new plants) also influence investors' confidence in the policy system. Generally, the guaranteed price is offered for about 15 years (Menanteau et al., 2003). The tariffs degression and revision depends on the specific rules defined by individual countries, but it is advisable to review the tariffs regularly and make changes in accordance with the evolution of RES-E technology and the share of RES-E in electricity demand (Gonzalez, 2008). It is inevitable that the existing plants must be influenced by the support system. To some extent, the support results in an extra amount of profit for existing RES-E producers. Lastly, the policy support is paid directly by the distributor, regulator or some public mechanism, but all ultimately pass on the cost to end consumers or taxpayers (Doherty & O'Malley, 2011).

Investment subsidies: it establishes an incentive linked to the investment itself or the operation of the plant. The support level is usually technology-specific. The cost of investment subsidies can be paid by taxpayers or certain institutions of the electricity sector. A potential problem here is that if the source of funds is uncertain or unsustainable, the initiative is unlikely to be successful (Bjork et al., 2011).

Some elements deserve increased attention when designing investment subsidies. The first one is the need to cooperate well with relevant organizations since the subsidies are usually provided by special departments such as an environmental agency or residential and housing department. The second element is the support level. Normally this kind of scheme offers RES-E project developers subsidy as a percentage of total investment cost, or as a predefined amount of € per installed kW (Ragwitz, Resch, Faber, & Huber, 2005). Of course, the percentage or predefined amount differs based on technologies, plant size and other conditions in some cases. Lastly, since most of the investment subsidies are subject to a fixed annual budget, how to allocate these funds becomes an issue for policy makers. It could be allocated based on the "first-come-first-in" rule, tendering process, etc.

2.2.1.2 Quantity-driven instruments

Quantity-driven strategies are based on a government decision on the desired level of generation or market penetration of RES electricity (a quota or a Renewable Portfolio Standard) (Haas, Panzer, et al., 2011). Two main quantity-driven measures are described as follows:

Tradable certificate systems (TGC): it is a relatively new support system and also called quota obligations/Renewable Portfolio Standard. Typically, quota obligations are placed on the power suppliers and large consumers, who are obligated to produce green power by themselves, or purchase either a portion of renewable power or the equivalent amount of green certificates (Beck & Martinot, 2004). In other words, they have to submit the required number of certificates to demonstrate compliance on time, otherwise they get fines. Tradable certificate systems are based on the idea of separating the actual power and its "greenness" (müller et al., 2011). Under such a system, standardized certificates and physical electricity can be traded separately in different markets.

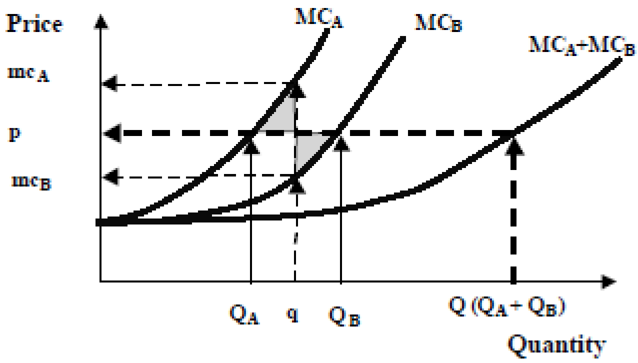

Figure 2.8 Operation of green certificate market (Menanteau et al., 2003)

Neoclassical economics explains the operation of green certificate market as shown in Figure 2.8. Distributor A and B are both assigned RES-E production objectives q. Since operators do not all benefit from the same opportunities to develop renewable energy sources, and thus these two distributors have different marginal production cost curves (MCA and MCB). In order to reach the objective q, distributor A, who has poorer quality resources, has to incur a higher marginal production cost MCA; while distributor B, who has richer quality resources, could keep a lower marginal production cost at MCB. The operation of green certificate market enables distributor A and B to change their power production to QA and QB, respectively, and also both reach the objectives q by trading the certificates at the equilibrium price p. The figure illustrates that the introduction of tradable certificate system could reduce the cost of achieving the overall objective (Q = QA + QB = 2q), shown by the shaded areas, compared with a situation without flexibility mechanisms where the distributors are subject to the constraints QA and QB (Menanteau et al., 2003).

Several policy design elements for TGC system are introduced as follows. Quota obligation (target) is a key design element for TGC scheme as the support level for FITs. Quota might be set either in relative (as a percentage of electricity production) or in absolute terms (in TWh) in TGC (del Río & Bleda, 2012). An absolute target ensures a certain market volume while relative quota may lead to a greater or a lower absolute amount of RES-E since it alters along with electricity sales. Technology specification comes as the second design element again. Different technologies might receive their individual quota targets, leading to two separate TGC market, with one quota for mature and another for non-mature technologies (del Río, 2010). The TGC price in the mature technology market will be lower compared to a single TGC market since the cost of marginal technology in a single TGC market must be higher to reach the quota target. Different from the FITs scheme, TGC adopts credit multipliers/technology bandings to distinguish the support levels for diverse technologies. It means a greater number of green certificates per MWh is granted to electricity generated by more expensive RE technologies (del Río & Bleda, 2012). However, in some cases the least mature technologies are excluded of TGC system since their costs are much higher than the marginal technology needed to comply with the quota (del Río, 2010). Penalty rate is an important element as well because an appropriate penalty is able to discourage non-compliance and trigger more RES-E investment. In addition it determines the maximum price of green certificates in most cases since in theory distributors or large consumers only prefer to buy TGC if its price is lower than the penalty. To reduce the risk of volatile TGC prices, some countries, like Belgium and Sweden, put minimum TGC prices into force. This design element works rather like a floor price for FITs. Comments on the existing plants under TGC system are different from those under FITs. Under a FITs scheme, RES-E investors are guaranteed a certain support in a long period, and this would always be the incentive for new renewables investment. Whereas if an amount of existing plants becomes eligible under a TGC scheme, only a very small additional capacity can be promoted despite significant profits since the renewable quota is fixed. Although the overall costs of the support system might be obviously lower if existing capacity is included, it can be seen that this negatively affects future RES-E investment (del Río, 2010). Banking TGreen certificates is a flexible mechanism aimed at avoiding price spikes for energy suppliers, but at a risk to consumers since energy producer could use it to make massive profits (P. del Rio, M. Bleda, 2012). Thus this design element more or less reduces the incentive to invest in relatively expensive renewable technologies. The TGC scheme also consists of a guaranteed duration of support and quota revision. Normally, a government or regulator will publish each annual quota for next few years and revise the minimum price according to the development status of renewables, but there are also exceptions.

Tendering system: a regulatory authority calls for tenders for installing a fixed amount of capacities by a given technology or suite of technologies and contracts are given meeting certain conditions. Project developers could name the price at which they are willing to develop the project. The bid winner could get either investment-focused or generation-based financial support (Haas, Panzer, et al., 2011).

The tendering system enhances the market competition which focuses on the price per kWh proposed during the bidding process. Proposals are classified in increasing order of cost until the fixed amount of RES-E to be contracted is reached (Menanteau et al., 2003). The marginal cost Pout is the price paid for the last project selected which enables the quantity Qin to be reached (Figure 2.9). Different from the three earlier schemes, the support level in tendering system is project-dependent since the implicit subsidies attributed to each generator corresponds to the difference between the bid price and the wholesale market price. Compared with FITs, the tendering system shows two remarkable differences. Firstly, the overall cost of reaching the target or reserved amount of installed capacity is given by the area situated under the marginal cost curve since the marginal production costs of all the producers can be identified during the competitive bidding procedure. Secondly, the exact amount of RES-E capacity concerned by the bidding process is a priori known under the tendering system, whereas neither the marginal cost, the total production of RES-E, nor overall cost of reaching the target can be determined beforehand due to its unknown shape of the marginal cost curve (Menanteau et al., 2003).

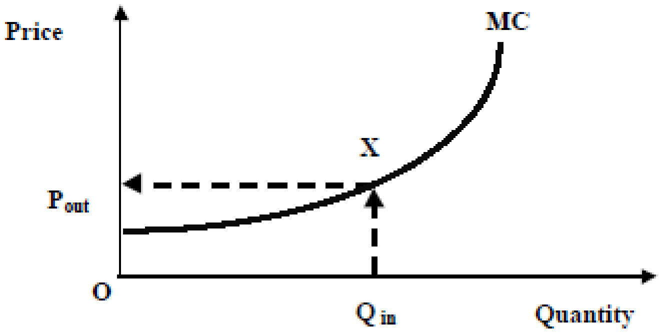

Figure 2.9 tendering system (Menanteau et al., 2003)

As a quantitative-driven strategy, the tendering system creates competition among investors to select the eligible project. Its support level could be designed as either FITs or investment subsidies. To be specific, generation-based tendering schemes provide support in the form of a 'bid price' per kWh for a guaranteed duration, while investment-focused schemes offer the investment grants per installed kW (Haas, Panzer, et al., 2011). Different from the tradable certificate market, tenders are launched in an irregular schedule. Therefore to some extent tendering schemes works more like a price-driven strategy once the bid winners have been decided upon. Well-designed tender procedures and requirements for bidders also influence the performance of the entire system. What's more, both the amount of RES-E and the technologies for bidding are determined by governments rather than market-based competition. It indicates that the development orientation of RE technologies is primarily guided by the authorities under the tendering scheme.

According to the above description of four RES-E policy instruments, two tables (table 2.6 and 2.7) summarize the key design elements of each scheme and the advantages and disadvantages of each of these, respectively. Table 2.6 shows that tradable green certificate systems have most design elements, which indicates more efforts should be made by policy makers and improper designs will occur with a relatively higher degree of possibility. The four kinds of policy instruments all have their own merits and demerits as shown in table 2.7.

Feed-in tariffs	Tradable certificate systems	Tendering system	Investment subsidies
Support level	Quota obligation	Support level	Support level
Technology specification	Technology specification	Tendering rules	Allocation rules
Support duration & tariffs degression	Support duration & quota revision	Determination of the amount and technology	Technology specification
Rules for existing plants	Rules for existing plants		
	Minimum price		
	Banking		
	Penalty rate		

Table 2.6 A summary of key design elements of four main RES-E support instruments (own creation)

Features/policy schemes	Feed-in tariffs	Tradable green certificate	Tendering	Investment subsidies
Pros	- Low risks in terms of price, sold volume and market balancing costs - Technology-specific support leads to technology diversity - Long-term and guaranteed support - Positive impact on domestic industry and employment -Low burden for end customers due to decreasing tariffs	-enhance competition -quick cost reduction -low burden for consumers -Increase market liquidity -Stimulate technological innovation -clear market-based price signal -Guarantee the renewable target	-High total social benefits -Enhance competition -long-term contract with guaranteed price, low revenue risk -Guarantee the renewable targets -A priori known overall cost of reaching targets	-Transmit the message about the added value of renewable energy to final energy consumers directly -Stimulate investment obviously -Annual cost is fixed
Cons	-Less technological innovation -Non cost-efficient (difficult to avoid high profits or additional administrative cost) -Non market oriented -None of the marginal cost, the total production of RES-E, or overall cost of reaching the target is unknown beforehand	-Higher risk in terms of GC market price -Higher transaction costs due to trade, monitoring and verification of GC -Risk of setting improper quota, floor price or penalty -Immature technology excluded	-No incentive to innovate technology -All decisions made by policy makers, losing the market function -Investors' potential strategic behavior -Higher transaction and administrative cost	-No long-term certainty, increasing the revenue risks -Not a long-term main support scheme for a country -Difficult to harmonize at the international level -No impact on competition

Table 2.7 A summary of pros and cons of four main RES-E support instruments (own creation)

The current discussion within EU Member States focuses on the comparison of two systems, FITs and TGC. Other policy instrument such as tendering schemes and investment subsidies are used as supplementary policies instead of a dominant policy instrument in many European countries. A single support instrument usually is not sufficient to develop the full spectrum of renewable energy sources available in a country. Most renewable investments have been realized through a combination of support measures, and in the meantime it is quite important to have a long-term policy framework and target setting to create a stable investment climate. If long-term certainty is missing, investors will be reluctant to bear the higher interest rates requested by banks or other financiers, which might result in lower penetration of RES-E technology than expected with the same level of financial support. According to several studies and surveys, the renewable support schemes are generally compared with each other (Figure 2.10). The feed-in tariffs ranks highest of all the support instruments followed by investment subsidies and quota obligations, while the tendering system comes last.

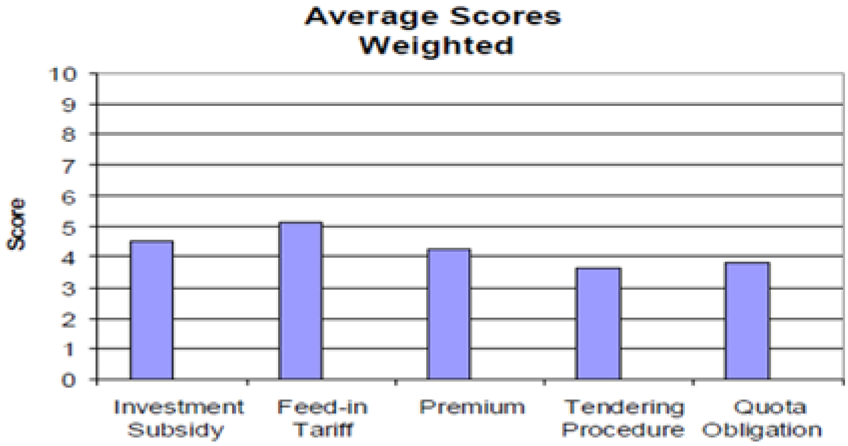

Figure 2.10 Score of support instruments according to RE-Xpansion project (Ragwitz, 2007)

2.2.2 RES-E policy instruments in institutional context

These policy instruments are implemented in a real world rather than in an ideal market with several assumptions defined by neoclassical economics theory. Institutional economics emphasizes the great importance of institutions in shaping economic behavior and it focuses on the behavior of market actors as influenced by institutional arrangements (Scholten et al., 2014). The institutional arrangements are themselves "shaped by a path-dependent interaction between political, [social,] economic, physical [and/or environmental] factors" (Correljé and de Vries 2008, 69) that drive the interests, strategies, and choices of policy makers, firms, consumers, and other actors. Therefore it is essential to study how the RES-E policy instruments work in an institutional context in order to understand why the policy performances in practice differ from the neoclassical economics theoretical outcome.

Due to the long time horizon, the economies of scale and scope and the highly political nature of the investment, infrastructure investments are especially sensitive to a country's institutional environment (Williamson, 1976; Spiller, 1993; Levy and Spiller, 1994; Spiller and Vogelsane, 1996, Savedoff and Spiller, 1997). Institutions are defined as "the rules of the game" (North, 1990), and they can regulate the interaction among actors involved in the functioning of a (technological) system (Koppenjan and Groenewegen, 2005). Thus it can be said that to achieve the goals of markets or energy systems, institutions should be well designed. In other words, markets require institutions to function efficiently and deliver socially desirable outcomes (Scholten et al., 2014). Here we adopt the adapted Oliver Williamson's four layer model to distinguish the various institutions relevant to the market design of infrastructure system. This model provides a useful starting point for the analysis of institutions and the analysis of the economic activities from an institutional angle. What's more, it may be a useful tool in exploring the reasons behind the failure of RES-E policy instruments.

As seen in figure 2.11, the top level refers to the informal institutions which cover the customs, traditions, norms and religion. The institutions at this level change very slowly and emerge spontaneously out of the interactions of millions of actors (Künneke and Fens, 2007). For the development of clean energy technologies, the nuclear power disaster influences the attitude of people worldwide on nuclear energy, but this does not accord with the characteristics of informal institutions. To shape people's opinion on the RE technologies, a long period of public awareness-raising should be ensured.

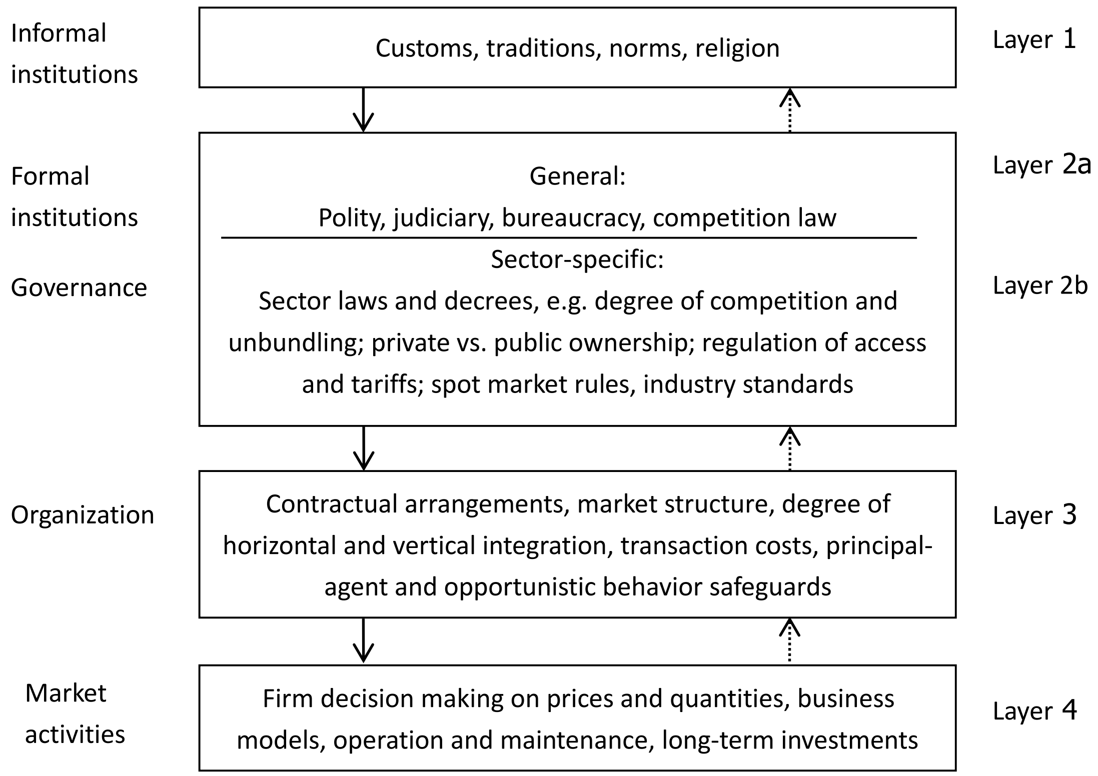

Figure 2.11 Four layers of economic institutions for energy infrastructures (Scholten et al., 2014)

*The arrows show 'solid' top down relations and 'dotted' relations as feedbacks signalling the focus of market design; while in the fullness of time feedback occurs and the system is fully interconnected, when designing institutional arrangements, the logic is that lower levels are embedded in and framed by higher levels.

The second layer deals with the formal institutions, like the general judiciary, bureaucracy and competition law. They are usually designed by economists to provide individual actors with the right incentives to maximize profit and utility or to minimize costs (Correljé et al. 2014). Layer 2b focuses on the sector-specific governance. For instance, free market functioning should be safeguarded so as to generate efficient market outcomes. Regulation may be necessary in light of welfare considerations or specific social goals. The RES-E policy instruments belong to this level, since they exist to influence tariffs/prices, profits, quantities and a few other aspects with the aim of reaching RES-E targets. It is worth mentioning that regulation should be enforceable and less costly than the market imperfections it tries to correct (Perez-Arriaga 2012).

The third layer relates to the organization that accommodates market transactions. As mentioned before, economic transactions increase after an electricity market liberalization. In addition to the power exchange, a green certificate market is also created under the TGC scheme. Transaction cost economics focuses on the coordination costs for searching, negotiating and monitoring contracts, therefore transaction cost minimization is desirable, and efficient coordination of firms is expected to promote the RES-E projects at this level.

The last layer concerns short term market activities which relate to our objectives, company decision making on RES-E investment. The sum of actor activity makes for a certain market outcome, usually expressed in terms of the static and dynamic efficiency of markets and/or the effectiveness with which a specific good or service is provided to consumers (Scholten et al., 2014). This is closely linked to the policy performance of RES-E support instruments based on neoclassical economics theory.

As the institutional environment (layers 1 and 2a) frame the setting for the governance and organizational arrangements (layers 2b and 3), which in turn incentivize actor behavior on this fourth layer, the RES-E policy instruments do not directly influence the investment decision, nor do they determine the investor behavior. In fact, they are emended with the institutional arrangements and affected by the institutional environment and organizational arrangements. This indicates that the policy selection and policy design is not a simple work. We should not determine the policy instrument merely according to its policy effectiveness and static cost efficiency regardless of the institutional environment. The key issue which cannot be ignored here is the transaction costs. For instance, in the liberalized power market, economic transaction is increasing and so transaction costs play an important role on policy assessment especially market-based schemes are adopted. The neoclassical economics assumes no transaction cost, which might explain the phenomena that some policy performances in reality are different from theoretical expectations.

Lastly, in order to better assess the policy instrument, we have to include new institutional economics with consideration of the following conclusions. NIE is considered as an ongoing attempt to expand the neoclassical economic theory to include different aspects of economics, organization, law, sociology and political science in order to understand the institutions of social, political and commercial life. The NIE emphasizes that good rules and arrangements could provide a predictable and transparent framework that attracts more investments, and it focuses on the reduction of transaction costs relevant to business activities (Sedik, 2012). Sound empirical evidence supports the idea that the failing of institutional infrastructure (low respect of law, lack of credibility and corruption, political instability among others) brings about negative effects on investment (Zouhaier, 2011). Throughout history, institutions have been designed to create order and reduce uncertainty in exchange (North, 1991). Together with the standard constraints of economics, investors with institutionalism ideas will define the choice set and therefore determine transaction and production costs, and hence the profitability and feasibility of participating in economic activities (Bergara, Henisz, & Spiller, 1997).

2.2.3 Practical experiences

There are several regulatory instruments (Table 2.4) available for renewable energy development. As seen from the history of the renewable energy support schemes, most European countries changed or adapted their support systems after 1997 (Table 2.8). Each country deploys RES-E technologies in different phases (Table 2.1) and adopts its own promotion instruments. Figure 2.12 shows that Germany, as the leading European member state, will reach 783.4 PJ of RES electricity in 2020 which accounts for 18% of the total production in EU27. Spain, UK and France are expected to each generate more than 400PJ of RES electricity, meaning that these three countries together contribute almost 35% of the RES electricity in EU27. Sweden and Italy are each estimated to produce approximate 350PJ in 2020 (Jäger-Waldau, Szabó, Scarlat, & Monforti-Ferrario, 2011). Some of these leaders apply feed-in tariffs while others prefer quota obligation or other policy schemes. However, the success of renewable energy development depends on the specific design and implementation of the support instrument rather than the policy type selected. This section outlines some main policy schemes applied in Europe and presents relevant experiences. It helps understand the implementing regulations of these support schemes in practice as well as the successes and failures.

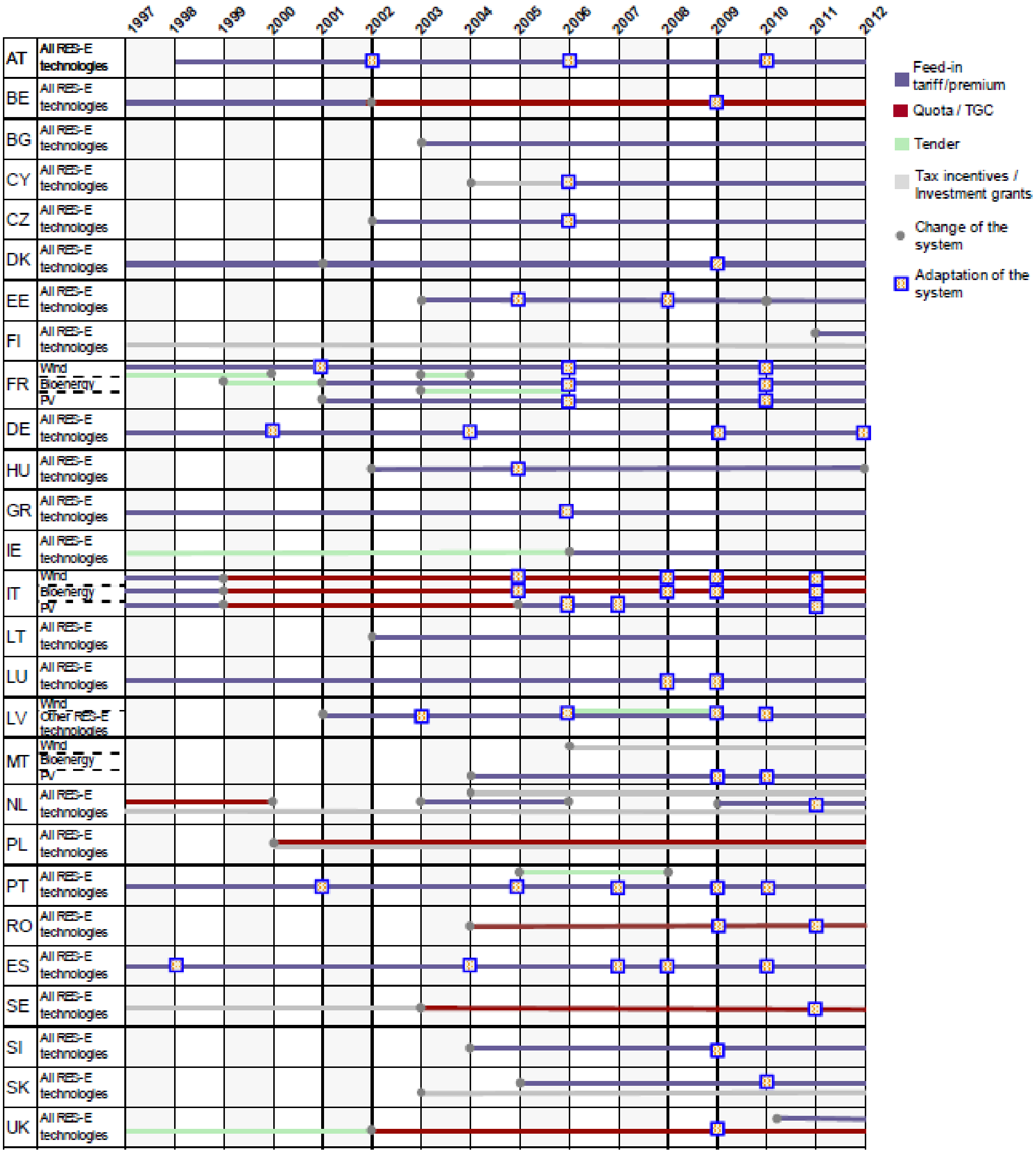

Table 2.8 Evolution of the main support instruments in RES-E (Steinhilber, Ragwitz, Rathmann, Klessmann, & Noothout, 2011)

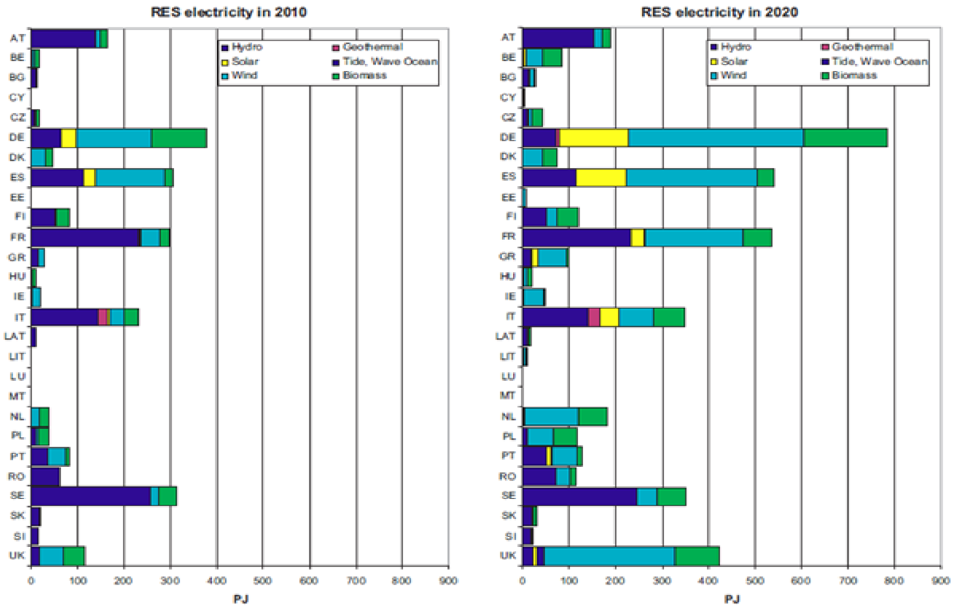

Figure 2.12a RES electricity generation breakdown by source in MS-s in 2010 and 2020 (Jäger-Waldau et al., 2011)

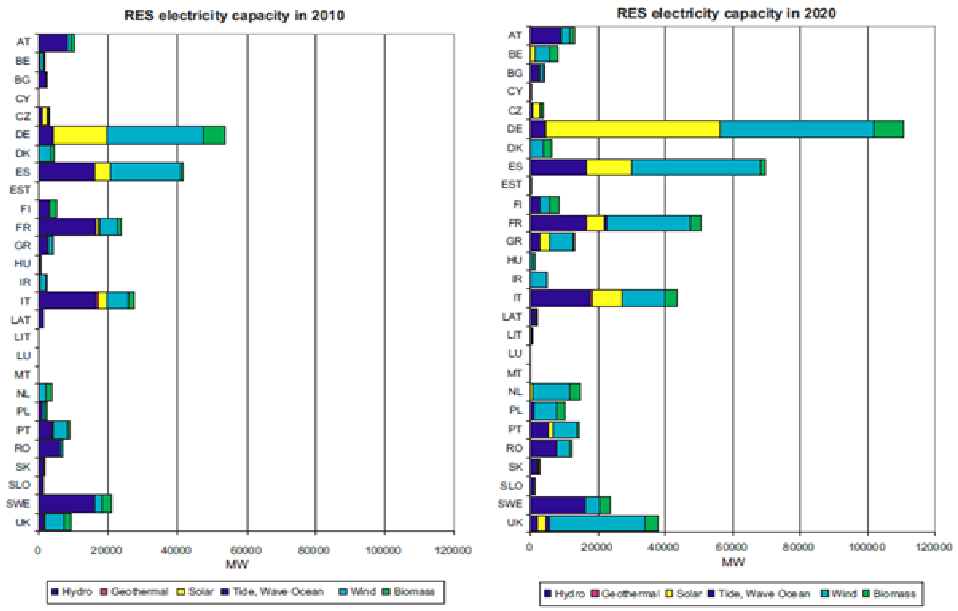

Figure 2.12b RES electricity capacity breakdown by source in MS-s in 2010 and 2020 (Jäger-Waldau et al., 2011)

Feed-in tariffs

Feed-in tariffs have been adopted by at least 65 countries and 27 states/provinces as of early 2012 (Sawin, 2012) . The system is well known for its success in deploying large amounts of wind, biomass and solar energy in Germany, Denmark and Spain.

A fixed FITs system for RES-E has been established in Germany since 1991, and was substituted by the “Renewable Energy Act” in 2000. In the new act, several important changes were made, for instance it set precise RES-E targets, established new principles for stepped tariffs, added a design element of tariff degression, and guaranteed the time-scale of FITs support (Haas, Panzer, et al., 2011). As the tariff degression was established for new installations, the FIT for onshore wind was reduced and wind power plants situated at bad wind locations were excluded from the FIT. Although Germany achieved stunning results in the installation of wind power after 2000, and got approximate 11% electricity from renewable energy in 2005 (compared to about 4% in 1997), some large incumbent utilities criticize the large amount of expenses for RES-E promotion. For RES-E producers, Germany provides them investment security of RES-E production with long-term support.

Spain introduced two alternative schemes for RES-E generators in 1998, a fixed tariff scheme and a premium tariff (on top of electricity market price). It is worth mentioning that lobbying groups pushed for a FITs system from the start, regarding it to be an appealing instrument, citing successful adoption elsewhere, albeit lacking a scientific theoretical basis. Therefore, human factors were initially considered major drawbacks of the support system, such as the annual revision of support level by the government (Gonzalez, 2008). The support system experienced two successive reforms which lead to an impressive increase of RES-E generation, particularly wind farms, in Spain. In the first reform, support levels were tied to the average electricity price (AET), a more objective parameter. RES-E sale options, support duration and degression, penalty for deviations, and target classification for different RES-E technologies were established or revised as well. The specific targets were welcomed by RES-E generators, since they signified medium-term continuation of the support scheme. To be specific, once these targets were reached, support levels would be revised (Haas, Panzer, et al., 2011). The second reform made several improvements on the security of electricity supply, support level setting (linking to CPI instead of AET), and the rights and duties of RES-E generators (Gonzalez, 2008). The greatest and most important change was the cap-and-floor system, which simultaneously guarantees the minimal profit of RES-E generators and limits the policy costs. Sáenz de Miera et al. (2008) have once demonstrated that in the Spanish case an absolute negative correlation exists between wind electricity promotion and the wholesale market price. In other words, the success of Spanish RES-E support system indicates that the policy support is not as burdensome for end consumers as it is usually assumed. (Haas, Panzer, et al., 2011) state that continuity and stability of the renewable energy policy, even under changing governments, have contributed significantly to the success of Spanish policy instruments. In this regard, the promotion scheme was revised by ensuring the payment of feed-in tariffs during the whole lifetime of a plant in 2004, and as Spain made successive reforms, the structure of the support system has been maintained.

In Demark, wind power experienced a large scale integration in the power system, which can be explained by its important role in the official Danish energy plans from 1990 to 1995 (Haas, Panzer, et al., 2011). Specifically, a stable investment climate and the introduction of wind atlases are considered to be the two key reasons for the Danish success (Doherty & O'Malley, 2011).

Tradable green certificate

Six EU countries now employ quota-based trading systems: the UK, Belgium, Italy, Sweden, Poland and Romania (Haas, Panzer, et al., 2011).

Sweden has the highest quota target among this group of countries. It got the TGC scheme started earliest in 2003 and is currently set to last until 2030 (Jacobsson et al., 2009). A strong increase of RES-E generation relies not only on its abundance of natural resources like water and biomass, but also on Swedish policy design of the RES-E support. Sweden allows old capacity to participate in the tradable certificate system to obtain a liquid market, leading to the outcome that more certificates ware produced than redeemed until 2006. Excessive profits were generated due to this rule, since many existing plants had received demonstration subsidies, which meant they would benefit from an additional income stream for about a decade (until 2012–2014) in spite of zero or low additional costs (Jacobsson et al., 2009). In the TGC system, until 2007 the end users were responsible for the accomplishment of quota obligation instead of energy suppliers; moreover, additional investment subsidies are available for certain technologies (wind) besides the quota system. As observed, the certificate prices in Sweden are kept lowest (Haas, Resch, et al., 2011). Despite this low certificate price, up to half of the payments to power producers are still estimated as excess profits to biomass CHP and land-based wind power due to the windfall profits for low cost technologies (Jacobsson et al., 2009).

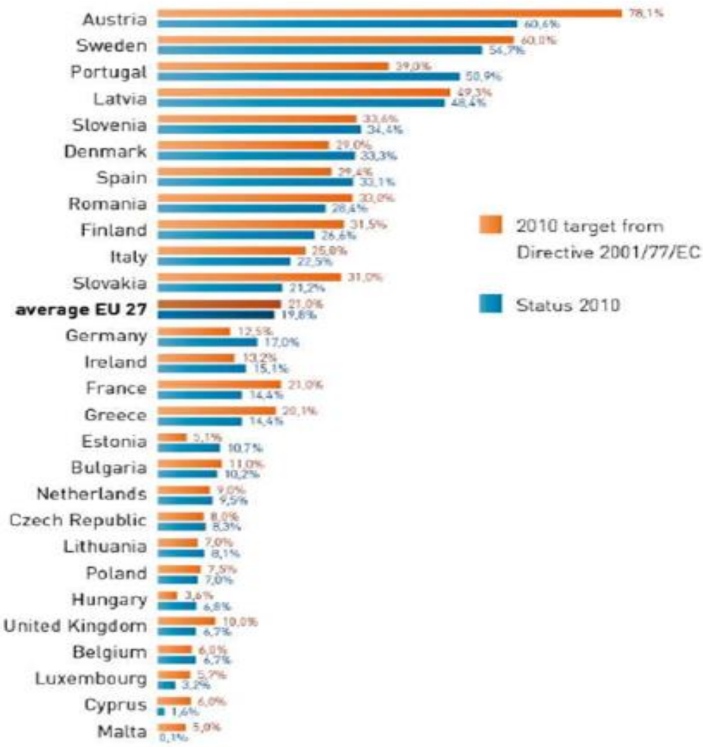

Figure 2.13 Share of renewable energies in gross electricity consumption of EU countries in 2010 (EurObserv'ER, 2012)

Although the RES-E target in UK is relatively low, the quota has so far never been fulfilled (Figure 2.13). Haas et al. (2011) have stated that three major factors lead to this failure: low penalties, location and permitting constraints, and the lack of certificate banking. The British special penalty mechanism and the high risk of its quota system explain why its certificate price was higher than the buy-out price ("fine") and why UK is still far behind the European average in RES-E consumption (Figure 2.9). To improve the situation, in 2010 a well-intended FITs system was started to encourage renewable energy generation in the UK, but frequent slashing of the support level by the government undermines the confidence of power producers in RES-E investment. Similar to the Swedish TGC system, the RO has been costly for the consumer, so technology banding was introduced in 2009 for the UK ROCs market to avoid the windfall profits for low-cost technologies (Jacobsson et al., 2009). However, the non-mature market environment with issues such as administrative barriers are still a big reason for the failure of quota fulfillment. (Verbruggen & Lauber, 2009) have examined the failures of the UK policy scheme and classified these into two categories, internal and external. As can be seen from Figure 2.14, the reformed RO has addressed some of these failures which appear in previous schemes, but a number of internal and external failures still exist and will increase the risks, costs and uncertainty for renewable generators/investors and thus seriously limit the deployment of RES-E, as it was before (Verbruggen & Lauber, 2009).

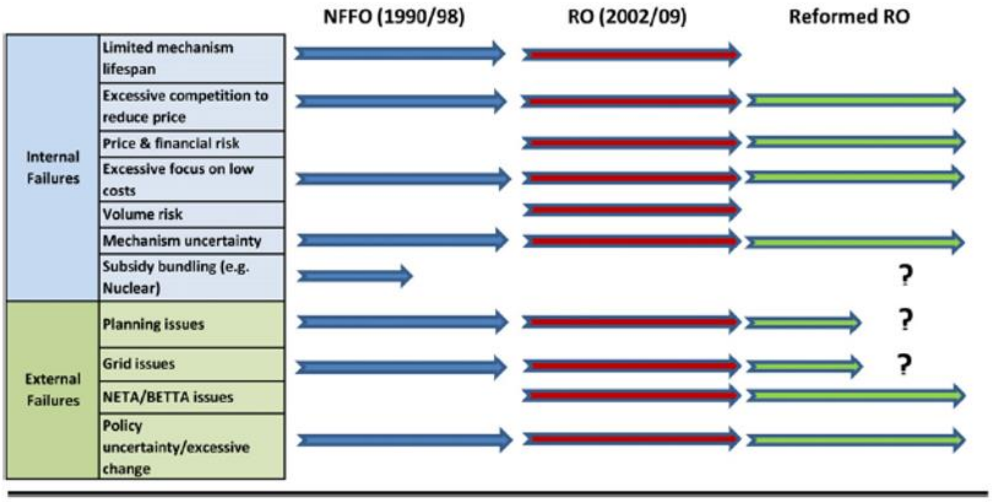

Figure 2.14 the internal and external failures of the NFFO, RO and reformed RO (Verbruggen & Lauber, 2009)

Italy has the highest TGC price and is still behind on its target even though both wind and solar power experienced a strong increase in last few years. There are several special design elements in the Italian TGC system. Firstly, the RES-E quota obligation is given to producers and importers instead of energy suppliers, and the green certificate could be traded internationally. Secondly, existing plants are not eligible for certificate trade although they do count towards quota fulfilment. Thirdly, no penalty or legislative sanction has been specified until now. Moreover, the banking of certificates has been allowed for two years in order to facilitate the control of the certificate market. Lastly, in 2009TGC banding was introduced as an important incentive. It means that all kinds of technology get the same price per certificate but different numbers of certificates are issued according to their GC coefficient. The Italian support system has undergone many adaptions, and now renewable electricity is mostly promoted through a combination of TGC and FITs. The certificate price sold by GSE (Italian Energy Service Provider) is quite unpredictable since it is influenced by an Italian special price setting mechanism (Ragwitz, 2012). This might be the reason why in Italy the quota system will be replaced by a tender scheme and feed-in tariffs starting from 2013. Indeed it is obvious that the “Conto Energia” program under FITs shows much bigger success on PV deployment than the previous TGC system, yet it cannot be ignored that the sudden rise may cause a number of potential problems (grid expansion, support degression, etc.) as was the case in Germany and Spain (GSE, 2012). Administrative constraints such as complex authorization procedures at the local level are also regarded as a serious barrier for RES-E investment (Zervos, Lins, & Tesnière, 2011).

Belgium has its own characteristics in the policy design of RES-E support scheme. It has two parallel TGC systems in Flanders and Walloon since 2002 and the liquidity of certificates has been a constant issue from the start. It is the only country which sets a floor price with technology specifications in the TGC system. Some existing capacity is allowed to fill the quota, and therefore windfall profits become a problem. Penalties in Belgium are not a grave threat since it comes closer to the actual certificate price (Haas, Panzer, et al., 2011). In the early stage (2002-2007), most of RES-E in Flanders was generated from bio-waste flows exploited by incumbent power companies or waste processing companies (Jacobsson et al., 2009). The excess profits generated by Flemish TGC system was associated with some investment in mature technologies, but little money has been spent on real RES-E innovation. The details of Belgian RES-E support schemes will be analyzed in the case study.

Tendering

The tendering system is currently widely used as part of some programs/projects rather than as a major promotion instrument. Between 1995 and 2005, Ireland has had a tender scheme to support RES-E, but one problem was that the associated administrative costs were rather high. The tendering system was then replaced by a Feed-in tariff in 2006, and the new policy scheme offers investors much certainty and made Ireland successfully reach its target in 2010 (CRES, 2008). Another big lesson from tendering is the failure to meet the expected capacity targets. The UK's NFFO is a good case to show this (Haas, Panzer, et al., 2011). Even though since 1990 a lot of contracts have been awarded and the price for wind power was even cheaper than that for conventional power, the results did not live up to the expectations. Some investors could not finish projects as planned due to unrealistic bid prices or slow progress. A more important reason which lead to this situation was however that a tendering system without penalties cannot threaten these investors in order to gain the benefits which were promised. One study came to a conclusion that bidding systems may indeed lead to low support levels but only in the case of limited capacities at the 'best' locations (Jacobsson et al., 2009).

Investment subsidies

Instruments like tendering and investment incentives are frequently used as supplementary instruments. Only Finland employs a single investment grant since 1997, and until 2011 added feed-in premium as a new instrument in order to promote renewable electricity (Ragwitz, 2012). Specifically, in Finland the construction costs of renewable energy plant could be co-financed by the government with grants of up to 40%, and the electricity tax could be refunded, depending on technologies used, to RES-E suppliers (Zervos et al., 2011). The support policies for bioenergy are quite effective and they make Finland a world leader in the utilization of bioenergy. However, to achieve the renewable target, Finland adopted a new support scheme (feed-in premium) and sets the support value in its own manner (feed in premium = target price – market price). In general, Finland spends less but receives good policy effectiveness, although some problems still exists, such as conflicting views on nuclear power, less diversification of production technologies, and economic uncertainties (Valkila & Saari, 2013).

On top of the description of country-specific RES-E policy systems, a number of viewpoints and conclusions, based on facts and actual data, are summarized based on literature review. It is believed to help better understand the function of different policy schemes in reality, with consideration of the various experiences of more countries, and the policy comparison.

The statement that the reason for higher RES-E generation is a higher support level is refuted by the fact that countries with the highest support levels, such as Belgium and Italy, are among those with the lowest specific deployment (Haas, Resch, et al., 2011). As for technological innovation, (Jacobsson et al., 2009) state that "in the EU, it is imperative that some countries continue to use frameworks that give stable and long-term incentives (FIT) to investors to explore new technological opportunities and build new capital goods industries. The rest of the EU (and other countries) may then rely on these countries for acquiring the new technologies in such volumes and at such cost levels." Mitchell et al. conclude that low risks imply high policy effectiveness, which is justified by the fact that the German FIT-system provides higher security for investors than the British Renewables Obligation (Haas, Panzer, et al., 2011). Furthermore, the higher risks associated with TGC-systems compared with FIT systems result in higher profit requirements by investors (Haas, Panzer, et al., 2011).

So far, most studies argue that a well-designed FITs is more effective and cost-efficient than other promotion schemes (Haas, Resch, et al., 2011) (Haas, Panzer, et al., 2011). Compared with another main policy instrument (TGC), FITs shows many different features which can perhaps be called merits. Firstly, a FIT system guarantees a long-term of modest revenue in a technology-specific manner, while a TGC scheme has many uncertainties like a volatile electricity price and certificate price. Second, FITs is proven to contribute to technological innovation, whereas TGC focuses on minimizing the cost for achieving this target. So less technological innovation occurs in countries with TGC scheme, and the dominant RES-E in these countries are normally generated by low cost technologies (del Río & Bleda, 2012; Jacobsson et al., 2009). Third, the utilities are legally obligated to pay the prescribed FIT as long as the RES-E project is technically acceptable. This means that the annual production of RES-E under FITs cannot be roughly estimated in advance as it can under a TGC scheme. Lastly, it can tell that TGC favors corporations with large market power, while FIT is good choice for those countries who favor a competitive market and as much RE investments as possible (Fouquet & Johansson, 2008). Even though countries with FIT have achieved great success, it does not mean that it will work well anywhere and anytime. In the U.S., after an initial growth spurt in the 1980s, the 1990s saw relatively little new development as the FITs established in California and other states were largely abolished (Haas, Panzer, et al., 2011). In this regard, FIT and TGC share one similarity, which is that the investment incentive provided by these schemes varies significantly depending on how each policy is designed and the market in which it operates (Jenner, Groba, & Indvik, 2013).

Overall, the TGC system is widely characterized by low deployment, large excess profits, less technological innovation, an illiquid certificate market, and high investment risks (Haas, Resch, et al., 2011) (Haas, Panzer, et al., 2011) (Verbruggen & Lauber, 2012). However, it is still too early to conclude this, since on one side the TGC scheme is immature and relatively new and on the other hand the policy results depend on the specific design and implementation of the policy instrument rather than simple policy type. What's more, people have a range of reasons for advocating TGreen certificates beyond their faith in neoclassical economics, such as flexibility in target achievement and a framework for importing renewable energy (Jacobsson et al., 2009). There is no doubt that in practice TGC systems did not function the way the theory predicted. To improve the situation, several adaptations like banding, floor and ceiling prices, post-adjustment of set quota, are recommended and deemed necessary (Verbruggen & Lauber, 2012).

The practical experiences confirm that the textbook analysis of market-based instruments are far removed from the real world of complexity and uncertainty. In the socio-technical energy sector, more attention should be put on the complex institutional reality in order to avoid distortions and achieve cost- effectiveness (Jacobsson et al., 2009). Each policy is developed in a particular context (history, culture and politics) that will influence what issues are given priority and how they are addressed. Therefore, even though countries adopt the same policy mechanisms, the outcome can vary because of the context (del Río & Bleda, 2012).

To stimulate the investment in renewables-sourced power plants, many non-economic barriers also need to be overcome. For instance, non-discriminatory connection and access to the grid, transparent and sufficient information and simplified administration procedures should be ensured to facilitate the investment of project developers.

2.3 Policy evaluation and selection

In principle, the investment profits could be calculated by cost-benefit analysis, but it is not that simple when designing RES-E policy instruments. On the one hand, it is difficult to estimate the real value of negative environmental externalities; while on the other hand, the costs of environmental damages are subject to uncertainties. Therefore, most studies rather assess and conceive policies based on the target achievement in a cost-effective manner (Baumol and Oates, 1988). Two policy assessment criteria, effectiveness and cost efficiency, are widely used and they are likely to reflect the entire literal assessment objective. However, these are not enough to evaluate RES-E policy instruments due to several reasons: the imperfect market in reality, changeable goals of governments, a long-term instead of short-term period of assessment, the impacts of institutional environment, etc. It seems that deciding on the best approach or combination of approaches should be partly an economic exercise, and partly a political and social analysis. In this regard, it is necessary to define other assessment criteria regarding the real context of policy application and implementation. Sections 2.2 has illustrated the RES-E policy instruments from neoclassical economics, new institutional economics, and practical perspective respectively, which lay a foundation for setting the evaluation criteria.

Even if more comprehensive policy assessment criteria were established, they cannot totally explain the real development and deployment of RES-E or say which the best policy scheme is. First of all, as seen from section 2.1 the investment in power generation is determined by a number of interactive factors in different domains. RES-E policy instrument is just one of these factors. It means the observed policy performance is the result of interaction of multiple factors instead of policy instrument alone. Therefore, we only compare the policy instruments on the basis of the intrinsic qualities of their reference design rather than refer to the real results as proof of intrinsic performances of these schemes. What's more, competition exists between the different types of RES-E promotion schemes and the different systems are expected to gradually converge into an optimal strategy consisting of the best features of the various policy schemes (Haas, Panzer, et al., 2011). Currently, each instrument has many variants. For instance, Belgium sets a floor price in its TGC system to guarantee the minimum revenue for RES-E investors; and the FITs or investment subsidies for some technologies are granted through a bidding process by some countries (e.g. wind turbines for FITs in Hungary). Therefore, a full assessment of all experiences with RE support instruments would require a separate appraisal of each case, since it seems that no real-life instrument is a clone of another (Verbruggen & Lauber, 2012). We cannot say whether FITs or TGC is the best policy instrument, since they work differently according to the market context and policy design.

2.3.1 Rules for policy selection

Before elaborating on the policy assessment criteria, it is worth mentioning two normal rules for policy selection as follows.

Policy choice depends on the objectives of the policy makers of the day – it is on this basis that policy is usually evaluated (Simeon, 1976). For most member states, the objectives of RE policy are remarkably similar, and that is to meet its RE targets set out by European Commission by increasing the share of RE in the electricity mix. In addition to this, there are other objectives that some countries expect to attain through policy instruments as well, such as to ensure security of supply, guarantee sufficient remuneration for investors, meet least-cost criterion, foster technological innovation, or increase local and regional benefits (Lipp, 2007). For instance, as a leading country in terms of promoting renewable energy, Germany plays an important role in technological innovation, whereas some other countries in the EU choose to be a free rider and put other objectives on their respective priority list. Figure 2.15 shows the different issues which need to be tackled at different deployment phases of RE technology. Therefore, the evaluation of RES-E policy instruments starts with clarifying the objectives adopted by policy makers when designing the support schemes (Verbruggen, 2009). However, a common difficulty is that the policy objectives are rarely stated in a comprehensive and explicit way, are subject to changing priorities, and are sometimes conflicting (Lipp, 2007).

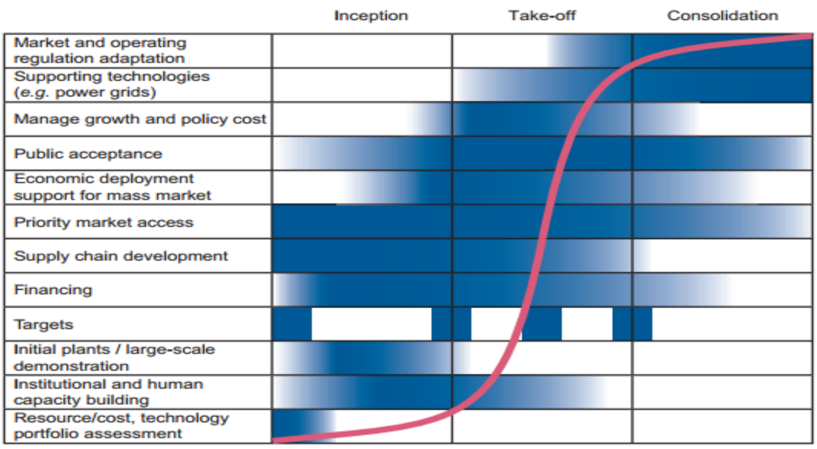

Figure 2.15 Issues to tackle as a function of deployment phase (müller et al., 2011)

Note: The cell shading reflects the relative significance of individual issue along the deployment path. Light shading suggests that interve ntion is required but not with the highest possible priority. Dark shading indicates high significance of the respective intervention.

The choice of instrument depends not only on the objectives of policy makers, but on the deployment state of different renewable technologies. All types of policy instruments could work efficiently under the right circumstances. The deployment of energy technologies can be understood in terms of market diffusion theory. Generally speaking, this theory assumes that the market grows slowly initially, picks up speed with time and accelerates up to a certain peak, after which it starts slowing down again (müller et al., 2011). Plotting the total market size over time could produce an S-shaped curve. The deployment could be segmented into different phases. In the inception phase, R&D funding could alleviate the high uncertainties surrounding the technology, since it is too risky to be financed by the private sector alone. Once a kind of technology is more established in the take-off phase, grants can still be useful for financing demonstration projects. Beyond that the pricing-driven policy seems appropriate as well. Venture capital and quantity-driven policies become available when technology is nearly established in market consolidation phase. Once some technology is capable of being deployed but not yet competitive, policy schemes should tend to shift from capital to operating support. Until now the most significant forms of operating support for renewables-sourced electricity are feed-in tariffs and tradable green certificates.

2.3.2 Policy assessment criteria

Next we aim to present a comparison between different RES-E policy schemes based on several assessment criteria which will be summarized from the existing literatures and the previous statements about the policies from different angles. As mentioned, most existing studies evaluate RES-E policy instruments based on effectiveness and cost efficiency which are the most direct embodiments of government objectives. However, other objectives like technological innovation and market liberalization cannot be neglected for some countries, so we take them into consideration while designing the criteria. Moreover, to stimulate the RES-E investment effectively, it is better to include the issues most concerned by investors as well. Experiences show that certainty or low risk is expected by RES-E project developers as well as non-discriminatory or priority treatment. Lastly, institutional economics illustrates that policy instruments are embedded in complex institutional arrangements, so the institutional environment is very important to the function of policies. A big criterion concluded from this theory is that the transaction costs of policy instruments should be low and the support system should not be too complex. A. Verbruggen & V. Lauber (2012) make a good start by including institutional feasibility into policy evaluation, and that will be adopted in this paper. Each policy assessment criterion is presented as follows and these criteria will set the ground base for the policy evaluation of the Belgian support framework and the policy recommendations for policy makers later in the paper.

2.3.2.1 Effectiveness

Realizing goals, objectives, and targets is the final measure of effectiveness, and thus how far a country is from achieving its RES-E targets and how fast it is moving towards these goals are a simple way to explain the policy effectiveness. In most studies, in order to facilitate the policy comparison, the metrics of effectiveness of a policy instrument is the amount of renewable electric power capacity (MW) installed at a given moment or during a given period compared to the renewable energy potential of the jurisdiction under consideration, or the MWh generated in a given period (year) (Verbruggen & Lauber, 2012). Therefore, Haas et al., (2004) introduces the following equation to measure the effectiveness indicator, which is widely used by researchers.

$$E_n^i = \frac{G_n^i - G_{n-1}^i}{ADDPOT_n^i} = \frac{G_n^i - G_{n-1}^i}{POT_{2020}^i - G_{n-1}^i} \quad \text{2-1}$$

E_n^i: Effectiveness indicator for RES technology i in the year n

G_n^i: Existing electricity generation potential by RES technology i in year n

$ADDPOT_n^i$: Additional generation potential of RES technology i in year n until 2020

POT_{2020}^i: Total generation potential of RES technology i until 2020

2.3.2.2 Efficiency

Efficiency is the economist's favorite and as an economic term it logically comes as the second criterion after physical effectiveness since efficiency is the ratio of outcomes to efforts by definition (Verbruggen, 2009). No efficiency exists if there is no effectiveness (outcomes). Efficiency has multi-layer implications, and here three main concepts are interesting: static cost-effectiveness, dynamic efficiency, transaction and administrative costs efficiency (Verbruggen, 2009; Verbruggen & Lauber, 2012).

Cost effectiveness: Efficiency is mostly measured in a static context. It represents the capacity of a policy instrument to fulfil a predefined target at least cost in a short run. To minimize the operational costs, it requires to remunerate every generated kWh along the ranking of generators in merit-order at their short-run marginal costs. A perfect market could theoretically realize the RE targets at least cost, but in real life, the system marginal cost price will generally be insufficient to pay off the investment in RE plants. The real costs depend on the support level which internalizes the external cost and risks. To some extent, the static cost-effectiveness means the producer surplus should be minimized or excess profits should be avoided.

Dynamic efficiency: Normally policy instruments are assessed from a static point of view with the assumption that the RE technologies are given and unchanging. However, it is often argued that in the long term dynamic environments where the technology changes play an important role in achieving RE targets (Götz, Blesl, Fahl, & Voß, 2012). Therefore, the ability of an instrument to adjust to new information in a flexible and swift manner should be taken into consideration. Regarding the design elements of RES-E policy schemes, support degression and policy revisions are most relevant to this issue. Overall, dynamic efficiency is applied so as to enlarge the efficiency perspective to evaluate the performance of a policy instrument, and to some extent it reflects the objective of technological innovation in a country.

Transaction and administrative costs efficiency: Most studies assume zero transaction costs while assessing the policy efficiency. But these costs cannot be ignored in reality since public authorities should not avoid the efforts of clarifying the understanding of RE resources, technologies, the implementation of policy instruments, etc. Moreover, a simple and transparent support system with sufficient and consistent information will save many costs of investors and effectively stimulate the investment in RES-E.

2.3.2.3 Certainty

Compared with the mature conventional technologies, RE technologies face more investment risks besides being capital-intensive, so it is very important to mitigate risks and avoid backlashes in transitional periods (Haas, Panzer, et al., 2011). Investment risks are related to policy and non-policy factors. Only risks related policy factors are considered here, which cover the market risks caused by fluctuations on the policy support level (price and volume), and the political risks caused by the changes or revisions to the policy schemes. The latter particularly happens if incoming political parties have a different opinion of energy policies or when the policy scheme is found to have had much less of an effect (Gross, Blyth, & Heptonstall, 2010). The non-policy factors include technical risks, market risks (electricity price, gross power supply and demand), and regulatory risks such as difficulty of securing permissions, and grid connection and access. Since certain design elements inherent to policy instruments make them more risky for investors and subsequently influence the investment in RES-E, it is essential to evaluate the risks related to policy factors in order to choose a proper instrument (del Río & Bleda, 2012). For example, Figure 2.16 shows that the tradable certificate system has to add an extra generation costs risk premium on top of monetary generation costs to recover investments with relatively high market risks. This finally explains why the support costs in most trading schemes tend to be higher than in FIT countries, and illustrates that the more risks exist, the higher the remuneration or support level is needed to be in order to activate the investment behavior of project developers. Based on this, it tells us that policy certainty can encourage the deployment of RE projects with lower policy cost, or, we might say, increase the policy efficiency.

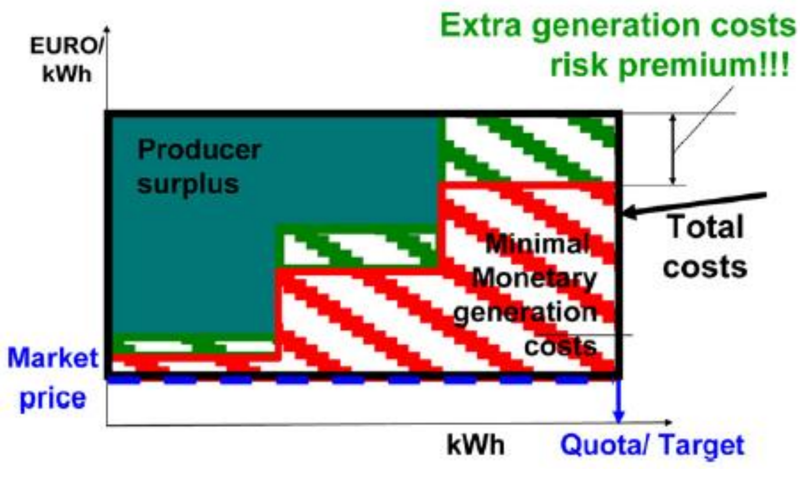

Figure 2.16 Possible producer surplus under TGC scheme with extra generation costs risk premium (Haas, Resch, et al., 2011)

To some extent, the policy certainty should have these characteristics or benefits for investors: predictability and credibility. To be specific, due to the fast development of RE technologies and the immature market, RES-E investors often require a high degree of regulatory predictability and stability. Policy certainty offers them the possibility to foresee the future situation, but it is argued that some investors have no faith in the long-term reliability of the policy scheme that supports the sector, and their investment will instead focus on short-term costs and revenues. Credibility can be interpreted as reliable government commitment which could be reflected by fewer retrospective and retroactive changes to policy schemes or certain acceptable rules for existing investors during the policy transition period.

2.3.2.4 Compatibility

As we know most countries adopt more than one policy scheme to promote the development and deployment of RE projects. Since complex interactions among these support programs might reduce the net benefits of RES-E policy instruments, policy interaction and compatibility should be considered by each country (Azuela & Barroso, 2011). This policy assessment criterion is embodied in a policy design element which is policy scale and combination. Belgium is a typical example: it has four isolated TGC schemes and incompatibility between these systems leads to low liquidity of the green certificate market. What is more, some countries have not made clear stipulations on the policy combination or sometimes inconsistent information might be published by different organizations or authorities. Under such circumstances, investors are not well informed and probably have to cope with higher transaction costs in order to acquire the correct policy support. These lessons tell us that the policy scheme should be designed taking into consideration the interactions with other policies: clear and consistent provisions are necessary, and coordination among different agencies should be enhanced.

2.3.2.5 Equity

It is a controversial issue to define, evaluate and address equity which is completely ignored by some countries (Verbruggen & Lauber, 2012). However, to make the RES-E policy instruments work efficiently and to create a balance between competing energy sources, several themes about equity issue merit special attention in the context of RES-E support: who pays for the extra cost, how to allocate the revenues and expenditures by the support mechanism, and how to deal with the non-economic factors like administrative procedures and grid connection and access (Ragwitz et al., 2006). In fact, all countries have made specific provisions concerning these three themes in their RES-E support system, but few relate these issues to equity. For instance, technology specification in FIT systems shows equal opportunities for each RE technology option no matter it is mature or immature, whereas TGC systems focus on least cost technologies and consequently most of their RES-E project are based on mature RE technologies like biomass, CHP and onshore wind. Besides the policy equity in the economic aspect, a few governments stipulate that RES-E investors should be treated in a non-discriminatory manner or even with priority. It is hard to say whether simplified administrative procedures and priority for RES-E projects breaks the equity between conventional power plants and renewables-sourced power plants since these two categories of power generation technologies are not competitive yet and in addition most governments hold objectives and preferences in the development of RE projects. However, observations indicate that the equity created by technology-specific support can contribute to technological innovation and reduce the occurrence of excess profits, and non-discriminatory treatment is the most basic safeguard for the deployment of RE projects. Put in another way, policy equity can also reflect many governmental objectives and influence the policy effectiveness and efficiency.

2.3.2.6 Institutional feasibility

According to Verbruggen's study (2012), institutional feasibility can be assessed in two aspects, endogenous and exogenous. Endogenous refers mainly to the complexity of a policy instrument, which influences transparency, predictability, participation and compliance. Exogenous means the varieties of preconditions for making a particular instrument perform well (Verbruggen & Lauber, 2012). In general, FIT is simple, transparent and predictable, and it can attract participation by investors, even those outside the conventional electricity sector. TGC on the other hand is relatively complex, which can be understood from its combination of the normal electricity market and a green certificate market, and its requirement of designing more elements of the policy scheme. The TGC is created based on neoclassical economics theory, and many institutes and countries who are strongly committed to neo-liberal recipes for regulating the economy have supported the market-based schemes, but the real market is of course not a perfect competitive model and thus actual experience paints a different picture. As aforementioned, policy instruments, as a kind of governmental governance, are embedded in the institutional arrangements. It must work under the impacts of other institutions at different layers. Or, we can say, the institutional environment (exogenous) influences policy performance. For instance, it is argued that a reasonably long period of nurturing RE development in Denmark and Germany is conducive to the successes of their fixed-price mechanism in attracting RES-E investment (Lipp, 2007). Another phenomenon is that no one Anglo-Saxon country has used FIT until 2008, when the liberalized economics was called into question by the financial crisis. What is more, the 'Not in my backyard' effect and public acceptance on issues of energy and climate could considerably impact the deployment of RES-E projects. All of these can be considered to be related to informal or formal institutions. Specifically, the nurturing of RE development and enhancing of awareness-raising both aim to influence the values or notions of people on renewables; liberalized economics is adopted more as a basic theory of designing formal institutions. So far, we can understand why some policy instruments achieve success in some countries but not in others based on the assessment of institutional feasibility.

2.3.3 Policy comparison

After a comprehensive understanding of renewable energy support schemes and the establishment of policy assessment criteria, it is necessary to make a brief comparison of the four main policy schemes. In order to make these schemes comparable, two issues first have to be addressed: making certain assumptions, and operationalizing the policy assessment criteria.

For the first issue, we assume that the investment climate of renewable energy remains the same for each kind of policy scheme. Or to be more specific: all investment determinants except for the RES-E policy instrument itself are simply set in a manner that do not have much of an impact on the policy performance and they are considered to be constant. To some extent, these policy schemes are compared under ideal circumstances here. For instance, in the technology domain, we assume that all types of RE technologies have great development potential and have no problems in the operational level (e.g. grid connection and access), but the dynamic development of RE technology should be taken into account since it is related to the policy assessment criteria (dynamic efficiency). In the economic domain, we make some assumptions: there must be a power deficit; the electricity price is not enough to cover the generation cost of RES-E; the budget for promoting renewable energy is always sufficient. However, the market power cannot be ignored since in reality in most countries the electricity market is dominated by incumbent companies. In the institution domain, there is an assumption that no obstacles exist regarding administration procedures and information quality, and other regulatory policies are not considered besides the four main RES-E policy schemes. Lastly, there is nothing special in terms of the public acceptance of RE technology, nor political issues such as regime change.

As for the second issue, we are attempting to operationalize the six policy assessment criteria based on their previous definitions as follows.

Effectiveness: in order to facilitate the policy comparison, the metrics of effectiveness of a policy instrument is defined as the amount of renewable electric power capacity (MW) installed at a given moment or during a given period compared to the renewable energy potential of the jurisdiction under consideration, or the MWh generated in a given period (year) (Verbruggen & Lauber, 2012).

Efficiency

-Cost effectiveness: this is usually measured in a static context. High cost effectiveness means that the policy could encourage RE market growth at preferably low costs. In an ideal situation, the support level of RES-E policy instruments should be sufficient to stimulate capacity growth of RES by offering a certain profitability level to potential investors, but should also avoid windfall profits caused by hig h support levels exceeding the requirements of the RE technology. According to the study, comparing the support level contributes to the identification of best policy in terms of cost effectiveness. However, the actual support levels are not comparable due to differing support durations, so the remuneration level has to be considered. The annualized remuneration level[4] is calculated based on the net present value[5].

-Dynamic efficiency: as Verbruggen stated, the reliable indicator of dynamic efficiency is the degree to which the policy instruments encourage technological inventions and innovations to take place in a long term (Verbruggen, 2009). This mainly includes aspects such as technology diversity and resilience. In general, the dynamic efficiency of a RES-E policy instrument can be reflected by the technology-specific support and the policy flexibility for the development of RE technology.

-Transaction and administration cost efficiency: in real life, public authorities should not avoid the effort of clarifying the RE resources, technologies, transition processes, policy instruments,

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[4] For more information about the calculation, refer to http://www.reshaping-res-policy.eu/downloads/RE-Shaping%20D17_Report_update%202011_final.pdf

[5] For more information about the net present value, refer to http://en.wikipedia.org/wiki/Net_present_value

etc. In order to create a predictable investment climate with acceptable error margins and save much money, policy regulations should be transparent and not affected by arbitrary interventions. To some extent, a simple policy with few elements and few actors involved has high transaction and administrative cost efficiency. Of course, providing sufficient, consistent, objective and transparent information will also make the policy instrument perform better in this regard.

Certainty: many studies argue that the main reason for the unexpected performance of TGC scheme in practice is its high uncertainty (Haas, Resch, et al., 2011; Steinhilber et al., 2011). So it is of great importance to evaluate the policy certainty in order to understand the real performance of RES-E policy instruments and make improvement. As mentioned previously, two kinds of risks (market and political risks) are related to the policy factors. We consequently take the policy design elements which are closely related to the market or political risks as indicators to assess the policy certainty. They are policy support level and policy revision. More specifically, we need to have access to certain information such as whether the support price and volume are guaranteed and how frequent the policy scheme will be changed or revised.

Compatibility: this policy assessment criteria is usually used when more than one RES-E policy instrument is implemented simultaneously. However, it can also show whether the same type of support scheme works similarly in different regions of one country. This is particularly important for TGC scheme since the certificate trade depends on policy compatibility. In this paper, high compatibility is the guarantee for an efficient policy instrument. It is difficult to tell what kind of policy combination work better since the same policy can be applied by different countries or regions with differing policy designs. But what is certain is that there must be clear and consistent provisions on the policy scale and combination, which can indicate that policy makers have at least taken policy interaction and compatibility into account, and can definitely reduce the transaction costs as well.

Equity: due to the increase of intertwinement between efficiency and equity, two criteria are usually proposed to be applied for measuring the performance on equity of RES-E policy instruments: first, the realization of the polluter pays principle; second, the avoidance of excess profits. To put it simply, it requires an answer to the question who pays for the costs of development of RE technology, and whether there are regulations and special designs to reduce the excess profits caused by monopoly power and free-riding (Verbruggen & Lauber, 2012). Besides these, non-economic factors like administrative procedures and grid connection and access can also be considered as an indicator to assess the equity of RES-E support system although these are independent of the types of policy instruments used.

Institutional feasibility: as stated before, two aspects are taken into account to evaluate the institutional feasibility of policy instruments: endogenous and exogenous. The former mainly refers to the complexity of the RES-E policy scheme, and the latter means the varieties of preconditions for making a particular instrument perform well (Verbruggen & Lauber, 2012). We can see the endogenous aspect here seems related to the transaction and administration cost efficiency which is influenced by policy complexity. It illustrates that transaction cost really cannot be ignored when including the institution aspect into the evaluation of the investment environment or policy instruments in reality. On the operational level, we can assess the complexity on the basis of the number of policy design elements and variables which need to be defined, and the transaction and administration process. Political preference and public and investors' acceptance are the key indicators to explaining the exogenous aspect. In this regard, it seems that part of institutional feasibility is not determined by the design of RES-E policy instruments but has a large impact on the policy choice and design the other way around.

After the explanation of two issues, the comparison among the four RES-E policy schemes are made as follows.

Feed-in tariffs (FITs)

Compared with the TGC system, FITs are characterized by unpredictable investment results since the interplay of subsidy terms and investors' reactions is not exactly known. The RE targets are also set by member states with FIT policies but they are just indicative milestones on the intended development path of RE instead of an obligation given to electricity suppliers or producers. This means that investment in RES-E might exceed or fall behind the targets due to the dynamics of the FIT system, and policy makers can control the pace of deployment of RE technologies only by regular adaption of the support levels.

FITs are cost-effective when the fixed rates are set at the right level by category. Since the investment risk under this scheme is relatively low, it does not need a quite high remuneration level to trigger the investment in renewable energy. In most cases, the tariffs rate is set to decline annually to incorporate technological learning. That means that when rates are deviating from the optimal levels, adjustments can be made in a relatively short time. In general, categorizing RE supplies (technology-specification support) and applying proper FIT rates by category can promote innovation for several RE technologies in parallel, safeguarding dynamic efficiency (Jacobsson et al., 2009). FIT in its pure form of fixed prices per kWh is the simplest RES-E policy instrument applicable for investors. Compared with the TGC scheme, FIT has fewer elements to be designed by policy makers. The number of actors involved and the information quality depend on the specific situation. Overall, the transaction and administrative costs of FIT are low.

The key factor of FIT's high rate of success in deploying renewable electricity is its clear and robust solution for integrating RE technologies in existing power systems via its guarantee of a fair and safe return on investment. Specifically speaking, purchasing obligation and fixed support level of FIT minimize the market risks. Under this system even investors not specialized in electric power systems can become power producers with calculable and limited risks (Verbruggen & Lauber, 2012). Therefore, numerous small investors actively participate in this sector while incumbents may show lack of interest. For feed-in premiums, RE generators remain exposed to the uncertainties of power market behavior (Couture and Gagnon, 2010). Even though the support volume (capacity) is still ensured, the support price will change along with the volatile electricity prices. Potential RE investors are then consequently restricted to a few companies understanding central power systems and exchanges and capable of absorbing such market risks.

According to the study, FIT implies that incumbent power systems assume the burden of integrating RE and transforming present power systems (not so for premiums). The absence of excess profits makes it easier to balance support receipts by beneficiaries and payments by non-beneficiaries (taxpayers or grid electricity customers) (Verbruggen & Lauber, 2012). A well-designed FIT includes the policy element of technology-specific support which allows a broad range of RE technologies to develop simultaneously. Excess profits are almost avoided under FIT schemes since every category of RE supplies gets the adapted remuneration. There are, of course, exceptions. For instance, the substantial decrease of generation cost of solar power in recent years causes excess profits or unnecessary losses in many countries including the leading country in terms of FIT application, Germany. In practice this has played a minor role, except for where FIT tariffs do not correspond to the levelized cost price of the supported RE projects. Normally, the support rates are designed differently based on technology, commissioning date, installed capacity and nature of investor. Except for very special cases with restrictions, FIT is more attractive for new and small-scale RES-E producers than for intermediate and large producers when rates are differentiated by size.

In general, FIT is transparent and predictable and its complexity is low, but all of this depends on the type of FIT. Difficulties of designing FIT are making an accurate and detailed cataloging of RE supplies, and setting and adapting the support level appropriately. In some cases, calibration may require a complex administrative process in consideration of the design complexity of FIT, which suggests that FIT might be complex. Still, the advantage of FIT becomes more and more apparent: increasing experiences with FIT are available to help solve the above mentioned difficulties and make FIT well-designed. What’s more, most existing studies demonstrate that FIT is the most effective and efficient RES-E policy instrument, forming a good environment for the further promotion of the FIT.

Tradable green certificate (TGC)

In neoclassical economics theory, the TGC and tendering system are market-driven instruments. To some extent, these quantity approaches could enhance the market competition and effectively reach predefined fixed targets in a perfect market. However, the real market is imperfect, and the intrinsic design of TGC influences its policy performance. The effectiveness of a TGC system is closely related to several elements: quota, penalty level, and banking. The quota set could be considered as a ceiling on RE growth. The realization of quota is likely to happen when penalty levels for shortfalls are high. However, RES-E generators may prefer to underperform on the quota in order to increase the prices of certificates, which becomes obvious in the UK. If RE growth exceeds the targets, an overflow of green certificates will become worthless, consequently leading to crisis for existing installations and shelving or abortion of projects. If a banking mechanism is available, surplus certificates can be banked for following years but will act as a brake on future growth of RE projects and a barrier to new entrants (Verbruggen & Lauber, 2012). So it is quite important to set appropriate regulatory quota, penalty rates and banking rules, whereas in fact the quick technological development with cost decreases makes it very difficult to estimate the best RE quota years in advance. What’s more, since the TGC scheme overrides categorizing of RE supplies and makes all RE projects irrespective of source type, technology, vintage, maturity, etc. compete in the same market, some technologies which are more expensive than the lower cost options are neglected. This characteristic of the TGC scheme to some extent limits the choice of RE technologies and consequently affect the policy effectiveness of the TGC system.

Table 2.8 and Figure 2.13 show that 19 countries out of the EU 27 adopt Feed-in tariff/premium as main policy instrument, half of whom, especially Portugal, Spain and Germany, have successfully achieved their 2010 target from Directive2001/77/EC. At the same time, of the six countries with TGC schemes, only Belgium has accomplished its 2010 RES-E national target. Figure 2.17 indicates that UK and Italy have almost never fulfilled the quota completely since they started implementing the TGC scheme. Only Finland uses investment subsidies as a major policy scheme, but evidently it fails to reach the obligatory target. The observations on policy indicators from R. Haas et al. (2011) and S. Steinhilber (2011) make similar conclusions: the countries with feed-in tariffs as main support scheme achieved higher effectiveness compared to countries with a quota/TGC system or other incentives.

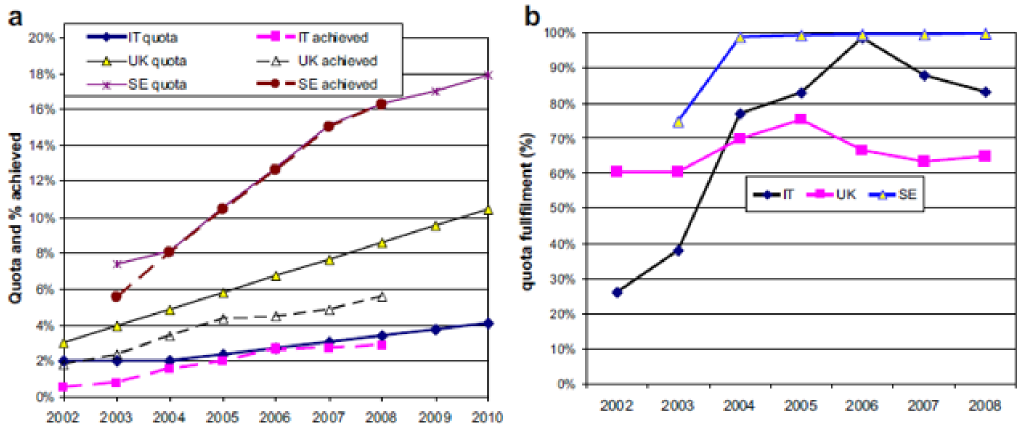

Figure 2.17 Quota and actual shares achieved (left) and quota fulfillment (right) in different European TGC markets (Haas, Resch, et al., 2011)

All in all, although the TGC scheme has advantages in stimulating the RES-E investment from a theoretical perspective, a series of observations illustrate that the FIT system works more efficiently in the real world. Among numerous studies on policy analysis, one good viewpoint is worth a mention. It states that to date TGC schemes are effectively encouraging total RE investment and deployment but not effectively increasing the percentage of RE generation in the national electricity portfolios. This view makes sense since unfinished or suspended RE project cannot be counted in the estimation of policy effectiveness and poorly structured policy design features or weak enforceable penalty mechanisms increase the inconsistency of policy successes. What is more, it is also possible that the rate of RE growth may simply be overwhelmed by the rate of overall electricity demand growth. From a policy evaluation perspective, these findings reveal that weak or inadequately structured policy design features, a lack of enforceable penalties for non-compliance, and an inconsistency between demand growth and TGC implementation are all potentially significant problems that need to be addressed by countries with tradable green certificate systems (Ölz, 2011).

In a TGC system, the lowest cost RE technologies are picked first. It indicates that for a given RE quota in an ideal market the total costs will be lower than when more diverse and less mature RE technologies are included. As such, TGC seems to deliver static efficiency in the short run. However, in the real life the electricity market is imperfect. Due to the character of high investment risks of market-based policy instruments, the remuneration level for investors should be higher under TGC scheme in order to trigger the investment in RES-E. Therefore, in practice, for reaching a certain RE quota the total cost may not be lower under the TGC scheme than that under FIT scheme. The results depend on several issues, for example, whether the FIT rates are set appropriately, and how investors monetize the extra market and political risks under the TGC scheme. Studies show that the RE prices obtained by the TGC systems are remarkably higher than when a well-designed FIT system is applied. This arises from TGC including high profit mark-ups on top of factor costs (and from the fact that the system discourages new entrants), particularly when there are large cost differences between the different sources included in the system (Haas et al., 2011). Since the TGC scheme focuses on nearby cheap supplies, innovation and dynamic efficiency are ignored, and an equipment industry is unlikely to flourish under this regime (Jacobsson et al., 2009). To be specific, it is difficult for policy makers to monitor the state of technological maturity and quality and adjust the support level (certificate price) directly to include technological learning because all kinds of RE projects are amalgamated in TGC markets and the green certificate prices are determined by the markets. Moreover, the bid is usually won by lowest quality or more mature RE technology, which is not conductive to technological innovation and leads to retarded availability of some promising RE technologies in the energy transition period. It is proven by the fact that technological innovation and development mostly happens in the countries which adopt FIT as main RES-E policy instrument. There is no doubt that the transaction and administrative cost for independent RE project developers and operators are higher for TGC systems than for FIT, making participation of new entrants cumbersome and limited (Stenzel and Frenzel, 2008). This high cost can be explained by the fact that under TGC system there are relatively more elements which need to be designed and many economic transactions in both electricity market and certificate market.

Under the TGC system, selling green certificates is one part of the remuneration of RES-E producers, the other part comes from selling the power (or using it for their own purpose). The TGC system therefore faces the double risks of the standard electricity market and certificate market. These risks can be partly eased by the implementation of certificate banking, purchase obligation or minimum stationary price. In such a high-risk investment environment, experienced agents such as incumbent power companies who are better able to handle those risks take precedence in developing mostly larger scale RE projects (Stenzel and Frenzel, 2008). Without sufficient and lasting revenue, it is quite difficult for independent SMEs and households to enter the market, leading to a higher concentration in the RE market.

TGC mostly promotes the use of mature technologies, with the corollary that part of the industrialized countries are not assuming their leadership responsibility. As aforementioned, few European countries adopt TGC systems to promote the development of renewable energy. The documented and analyzed results based on its experiences in a number of past years reveal extremely high and persistent excessive profits (Verbruggen, 2009; Bergek and Jacobsson, 2010; CEC, 2008). Under TGC most excess profits are acquired by incumbent companies, and only a minor part of the profits goes to independent RE promoters, companies, etc. However, an interesting phenomenon is that although they mostly prefer FIT as more favorable to new entrants, they are de facto co-opted into TGC systems by sharing in the excess profits (Verbruggen & Lauber, 2012).

Since this policy assessment criteria is usually used when more than one RES-E policy instrument is implemented simultaneously, the performance of RES-E support systems depend on the specific situation. Unlike the other three policy instruments, the TGC scheme creates a certificate market. In order to make the market work more efficiently, market liquidity should be guaranteed. Therefore, this means that the TGC scheme is better off having high compatibility. In other words, certificates issued by different regions should be tradable and recognizable across the country.

The TGC system is very complex by combining standard power markets and certificate markets. Many elements need to be defined, such as the issuing base of certificates, obligatory targets/quotas, penalties, etc. Moreover, the TGC scheme involves quota obligators (e.g. energy suppliers) besides electricity regulators and RES-E producers. All of these issues make TGC markets require high institutional and administrative capacity to deal with the policy design. In reality, the TGC scheme is opaque, which might be because there are an amount of interactions among these policy design elements and it leads to the intricacies and vagaries of power markets. In addition, the TGC scheme is created to function well when underlying electricity markets are working according to the competitive model. Obviously, actual experience shows a different picture. Nowadays in EU member states, few adopt TGC schemes and the relevant experiences tell that incumbents were generally able to use TGC schemes to generate excessive profits (Verbruggen & Lauber, 2012). Hence one can see that it is impossible to expand the application of TGC scheme to a large extent in a short time.

Tendering & Investment subsidies

For a tendering system, once the contracts are awarded to winning bidders, it seems that the set quota has been specifically and successfully allocated and would be finished if everything goes well. But the problem frequently appears in the implementation phase of developing projects. The bidders usually offer a low price in order to win the contract while some actually cannot complete the project under those conditions. Therefore, the government takes the risk of failing to meet the national targets. Due to the lack of punishment rules, investors will normally suspend or even stop projects until they receive sufficient support in their opinion. Investment subsidies provides the investment-based support which is relatively easier to calculate (e.g. total subsidies = X% * investment capital), so investors are attracted to this kind of scheme. Fixed annual budgets for investment subsidies is a big issue that limits the deployment of RE projects. Following the principle of 'first come first serve', investment subsidies cannot predict the final investment results either, but unlike FIT system, it at least knows the total policy cost in advance.

If competition is effectively fostered, tendering systems could deliver lower costs to promote RE technology. The design of a tendering system is equivalent to adding an auction mechanism to the FIT or investment subsidies. In addition, there are many bidders involved and proper design of project completion guarantees is necessary. There is no doubt that tendering also requires high institutional and administrative capacity to address the policy complexity. Investment subsidies is a simple policy instrument. It normally defines that eligible projects are able to receive certain percentage of their total investment capital. The percentage might differ by technology type, project size and nature of investors. Compared with the FIT, investment subsidies are a lump sum and avoid excessive numerical calculation. On the current situation of its application, investment subsidies are quite welcome as a supplementary policy.

As for the tendering system, bidders are exposed to high price risks (depending on contract design, market rules), so they also require higher IRRs with less predictable revenue streams. The situation would change when the tender is finished. Awarded contracts provide predictable revenue streams to the bid-winner: both support volume and price are guaranteed. Conversely then the risk is transferred to the policy maker, because the stop-and-go nature creates uncertainty which has led to project delays or suspension in a number of cases. What's more, tendering systems and investment subsidies are subject to annual limited budgets. In other words, it is more difficult to secure financing under these two schemes since the budget is determined by means of political decision.

Policy change and revision often occurs due to market mutation, regime change and bad policy performance. The frequency of occurrence depends on the particular facts, which could reflect the policy certainty.

Table 2.9 shows the results of this comparison based on the analysis above. It presents the different levels of impacts (positive or negative) of different schemes on each of six defined policy assessment criteria. We can see that in theory the price-driven policy instruments indeed work better than the quantity-driven ones in the ideal situation. Considering the overall policy performance, feed-in tariffs is the best scheme here. However, whether we could get the same results in the real case, the case study of Belgium will give the answer.

Criteria/policy type		Feed in tariffs	Tradable green certificate	Tendering	Investment subsidies
Effectiveness		+++	++	+	++
Efficiency	Cost effectiveness	++	+	+++	/
	Dynamic efficiency	++	+	/	/
	Transaction & administration cost efficiency	++	+	+	++
Compatibility		/	+	/	/
Certainty		+++/++	+	+*	+++
Equity**		+++	+	+++	+++
Institutional feasibility		++	+	+	+++

Table 2.9 Policy instrument comparison (own creation)

Note: + = weak impact, ++ = intermediate impact, +++ = strong impact

*this impact is measured from policy makers' respective

**the impact is measured excluding the effects of non-economic factors

2.4 Conclusion

This chapter tells us which factors influence the investment in power generation and particularly gives a more systematic and comprehensive understanding of a key investment determinant in institution domain, namely RES-E support scheme. This paper mainly focuses on four schemes: feed-in tariffs, tradable green certificate, tendering, and investment subsidies. Based on defined policy assessment criteria, these are compared under an ideal state. The policy comparison to some extent brings to light new information about the performance of RES-E support schemes since several new criteria are added into the policy evaluation. In real life, some investment determinants differ from our assumptions and policy schemes might show different evaluation results. Therefore, in order to know how to better understand the existing RES-E support system and improve it in practice, we would like to introduce the case study of Belgium in the next chapter.

3. Case study of Belgium

In order to have a correct and comprehensive understanding of the RES-E investment environment in Belgium, three questions should be answered. The first question, 'what is the current status of renewable-sourced power generation', could give a general overview of the growth and potential of RES-E. The second question is 'what is the performance of investment determinants'. The multi-system scheme could be applied here to help answer the question and present the RES-E investment environment. The last question is 'what are the RES-E policy instruments which are directly controlled by Belgian governments'. The history of Belgian RES-E policy instruments could give a deep insight into the policy design and the characteristics of Belgian support schemes. Lastly, an overview of the investment environment will be provided as a summary of the answers to these three questions. This provides basic but important information for the policy evaluation and selection in the next chapter.

3.1 The status of renewable energy in power generation

The development of renewable energy in Belgium is on the right track: the share of gross final energy consumption from renewable energy sources increased steadily from 2.3% to 6.8% over the period 2005-2012 (Figure 1.2) and the share of renewable energy in electricity consumption reached 11.1% in 2010 (Figure 1.3). This means the development progress has been faster than indicated in Belgium's national renewable energy action plan, which provides an indicative path towards the target. Specifically, biomass has always been the largest source of renewable electricity. In recent years, most coal-fired plants have been adapted for biomass or co-combustion, which explains the diverging development of these two types of energy in power generation (IEA, 2009). Two types of biomass are used for power generation in Belgium: (solid & liquid) biomass and biogas. As can be seen in Figure 3.1, the amount of electricity generated from (solid & liquid) biomass power shows a rapid increase between 2004 and 2008 after which it shows a lower growth rate. In 2011, Belgium became the third largest producer of bioliquids electricity, with 82 GWh (Najdawi, Banasiak, Spitzley, & Steinhilber, 2013). While electricity from biogas is increasing as well, its growth is relatively slow. Wind power has also experienced a rapid growth in the past decade and in many energy scenarios it is expected to continue its significant increase in the coming decade (Devogelaer & Gusbin, 2011; Teckenburg et al., 2011). In Belgium, onshore wind technology started deployment earlier and it generates most of its wind power to date (CONCERE-ENOVER, 2012). The first offshore wind farm was officially commissioned in May 2009 with 30 MW as a "pilot phase" and by 2013 the total amount reached 490 MW. In fact, Belgium has already awarded all seven wind farm concessions in the North Sea to various developers, meaning that according to the plan laid out in the Royal Order of May 2004, there will be no further investment opportunity in this technology in the short term. As for solar PV, many markets are still in their infancy and it is was expected to show significant growth in the short term. However, due to the sharp fall of generation costs of solar PV, this situation changed in recent years, as Belgium now shows a considerable growth in power generation from solar, from zero in 2008 to 1.2 TWh in 2011.

As described above, Belgium has made much progress towards to their 2020 targets, but how such positive trends can be effectively and efficiently kept up in the next couple of years has become a great issue. According to studies by the Federal Planning Bureau, realizing the energy transition and achieving the 2020 targets are technically feasible. The high 2020 potential for biogas power and onshore wind power also confirm this conclusion (Figure 1.4). It is worth mentioning that while the potential of solid and liquid biomass power was originally estimated to be around 3 TWh in 2020, Belgium already produced more than 3.4 TWh by 2011 due to the observed increase in cross-border biomass trade (CONCERE-ENOVER, 2012). This shows that investments in solid biomass power plants are still a good option in the future since this kind of renewable energy source is easy to trade and transport. In view of these results, the Belgian national renewable energy source industry roadmap estimates that the solid biomass could contribute 4.9 TWh to the electricity consumption by 2020 (EDORA, 2010a). Besides biomass and onshore wind energy, offshore wind is expected to play a more important role in power generation and even replace biomass as the largest renewable energy source for electricity (Federal Planning Bureau). Considering that wind farm concessions have since been granted, it is now more important to ensure that these projects run smoothly so that the climate and energy targets can be realized. Although the energy transition is feasible from a technical perspective, the process will not be so simple from an economic perspective. It is a huge challenge for any power market to secure a high level of additional investments, even more so concerning investment in renewable energy projects. The energy 'revolution' will not happen spontaneously, it requires strong policy signals and appropriate schemes to encourage RES-E investments in the social-technical power sector.

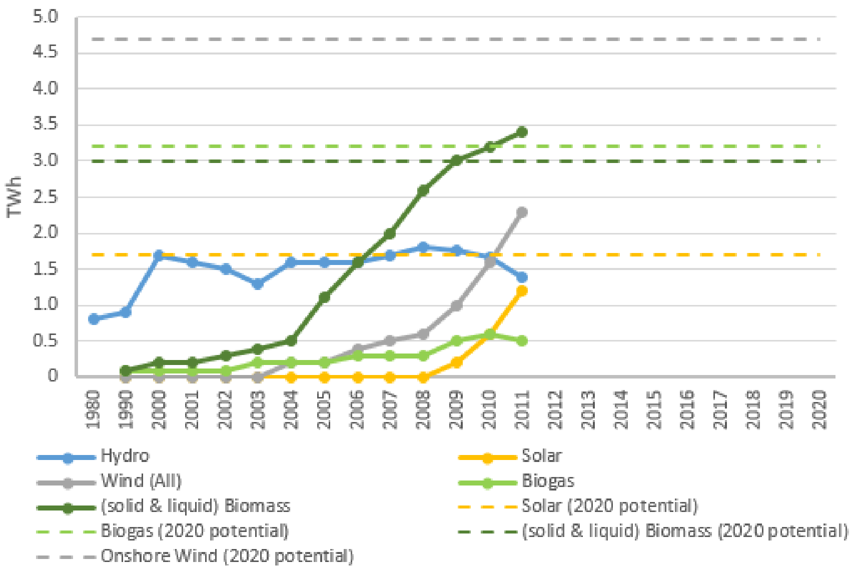

Figure 3.1 Annual electricity generation from primary renewable energy and the 2020 potentials in Belgium (source: IEA, Eurelectric and RE-Shaping)

3.2 Overview of Belgian power sector

3.2.1 Technology domain

Technology development phase: since the fossil fuel for power generation has globally been completely commercialized, these are also widely used in Belgium. In 2011, the power generated from natural gas and coal account for 30.1% and 6.2% of the gross electricity production respectively (Table 3.1). As for the RE technologies in Belgium, both onshore wind and biogas technology is moving to the intermediate deployment phase, followed by Photovoltaics which is in the immature phase. The solid biomass deployment has entered the advance phase, while on the contrary the development of offshore wind and geothermal electricity has only just begun and needs to be sped up from (Table 2.1).

Primary energy	Power generated	
	MWh	%
Nuclear[2]	45,723,502	53.3
Natural gas[2]	25,816,355	30.1
Coal[2]	5,350,522	6.2
Fuel[2]	65,180	0.1
Other auto-generated power autoconsumed [1]	5,073,887	5.9
Hydro and pumped storage[2]	1,635,125	1.9
Other [2]	2,135,430	2.5
Total[1]	85,800,000	100.0

Table 3.1 Breakdown of power generated per type of primary energy (CREG, 2011)

Generation technical and economic characteristics: the technical characteristics of different kinds of power plants are similar around the world and Belgium is no exception. In regard to the economic characteristics, the levelized cost of electricity of some types of technologies have been presented in section 2.1.1 (Figure 2.1). Here the cost curve of the main RE technologies in Belgium furthermore illustrates the deployment of different kinds of renewable electricity and their corresponding cost of power generation (Figure 3.2). As we can see, the cost curve is not flat, biomass generates most of the renewable electricity, and the cost of power generated by solar PV is highest.

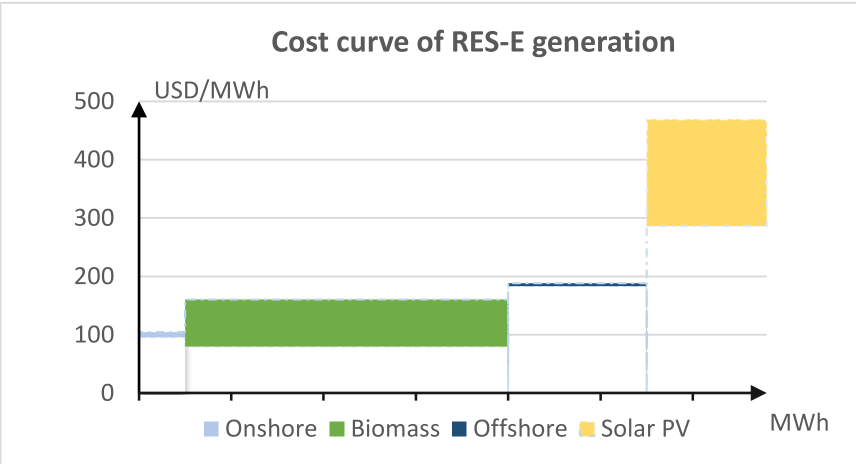

Figure 3.2 The cost curve of RES-E generation in Belgium (data source: IEA & Eurostat)

Operation and environment determinant: Concerning the transmission network, from a technical perspective, in Belgium there are no installations ready to come online but not connected due to capacity limitations of the grid. If Belgium chooses to rely intensively on electricity imports to meet its domestic demand, the export capacity in neighboring countries, namely in France, would become critical. As cross-border trade is continuously increasing and an implicit intraday capacity allocation system was introduced at the Belgian-Dutch border in 2011 (Elia Group, 2012), the interconnector capacity may require expansion in order to realize a single electricity market in European. Regarding the future development of wind farm projects under a dominical concession on the Belgian continental shelf, the extension of existing terrestrial network becomes essential. The Stevin project launched at the end of 2009 for the extension of the 380kV network from Eeklo to Zeebrugge was in response to this challenge. From the regulatory perspective, the transmission system operation is obligated to provide non-discriminatory grid access to power generators, which to some extent guarantees fair competition among the energy producers. In the past, the dominant company Electrabel owned more than quarter of Elia's share, and consequently grid access priority was supposed to be offered to the dominant market player (European Commision, 2009). With the electricity market reform, Electrabel no longer has the power to control Elia and the impartial grid connection and access creates a good investment climate for power plant investors. Finally, there is the matter of location selection: since the geographic conditions and natural resources vary between different regions in Belgium, each region is covered by a diverse mix of existing power plants (EnipediaPowerPlants, Belgium). Belgium is densely populated and heavily industrialized, so some types of technology such as CSP6 are not applicable there. In Belgium, most suitable sites for power plants have historically been owned by the incumbent power company, which deters the entry of new companies. The auction of three sites owned by Electrabel in 2006 and the imposed tax on unused sites aim to change this situation (IEA, 2009), but more measures should be evaluated and potential production sites should be announced to investors.

3.2.2 Economic domain

On the macro-economic level, the world experienced an economic crisis in 2009. For the European Union, without exception each country experienced a negative growth of gross domestic product (GDP). From 2004, Belgium kept its GDP growth pace in the range of 1 % to 3% until 2009 when growth dropped to a negative 2.8%. However it quickly recovered the next year (2010) with a +2.4% change on previous period and is one of few European member states to reach a GDP level in 2010 equivalent to or even surpassing the that of 2009. (Eurostat)

Demand and supply: the Belgian electricity demand recovered relatively quickly from the economic crisis, and saw an 11% increase between 2008 and 2009 levels (86.9 TWh in 2008 compared with 96.6 TWh in 2010). Even in Germany and Spain, electricity demand has not yet reached their 2008 levels (Eurelectric, 2011). Based on the results of energy scenarios from the Belgian Federal Planning Bureau, the average increase of generation capacity is estimated to be between 600 MW and 850 MW per year. The proportion of renewable power in gross electricity production is expected to increase substantially by 2020, and especially wind and biomass energy will likely see many opportunities. Moreover, 50% of current Belgian power capacity is more than 30 years old (almost all coal-fired base load capacity) and has to be replaced by 2020. To a large extent, Belgium will face a power shortage, which will peak in 2015 as a result of the anticipated closure of the three oldest nuclear power plants.

Flemish region	Since 07/2003
Walloon region (large users and business customers only)	Since 07/2004
Walloon region (all customers) and Brussels-Capital region	Since 01/2007

Table 3.2 Belgian energy market opening by region (IEA, 2009)

[6] Concentrated Solar Power

	Electricity (generation)
Very highly concentrated [HHI above 5000]	BE, FR, LU, LV,SK,GR
Highly concentrated [HHI 1800-5000]	ES, LT, PT, RO, SI,
Moderately concentrated [HHI 750-1800]	DE, GB, HU, IT, NL, NO, PL

Table 3.3 Degree of market concentration (European Commision, 2009)
(HHI by capacity – sum of squared shares of individual companies)

Market power: In response to the EU directives adopted in 2003 to open up European electricity and gas markets, Belgium has carried out its market liberalization gradually (Table 3.2). Flanders immediately opened up its electricity market entirely (including to consumers), and Brussels and Wallonia followed in January 2007. However, the Belgian electricity (generation) market is highly concentrated (Table 3.3). The differentiation in implementation of liberalization between EU countries and the earmarking of electricity production as a "national interest" in some member states has led to some large European utilities being able to expand into new markets while their own domestic markets were being shielded against competition (Happel, 2009). Foreign players (Figure 3.3) now control the majority of Belgian electricity production capacity, as Belgium was one of the first member states to open up its market. Now, the main foreign actors in Belgian power generation industry are France's GDF/Suez (owners of Electrabel and Electrabel Customer Solutions), Germany's RWE and E.ON, and Spain's Centrica (owners of 51% of SPE). The most important producers are still Electrabel and SPE, who together generate almost 86% of national production in 2009 (Happel, 2009). Electrabel (GDF Suez) owned about 80% of generating capacity as of early 2009, and its overall market share in the retail electricity supply market was 62% in 2008. An open competitive electricity market could attract new investors and diversify technologies used for power generation and subsequently lead to more efficient production and competitive prices. Although the liberalization of the Belgian electricity market has not yet triggered the expected competition between new players and the incumbents, the dominant power of Electrabel (Figure 3.4) was weakened over the course of 2010 and more competitors show a positive trend in electricity trade, as for example T-Power took up a market position with a 3% market share in just one year (CREG, 2011).

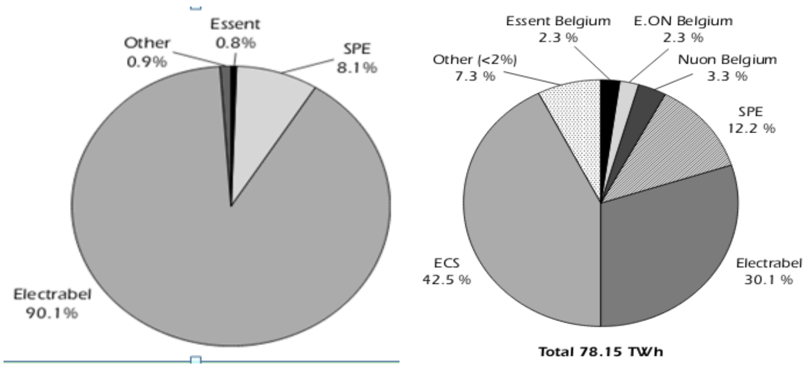

Figure 3.3 Electricity generation market shares (left) and retail market shares, 2008 (IEA, 2009)

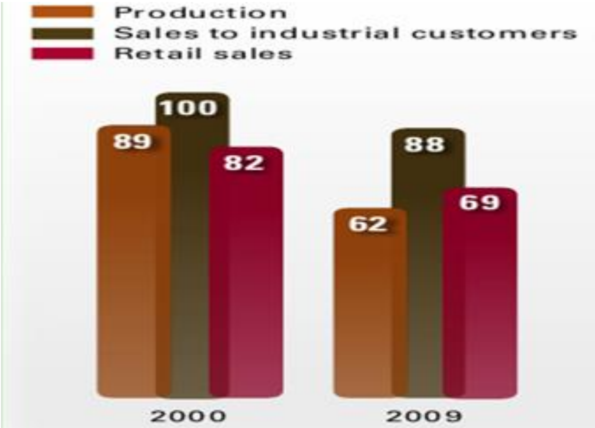

Figure 3.4 Electrabel share in % in Belgian electricity market (Electrabel, 2010)

Power price: in Belgium, the Beplex is a short term, physical power exchange platform for the delivery and off-take of electricity on the Belgian hub. Besides the spot market, energy companies often trade electricity in many different ways in order to manage price risks, including forward contracts and more complex financial derivative contracts. Most electricity produced in Belgium is traded internally within vertically integrated utilities or on bilateral contracts with large industrial customers (IEA, 2009). With the objective of a single EU energy market, Belgium could benefit from the market liquidity by coupling with other national markets, which results in a gradually converging price. At the same time, a connected market would lead to increased uncertainties as it may now be influenced at any time by other countries. For example, due to the impact of the closure of nuclear plants in Germany by 2022, the Belgian electricity wholesale price will be affected as a result of market coupling between Belgium and Germany (Publics.bg, 2011).

Market-based pricing is supposed to send the correct price signal to investors and consumers, but in Belgium neither wholesale nor retail market price result from fundamental market conditions (IEA, 2009). Compared with the neighboring countries (Figure 3.5), in recent years Belgium has kept nearly the highest retail price and low wholesale price (Figure 3.6), which even makes gas power plants unprofitable. The remarkable increase of retail power prices has attracted the Belgian authorities' attention, who might set fixed electricity prices in the future.

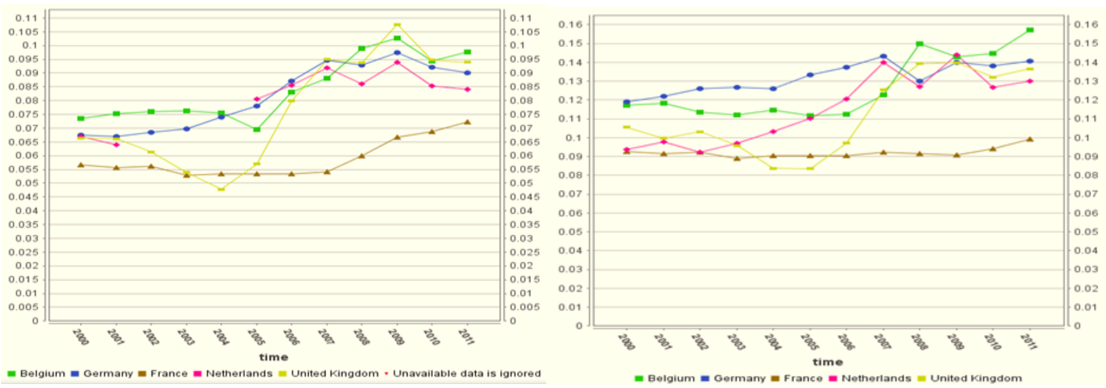

Figure 3.5 Electricity prices for industrial (left) and household (right) consumers euro/kWh (Eurostat)

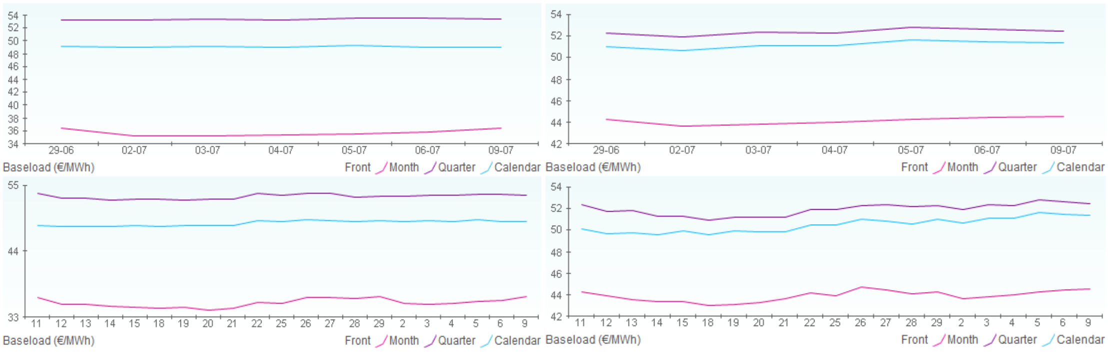

Figure 3.6 ENDEX power results for Belgium (left) and Netherlands (right) (ENDEX)

3.2.3 Institution domain

Belgium is a Federal state consisting of three regions: the Walloon Region, the Flemish Region and the Brussels-Capital Region. The regulatory framework for the electricity market is quite complex with these federal and regional levels. As seen in Table 3.4, the federal level takes more important responsibilities in the areas of the high voltage system as well as special energy (nuclear and offshore wind). Due to the political regional division, there is also one national energy regulator – the Electricity and Gas Regulatory Commission (CREG) and three regional regulatory institutions – VREG in Flanders, CWaPE in Walloina and Brugel in Brussels-Capital, which are responsible for the licensing and regulation of electricity distribution below 70 kV (IEA, 2009).

Federal level	*Regional level*
Security of supply	Promotion of the efficient use of energy
National Prospective Studies	New and renewable sources of energy (except nuclear)
Nuclear fuel cycles and related R&D programmes	Energy R&D (except nuclear)
Large stockholding installations	Market regulation for distribution of gas and electricity
Production and transmission /transport of energy (electricity grid >70 kV), including large storage infrastructure	Distribution and transmission of electricity (electricity grid <70 kV)
Distribution and transport tariffs	Public distribution of natural gas
Energy statistics and balances	District heating equipment and networks
Offshore wind energy	Recovery of waste energy from industry or other uses
	Energy statistics and balances

Table 3.4 Division of energy policy responsibilities in Belgium (IEA, 2009)

Administration procedure: in Belgium, most of the authorizations for renewable energy plants are granted at the regional level, except for offshore wind which falls under the federal authority, and the issuing administrative bodies differ between regions (Rademaekers, 2010).

The basic permits needed for RES-E plants are environmental permits and an urban planning permits, which are granted under the competence of respective regional administrative agencies for regional planning/territory and environment. Some biomass projects suffer from project delays which result from shared competences since waste legislation lies with the federal authority. Production facilities of more than 25MW also need to acquire production authorization from the federal authority. Moreover, a delivery or feed-in permit (an approval of the TSO or DSO) and at the end an approval from the regulator for green or CHP certificates are necessary to ensure the operation and profits of power plants as well. In the case of offshore wind projects, investors have to take into account the domain concession (granted by Minister of Energy and Climate), and a permit for the wind park and the offshore power grid (determined by CREG, FPS, TSO and MUMM).

Typically, an average of 7 permits are required for the installation and operation of a new power plant. It is inevitable that a number of public actors will be involved in the administrative process, and therefore a deadlock occurs more frequently due to their disagreements. To reduce project delays and administrative complexity, both federal and regional authorities have drafted legislations and provisions to limit the processing time, and a 'one-stop shop' has been adopted by Walloon and the Brussels Capital Region (Peeters et al., 2010). Although a mandatory time-schedule is established for permit processing, the renewable project authorization procedures are still too long, especially in the case of wind projects. Among these different technologies, PV has the shortest time for authorization (2 to 5 months), while the process could last several years for wind farms (Table 3.5). Currently, 9 out of 10 onshore wind projects lead to either project refusal or automatic appeal procedures, which delay the development of onshore wind power (EDORA, 2010b). The regional one-stop shop means that investors could obtain a "single permit" which serves both as environment permit and as an urban planning permit (Peeters et al., 2010). In addition, there are several authorization procedures considering the specificities of different renewable energy technologies and the capacity of the installation, most of which are taken at the regional level. For instance, biomass boilers in buildings with a capacity of up to 300 kW do not require authorization in Flanders, solar panels are mostly exempt from certain permits, and the Brussels Capital Region is planning to introduce a simplified procedures for granting environmental permits for small-scale wind turbines as well as for low-capacity biomass installations (Rademaekers, 2010). Overall, project developers struggle in the quite complicated and inefficient administrative system.

Technology	Time for authorisation (from application to obtaining the final permits)
On shore wind	6 months to several years (the final judgement of the Council of State takes max. 7 years)[7]
Off shore wind	The process is becoming faster as the first off shore wind turbines are realised (and thus the public officers are building up know how) but still takes several years. (the process why somebody gets the authorisation and somebody else not – if there are several candidates – isn't clear)
PV	2 to 5 months for most installations (for < and > than 10kWp). The main delay is due to a lack of follow up by the DSO, especially for >10kWp.
Biomass	6 to 12 months (time required is largely depending on primary energy used) for small projects (max a couple of MW) and up to 16 months for bigger ones. In function of legal issues, the process can last for many years. In Flanders it takes in general more time than in Wallonia (this is primarily due to the different attitude of the regulator regarding more complex issues).

Table 3.5 The time for authorization of RES-E technologies in Belgium (Rademaekers, 2010)

Information transparency and sufficiency: Transparent prices in all parts of the electricity value chain are the cornerstone of the liberalized market. In particular, prices should reflect the real balance of supply and demand, especially in peak hours. To achieve the liberalization of Belgian electricity market, the federal regulator has stopped setting parameters which are used by most suppliers to calculate the electricity bill (CREG). This means that the government is no longer responsible for price setting, yet Belgian power price formation remains non-transparent and the prices can not reflect the underlying economic conditions.

The access to the established rules on the processing of authorization, certification and licensing applicants is not a major problem (EDORA, 2010a), and it might be due to an official directive which stipulates that comprehensive information about the authorization procedures must be provided through various channels: website, ad hoc meeting, etc. (Peeters et al., 2010). Belgium offers abundant information of RES-E support measures, but how the support value is calculated is yet unknown. For instance, neither the Minister for Energy nor the operators of offshore facilities are aware of the assumptions and calculation method used for computing the minimum price of green certificates for offshore wind (CREG, 2012). Moreover, project developers often experience problems due to the lack of detailed information about provisions and regulations (Rademaekers, 2010). In turn, the costs of RES-E project are usually presented by developers strategically, which might cause policy makers to misinterpret the real state of the RES-E technologies.

As for public authorities, they have a major role to play in raising awareness of both investors and consumers whose thoughts are shaped by public information. Currently, the public has no ability to obtain objective and up-to-date information. This could be reflected by the fact that rumors and disinformation have formed a major constraint to the development of wind energy projects (EDORA, 2010a; Rademaekers, 2010). What's more, Belgium is lacking in regional spatial planning and available sites for new power capacity, especially in the case of wind projects.

A good thing is that Belgium sets and publishes various targets clearly. Nationally binding targets by 2020 are presented in Table 3.6. Several relevant national and regional action plans and targets are already worked out for these 2020 objectives. For instance, regional targets for CHP (10.5% share of CHP in electricity production in Flanders by 2021, 20% renewable electricity and high-quality CHP in electricity production in Wallonia by 2020) exist to contribute to energy efficiency (Höhne, Geurts, & Teckenburg, 2011). With the overall 13% RES target by 2020, the Belgian authorities forecast that renewable electricity (RES-E) will take the largest share of RES in 2020 (20.9%). RES in the heating and cooling sector (RES-H&C) and renewable in transport (RES-T) are projected at 11.9% and 10.1% respectively (Zervos et al., 2011).

Belgium	**2020**
Energy efficiency	-18%*
CO_2	-15%
Renewable energy	13%

* 3.4% of which is attributable to the impact of the economic crisis

Table 3.6 Belgium Energy-climate targets by 2020 (BFA, 2011)

Regulatory policy: Concerning non-transparent price formation, Belgian authorities have made various attempts to improve it through legislation. In order to provide a more stable and predictable climate, the Royal Decree has introduced a new multi-annual tariff-setting mechanism for electricity transmission and distribution (CREG). Moreover, The CREG gets additional competences to monitor electricity price components so as to protect consumers against predatory pricing. The transmission tariffs proposal for the period 2012-2015 submitted by Elia has been approved by CREG. To send appropriate tariff signals to the market players, the proposal was drawn up following consultation between the regulator and Elia. Compared with the data in the preceding period (2008-2011), the tariffs of grid connection and utilization have increased and injection tariffs as a new item are listed separately in the tariffs report.

To stimulate renewable energy development and reach energy and climate targets, a number of renewable energy support policies have already been implemented in Belgium and renewable electricity is promoted mainly by a green certificate system with quota obligations (Table 2.8). Apart from the green certificate system, several other incentives in the form of tax deductions, investment grants, subsidies or tenders for specific technologies also exist in some regions (Haas, Panzer, et al., 2011). Moreover, the cost of coal and gas power plants has increased due to Belgium's additional fossil fuel tax. Specifically, electricity companies have to pay a tax of 11.6526 €/tonne of coal and a federal levy of 0.7399 €/MWh when natural gas is used for power generation. Nuclear energy remains a vehemently debated topic in Belgium. After the Fukushima accident, Belgian authorities agreed to take some time to reflect on this subject, since there is much uncertainty about the nuclear phase-out law which has been in place since 2003. Still, the decision process should not take too long.

3.2.4 Other determinants

Actors: in the electricity system, there are many actors involved and each works on a different position with their own interests, resources and power. This report will focus on three main actors: the government, investors and consumers. Belgium has a very complex authority structure and regulatory framework. Its three regional systems work independently from one another and have their own rules and administrative procedures. However, both federal government and regional governments have similar objectives which are to optimize the social benefits and achieve the renewable energy targets. In short, the government is responsible for social welfare and energy development. How to make the tradeoff between the needs of power generation investors and consumers is always a challenge for government actors. The energy producer is another key actor, and makes the investment decision. Before each investment is decided upon, they must consider many factors and perform a certain kind of return on investment assessment. Finally there is the consumer. Their main need is for available, affordable and acceptable electricity. Furthermore, residents have the right to oppose power plant projects on the basis of perceived environmental pollution or other reasons. If the price of electricity goes beyond the consumer's acceptance level, electricity consumption may decline despite the elasticity of the demand for electricity being small.

Beside these three critical actors, many other players are involved throughout the value chain, for instance, the electricity transmission system operator (TSO), distribution system operator (DSO), the federal and regional electricity and gas regulators, and environmental and non-profit organizations. In Belgium, the legal unbundling between companies which are involved in production, transmission and distribution of electricity was completed in 2007 (IEA, 2009). ELIA, the transmission system operator, and the regional distribution system operators are legally fully unbundled from supply/production companies.

Public acceptance: other barriers include insufficient public awareness of new power generation technologies, and the NIMBY (not in my backyard) effect, which are caused by the high population density and limited available space in Belgium. After the Fukushima Daiichi nuclear disaster 2011, Belgian citizens protested against nuclear power and appealed to the government to phase out the nuclear reactors. It should be noted that according to the results of opinion poll published in February 2012, 58% of Belgians were in favor of keeping nuclear energy in the generation mix, and 62% favored reducing its share (Foratom, 2012). This uncertainness of public opinion increases the risk of the power generation investment. The government is commended for its efforts to improve public awareness and publish the state of public opinion in time, since any change could affect investment strategies.

Political issue: politics in the Belgium is quite complex, and energy issues always incur serious debate among the various political parties, especially in periods of administrative shift. In addition, some politicians may abuse their power for their own interest or to benefit their own regions. All of these issues make the Belgian electricity market uncertain and makes it unattractive for energy producers to invest in new power plants.

3.3 History of Belgian RES-E policy instruments

3.3.1 Characteristics of support scheme for RES-E production (tradable green certificate)

In this paper, eight elements which determine the tradable green certificate system are elaborated upon (Appendix A).

Project selection

Green certificates from offshore wind energy are controlled by federal authorities. Electricity producers can apply for these Green certificates only when it owns a concession area and certificate of origin guarantee. All RES-E technologies except for offshore wind are promoted under regional competence, and there are certain variants depending on which of the three regions it concerns. For instance, CHP units with high quality are eligible under the green certificate schemes designed by the Walloon Region and the Brussels Capital Region, while in the Flemish Region they benefit from a particular CHP scheme. To obtain Flemish Green certificates, a power plant should be new and located in the Flemish Region. A ‘new plant’ is defined such that the components of the generation system cannot have been previously used in a green power plant on the same site or another site owned by the same company. Both the Walloon Region and Brussels Capital Region stipulate that only production facilities which are certified by their own regulator and hold capacities lower than the maximum value are eligible to receive Green certificates. In addition, the criterion of a saving of 5% CO_2 should be met in the Brussels Capital Region.

Technology specification

While the issuing base of green certificates has nothing to do with the RES-E technology, the Federal authority and the Flemish Region have provided a system of guaranteed minimum prices which varies according to the RES technology. The Walloon Region also adds a minimum support system to its green certificate scheme, but the support value is the same for all kinds of RES-E technologies. Thus we can see that technology specific support is applied in only part of Belgian TGC systems.

Existing plants

The element of existing plants could be explained under two situations, policy establishment and policy revision. When Belgium adopted the green certificate scheme in 2001, the Flemish Region and Walloon Region included existing plants in their TGC scheme. Since few power plants generated electricity from renewable energy at that time, and the support for RES-E power plants is technology-specific, including existing plants put very little effect on the additional installation and technology diversity of RES-E capacity. Currently, among the established installations, only those with a capacity of over 20 MW are eligible under the Flemish TGC scheme. The second situation refers to the effects of policy revision which are likely to make retrospective and retroactive changes on existing plants. Specifically, the retrospective changes in renewable energy laws and policies could both change the revenue streams which are expected by renewable producers of existing plants and might undermine the confidence of investors. This especially happened to the PV industry in recent years, the details of which will be described later in policy revision.

Support level setting

The support level setting of green certificate schemes primarily contain an issuing base, guaranteed minimum price and penalty. They respectively stand for the calculation method of GC, the guaranteed revenue of producers, and how much suppliers have to pay if they fail to meet the quota.

The federal authority and Flemish Region issue Green certificates based on electricity production, whereas the Green certificates from the Walloon Region and Brussels Capital Region respectively represent 456 and 217 kg of avoided CO2 emission (IEA, 2009). In addition, the Walloon Region grants green certificates for photovoltaic installations following special rules made in 2006. To be specific, the Walloon Government decided to grant 7 green certificates per MW of photovoltaic electricity produced instead of 1 in the case of other technologies in order to compensate the high costs of PV installation (Dreblow et al., 2013). The federal authority sets guaranteed minimum prices depending on the technology, but shows no support for onshore wind and biomass energy. The most complex regulations on minimum price per certificate are displayed in the Flemish Region where minimum prices differ not only based on technologies but also the commissioning date of plants. The Walloon Region adopts a relatively simple rule to ensure the value of Green certificates, setting an identical €65 price for all types of RES-E technologies. There is no guaranteed price of Green certificates in the Brussels Capital Region. Since the development of renewable energy is under regional competence, neither quota nor penalty is set at the federal level. All three regions create a penalty value in their own region and occasionally revise these. As the Appendix A shows, the Flemish Region amends the penalty level most frequently. The market price of Green certificates is able to reflect the real revenue obtained by RES-E producers from the TGC scheme. The green certificates in these three regions are all traded with a value higher than the guaranteed minimum price, and the market price in the Brussels Capital Region even exceeds the penalty value. Banding factor is a new element added into the Flemish green certificate scheme. It aims to prevent oversubsidization and lead to evolving support based on an annually determined financial gap and expected market value of Green certificates for RES-E investment. However, the effects of this legislative amendment is uncertain, since the reform only came into force in 2013. Lastly, for the TGC scheme no cap is set on the total support volume.

Support duration & degression (or ascending targets)

Besides the support level, the support duration of the green certificate system is equally important to measure the RES-E investment. Here we introduce several key elements about the time span of the support and ascending targets set by regional level.

The Federal authority and Flemish Region grant Green certificates to RES-E producers during the entire service life of installation, while the Walloon Region and Brussels Capital Region offer certificates for 15 years and 10 years, respectively. In terms of benefits from the guaranteed minimum price, different durations are set on the federal and regional levels according to the technology. For instance, the Federal authority guarantees 20 years of minimum buy-back price for offshore wind turbines, the Flemish Region sets it at 10 years for all technologies except photovoltaic, while the Walloon Region made the duration variable to a reduction factor which gradually decreases the amount of certificates allocated to RES-E installations after 10 years. Certificate banking has an impact on the market trade of Green certificates. In Belgium, the duration of certificate life is 5 years. In July 2012, the validity of green certificates in the Flemish Region was extended from 5 to 10 years for all RE projects which are put into service after 1 January 2013 (VREG). The federal and regional governments have successively adopted green certificate systems in 2002-2005, but neither indicate a clear end date for the support scheme. The ascending targets here refers to a pre-determined quota obligation, which normally increases year after year.

Policy scale & combination

As a market-based scheme, tradable certificate systems are expected to perform well in large-scale certificate markets. However, in Belgium, international trade of Green certificates is not available. Furthermore, the liquidity of Green certificates is quite low in the internal market. While the Federal authority accepts Green certificates granted by any regulator, the Flemish Region and Walloon Region only recognize Green certificates issued by their own regulator. The Brussels Capital Region also accepts Walloon certificates, which could be because its certificate market is much too small. In addition to the TGC scheme, several support policies for investment in RE technology are employed to stimulate the renewable energy in Belgium. At the Federal level, offshore wind farms are supported through a contribution to the financing of the connection cost, while tax reductions for individuals and companies are also available as an incentive. At the regional level, all three regions have implemented a subsidy scheme for RES-E investment to different degrees. Moreover, there is some additional investment support for the high-cost technology of solar PV. The details of these investment supports and policy combination issue will be explained later in this paper.

Policy payer & rights and obligations of system actors

To guarantee support from the TGC system and understand the market situation, policy payers and payment principles need to be known. For investors, it is important to understand the rights and obligations of the different actors related to them.

In Belgium, the costs of green certificates are paid directly by energy suppliers, traders, or in case of the “fall back” minimum prices, by the TSO and DSOs. But all these extra costs of RES-E generation ultimately will be passed on to end consumers through surcharge tariffs. Only federal (CREG) and regional regulators (VREG, CWAPE, Brugel) are entitled to issue certificates to RES-E producers. The requirements to obtain these certificates were explained above at project selection.

The network operators (TSO, DSOs) are obligated to purchase the green certificates awarded by various Belgian regulators from any renewable energy generator upon request, but the relevant rules about this public service obligation and the rights of operators differ by region. At the federal level, Elia is responsible for buying green certificates granted to RES-E from offshore wind, solar, water or tidal energy in Belgium. For solar energy, only those photovoltaic facilities commissioned before 1 August 2012 are entitled to receive this support (Elia7). Since grid operators must buy back the Green certificates from generators connected to their grid, if the generator requests this, the local power transmission system (LTSO Elia) must carry out its obligations by applying local minimum support in different regions. What needs to be stressed is that even though the Brussels Capital Region has not set a guaranteed minimum price for RES-E generation facilities, Elia is still required to purchase Green certificates awarded by Brugel at €65 just as it must in Walloon. In the Flemish Region, DSOs as well as LTSO Elia are obligated to buy green certificates, but the former only supports the power plant which is connected to the distribution network and has been in service for less than 10 years. In the case of the federal and Flemish support mechanism, grid operators have the right to resell the green certificates bought from RES-E producers on regional certificate markets, and therefore only the net balance between the purchase price of green certificates paid by Elia/DSOs and the selling price on the market is financed by surcharge transmission tariffs. In the Walloon Region, the Green certificates purchased by LTSO Elia will be cancelled and cannot be resold on the market.

As for energy suppliers, they have to reach their quota obligation annually or quarterly under the TGC schemes. The Walloon and Brussels governments will publish these quota every year until 2020 and 2025, respectively. The quotas before 2012 were also predetermined in the Flemish Region, whereas since 2013 these are determined by means of a special formula. The new formula introduces a ratio between the number of granted green certificates and the total gross production of green electricity in a given year (n-2) in the Flemish Region, which better adapts to the reality since not all green electricity produced can obtain a certificate every year (VREG8). To receive benefits under the TGC scheme, RES-E producers are free to sell their Green certificates in several ways. As a traditional trading mode, bilateral transaction is available in each region. Moreover, Belpex establishes two different markets for the anonymous trade of green certificates in the Flemish Region and the Walloon Region. The third way is to require gird operators to buy green certificates at a statutory minimum price. It is worth reminding that the Green certificates granted by Federal authority can be sold only to TSO Elia because they are not recognized in the regional markets.

Policy revision

[7] http://www.elia.be/en/products-and-services/green-certificates/Minimumprice-legalframe

[8] Flemish Regulator of the Electricity and Gas market

This part explains the general revision mechanism of the TGC scheme on the one side and recent important revisions of the Belgian green certificate system on the other side.

There is no periodic revision for the green certificate scheme, but all three regions have set up a number of mechanisms to assess the technical and economic characteristics of RES-E production as well as the functioning of the green certificate market on a regular basis (Greunz, 2011). In the Flemish region, a study is carried out every three years to estimate the need for policy support in order to ensure the profitability of RES-E projects. The Walloon Energy commission too performs a study every three years on the technical and economic characteristics of electricity production by means of different technologies. In addition, CWAPE undertakes an annual assessment of the functioning of the green certificate market and makes projections related to the development of new medium-term installations (5 years). A study is also performed every year by the RBS's Ministry of Energy to determine the number of green certificates issued to RES-E investors over a 10- year period. (CONCERE-ENOVER, 2012)

In such a dynamic and rapidly developing society, regular feedback from the market and proper revisions on the TGC scheme are necessary to realize effective and efficient support for RES-E investment. In recent years, a number of policy revisions have been made in both federal and regional green certificate systems, especially concerning the support for photovoltaic installations.

-- The federal TGC scheme legislated by Royal Decree in 16 July 2002 underwent a large amendment in 2012. The Royal Decree of 21 December 2012 abolishes the federal support for projects linked to regional renewable energy. In the past, TSO Elia was obligated to purchase green certificates from producers upon request, at a federal minimum price. But at present, only facilities that use offshore wind, water or tidal energy, and photovoltaic facilities commissioned before 1 August 2012, are eligible under the federal support mechanism. In other words, Elia should apply minimum support at the local level instead of federal level to RES-E generation facilities connected to local transmission networks.

-- In the Flemish Region, the green certificate system has been reviewed and revised several times in 2011 and 2012. The certificate penalty has been decreased to €125 in 2012, €118 in 2013 and €100 in 2014 (CONCERE-ENOVER, 2012). As published by VREG, the guaranteed minimum support differs by production technology and the commissioning date of power plant (before January 1, 2013), and support levels have been lowered except for onshore wind and bioenergy (from solid or liquid biomass, bio-waste & bios-gas) (VREG). In June 2013, VREG adopted a legislative amendment on green certificates, which almost completely changed the TGC system. This reform introduced several new concepts such as a financial gap, banding factor, start date, etc. which greatly impact several policy design elements. For instance, a power plant commissioned before January 1, 2013 is eligible to obtain certificates only during a period of 10 years, and under certain conditions it could apply for extension of the support period, but during this extended period, the number of certificates granted for every 1000 kWh of electricity generated from renewable energy sources in the plant is equal to 1 multiplied by a banding factor. For power plants commissioned after January 1, 2013, this principle of certificate granting (with banding factor) will be applicable during the entire support period. What’s more, the energy decree has changed both the support period and the minimum support considerably compared to the previous version. Put simply, taking January 1, 2013 as a time dividing point, the Flemish green certificate system for supporting RES-E plants commissioned after this point works similar to the Walloon system to some extent, since its guaranteed minimum price per certificate is now fixed at €93 and the number of certificates granted is determined by the banding factor instead of pure production. Meanwhile, in the new energy decree a number of retrospective and retroactive changes were made for existing plants commissioned before the time dividing point. The large reform indicates that the Flemish government intends to substitute the green certificate system with a technology-specific banding factor and identical minimum support (€93) for one with technology-specific minimum support and identical issuing base of Green certificates (1 GC = 1 MWh). Moreover, the quota obligation of energy suppliers is no longer set as a percentage but by means of a specific formula. All of these changes demonstrate that this large reform makes the Flemish TGC scheme much more complex and it might raise many problems during the policy transition period.

-- In the Walloon Region, new targets for wind energy and photovoltaic by 2020 are adopted by the government as mentioned before. In the past, the quota was set to increase 1% annually, whereas after correcting it twice, in March 2012 Walloon established new fixed quotas until 2020 with 3.65% of annual growth rate (Association, 2012). To ensure the green certificate equilibrium on the Walloon market, a big modification of existing legislations came in force in 2008. This included amendments of the granting period (reduction factor "k" after 10 years) of green certificates, granting rates of green certificates (biomass, CHP biomass, photovoltaic), and the number of green certificates granted to historic facilities (reduce following "q" coefficient) (GUISSON & MARCHAL, 2009).

-- Lastly, it has to be said that it is rare to see revisions of the Brussels Capital Region's green certificate system, and its last amendment was made in 2011 to guarantee the financial return on PV installations.

To cover the relatively high cost of solar power, since the beginning policy makers have made a number of particular rules for the green certificate system. But as the cost of solar power generation dropped rapidly in last two years, many investors have chosen to install PV, leading to a crisis of the green certificate support scheme (certificate oversupply). In Belgium, to improve this situation, several revisions to the support for solar PV were made successively at different levels.

-- The federal support was changed to be only available for photovoltaic facilities commissioned before 1 August 2012. April 2012, the Flemish government decided to reduce the support for solar PV by decreasing the minimum prices and support period. Also they lowered the capacity threshold (from 1 MWp to 250kWp) of PV installations eligible for a higher support (Teckenburg et al., 2011).

-- Before long, the Flemish government further modified the scheme and applied some new principles of certificate granting and minimum support to solar energy which went into service from 2013. In particular, the financial gap and the corresponding banding factor of solar energy are updated by the Flemish government twice a year in order to guarantee a return on investment of 5%, whereas for other types of renewable energy, these data are updated annually (APERe, 2013).

-- In Walloon, the government has also adopted new rules which retrospectively reduced the returns of PV investors (Union, 2013). In the past, the Walloon government once decided to grant 7 Green certificates/MWh for photovoltaic electricity produced instead of 1 GC/MWh for other RES-E and guaranteed a minimum price of €65/certificate for 15 years. However, this vigorous support lead to excess green certificates becoming available on the market, making millions of GC devaluated or unsold (Dreblow et al., 2013). To address this situation, the Walloon government decreased its support to solar PV from April 2013 onwards (1.5 GC/MWh during 10 years for installation between 0 and 5 kWp and 1 GC/MWh during 10 years for installations between 5 and 10 kWp). After this transition phase, a new regime "Qualiwatt" is expected to replace the green certificate scheme for new PV installations in Walloon. It aims to add the extra cost of PV directly onto the electricity bill, providing a payback on investment in nine years at most and a guarantee of return on investment between 4% and 7% (APERe, 2013).

-- The Brussels Capital Region has already adapted its GC system in July 2011, which makes the system seem more responsive to market changes. In specific, it requires to link the GC value to the real cost of PV and reviews relevant parameters once a year to guarantee the financial return time of PV installation under 7 years (CONCERE-ENOVER, 2012). In October 2012, there was one change to certificate granting: a decline from 5 GC/MWh to 4 GC/MWh for solar power, while another change is being planned in Brussels Capital Region at the time of writing (APERe, 2013).

3.3.2 Characteristics of support schemes for RES-E investment (other support instruments)

As mentioned before, the Federal authority provides a special support for investment in offshore wind and tax reduction for both individuals and companies who invest in renewable energy. In July 2005, a law strictly called for the transmission system operator (Elia) to contribute one third of the costs of the submarine cable up to EUR 25 million for an offshore project of 216 MW or more (Peeters et al., 2010). Tax reductions are available at 15.5% of investment costs for enterprises and up to 40% only for households installing photovoltaic panels (IEA, 2009). The Flemish Region has implemented an investment premium (Ecologiepremie) since 2004 for companies who produce RES-E. The system provides at most 40% of the admissible additional costs for SMEs, and 20% for large enterprises (Peeters et al., 2010). Among all kinds of technologies, biomass receives the highest level of support in terms of the share of investment cost. In addition to this, financial support for demonstration project and special support schemes for solar power have also been put into force over the last decade. In 2005, RES-E investors in the Walloon Region started benefiting from an investment subsidy and an exemption from real estate taxed. Similar to the Flemish Region, for SMEs, the subsidy is at most 50% of the admissible additional costs, and 20%-30% for large enterprises (Peeters et al., 2010). Energy premiums are also used in Brussels, but only for households, owners of collective housings, and the service and industrial sector. In 2010, these premiums were only granted for investment in solar energy with a maximum subsidy of 30% of the invoice. But one year later, wind, hydro, biomass and geothermal are all included into the premium program, and the maximum subsidy for these is 25% of the invoice in investment and studies (Teckenburg et al., 2011). It could be concluded that tax reduction to companies at the federal level does not vary according to technology, but most regional support for RES-E investment does differ by the scale of power plant, the nature of the applicant (e.g. SMEs, large enterprises or households) and the technology utilized.

Regarding the policy design element of policy scale and combination, the TGC scheme and other support for RES-E investment are generally coexistent and can be granted cumulatively in Belgium. Normally, the support schemes set up by Federal authority are allowed to be cumulated. For instance, the contribution from TSO to offshore wind parks could be granted cumulatively with Federal green certificates. In addition, renewable energy production could be supported by subsidies from regional governments together with tax reductions at the federal level. In the three regions, investment grants cannot be cumulated and sometimes even cannot be combined with green certificates. For example, since 2011 the technologies supported by green certificates were excluded from the Ecologiepremie in Flanders.

Unlike the TGC system, investment subsidies are reviewed and updated more frequently and most have a fixed budget per year or per period. As few offshore wind farms were built, no periodic revision is planned for the financial contribution to its connection. The tax aid scheme set up by the federal authority is reviewed every financial year. For individuals the tax reduction has been abolished as per fiscal year 2013, but for companies it has not changed in recent years (Peeters et al., 2010). In Flanders, every year there are three new calls under the Ecologiepremie, and the list of eligible technologies and budget for the subsidy are subject to revision before each call to tender, however no adjustment mechanism has been established yet. Data shows that the 2011 budget was reduced by 20% compared to 2009 (Teckenburg et al., 2011). The investment premium in Walloon has been reviewed and optimized several times since it entered into force, but no periodic revision is planned either. The Brussels government reviews and optimizes their energy premiums scheme once a year both in terms of technical requirements and financing. Recently large revisions took place in 2010 and 2011. Specifically, the total budget in 2010 was lowered by more than two thirds compared with the previous year, and many kinds of technologies besides solar energy also became eligible to apply for the investment grants as per 2011 (CONCERE-ENOVER, 2012).

In view of the technical and economic characteristics of solar PV, some support programs have been created especially for photovoltaic installation. The federal government has once announced a tender for roof concession and allocated EUR 1.5 billion to attract PV developers (IEA, 2009). The Flemish government provided subsidies for PV panels as from 2002, amounting to 65% of the total investment cost, although this program was ultimately phased out and fully superseded by the TGC scheme by the end of August 2007. At present, various provincial and municipal grants for solar energy are also available in Flanders, and the support level and period all depend on its specific location (Dreblow et al., 2013). In Walloon, an implementation plan named “Solwatt” was established in 2008 to promote the development of photovoltaic, covering a broad support for PV installation, training of installers and R&D (APERe, 2013). Initially the Walloon government awarded grants (20% of the investment with a limit of EUR 3500) to households, very small enterprises, self-employed workers and private entities who installed photovoltaic systems, however the green certificates scheme is currently the most important part of this plan. The Brussels authority offered grants supporting solar power to households starting from 2007. Due to the dramatic development and deployment of solar energy, the maximum support level was decreased from 50% of investment cost in 2007 to 30% in 2010. All of the above policy measures and changes indicate that the special support for solar energy is becoming less and less, and their corresponding investment subsidies are gradually declining as well.

3.4 Overview of the investment environment in RES-E

According to the description of the Belgian power sector and its RES-E policy instruments, we get an overview of the investment environment of RES-E in Belgium.

Compared to other member states, the potential of renewable energy sources in Belgium is low due to its geographic and climatic conditions and its high population density. This limited potential adds to the overall cost and challenges. However, according to the studies from Federal Planning Bureau, realizing the energy transition and achieving the 2020 targets are technically feasible, and the most promising renewable energy for power generation are all those that are relatively mature in Belgium: biomass, biogas and onshore wind. As can be seen from figure 3.2, biomass and onshore wind generate power at lower costs. It indicates that Belgium will focus on the development of least-cost RE technology in power generation in the next few years. The grid capacity is sufficient by far, and network operators treat all power generators in a non-discriminatory manner.

In the economical aspect, to create a more competitive power market, Belgium government has made many efforts to weaken the market power of the incumbent company, Electrabel. Even though the production market and retail market are still concentrated, the market share of Electrabel is gradually decreasing and some new power generators have successfully entered the Belgian power market. In light of the power demand and supply, there are many investment opportunities in RES-E in Belgium since it will both face a power shortage and undertake the responsibility of achieving EU targets. However, as an important market signal, neither wholesale nor retail market prices in Belgium could reflect the fundamental market conditions. To be specific, the low electricity wholesale price in recent years even makes some kinds of power plants unprofitable.

In the institutional aspect, most project developers have to struggle in a quite complicated and inefficient administrative system although the regional one-stop shop concept has implemented in some regions. In terms of information quality, Belgian power price formation remains non-transparent. It offers abundant information of support measures, but how the support value is calculated is as yet unknown. Therefore, project developers often undergo problems due to the lack of detailed and consistent information. The public too has no ability to obtain objective and up-to-date information which leads to rumors and disinformation.

Most existing studies declare that FIT is better than the TGC scheme, so it is no surprise that the Belgian TGC scheme is often challenged. However, based on the previous description, some characteristics of the Belgian RES-E support system are thought to aid in the development of renewable energy whereas some others are not.

To be specific, all types of RE technologies in Belgium have the opportunity to get support for power generation and/or RES-E investment. But there is no doubt that some special programs and extra subsidies are available for certain RE technologies. For instance, offshore wind project are eligible to apply for funding for its submarine cable from Elia. The support level for renewable-sourced power generation is technology-specific. To decrease the revenue risk of investors, a floor price in the TGC scheme is set by most regions. Furthermore, Belgian TGC systems have specific pre-determined quota obligations and clear rules on certificate trade. In the last decade, no big amendments have been made to the TGC schemes besides regular reviews. All of these features contribute to the creation of a relatively stable investment environment for RES-E producers and stimulate RES-E investment in an efficient manner.

However, there still exist problems regarding the current Belgian RES-E support system. As we can see from the policy history above, the biggest problem is that there is a lack of communication and cooperation among the different regions on both the strategic level and operational level. Since the development of renewable energy is under the competence of regional administrations, consequently several isolated TGC schemes were created. As a market-based policy instrument, TGC is supposed to work efficiently with a large number of green certificate transactions. But due to the certificate issuing base being designed different per region, market liquidity is quite low even in the Belgian internal certificate market. What's more, the four TGC systems are highly dissimilar in their support level, support duration and degression, floor price, penalty, and policy review, which makes the entire RES-E support system very complex. The Belgian RES-E support system seems to also lack clear provisions about policy combination, which will force investors to keep a wait-and-see attitude and thus delay the investment in renewable energy. Another big problem does not only appear in Belgian RES-E support system but also in that other countries: frequent policy revision, especially in the case of solar PV. Due to the dramatic decrease of generation cost of solar power in recent years, the rule on floor prices in Belgian TGC schemes made it rather profitable to invest in solar PV for a while, which lead to the oversupply of green certificates. Faced with such a situation, the policy schemes for solar PV were subject to several revisions and the relevant support level was cut drastically for several years in a row. In the Walloon region, even some retrospective change happened to solar power producers. To some extent, these frequent and sizable changes will lead to an unstable investment climate and undermine investor confidence. This 'solar PV event' tells us that how to find the balance between policy flexibility and stability is an important issue for policy makers. Normally, several elements (e.g. support degression, quota obligation) in the RES-E support system need to be updated. To make the investment environment more predictable, it becomes particularly important to establish proper adjustment mechanisms which is something that Belgium has lacked.

3.5 Conclusion

This chapter presents an overview of the investment environment in RES-E in Belgium based on the introduction of different kinds of investment determinants and the historical review of RES-E policy instruments in this specific case. A general conclusion is that Belgium has the potential to achieve the national RES-E targets in 2020, but it has problems stimulating the development of renewable-sourced power generation. Since the RES-E investment depends on the RES-E support system to a large extent and Belgian TGC scheme is often challenged, there is a need in Belgium to better assess the performance of the existing policy instruments and make appropriate changes to the RES-E support system.

4. Analysis and discussion

As we can see from the policy comparison in Chapter 2, the tradable green certificate system does not seem like a very good RES-E policy instrument. However, it is not that bad for Belgium since at least among the six countries with TGC scheme Belgium is the only country to have so far achieved its RES-E targets and is on track to achieve its 2020 target. Therefore, we can neither tell which policy instrument is best nor simply conclude whether Belgium should change from the current TGC system to a new system (e.g. FIT). Even though different countries adopt the same kind of scheme, the policy performance can vary significantly. This illustrates that we cannot ignore the influences of a specific investment environment and policy design when evaluating the RES-E support system. The Belgian case is no exception. In this chapter, some investment determinants are firstly elaborated upon based on the overview of the investment environment in RES-E instead of being ignored in an ideal state. This can be turned into extra conditions or factors with which to evaluate the Belgian RES-E support system more objectively and accurately. After that, a policy comparison will be made again but this time it proceeds with the consideration of the real case. To be specific, only the TGC scheme is evaluated based on the Belgian historical policy design, while performances of the other three policy instruments are all estimated based on the previous knowledge of RES-E support schemes and the Belgian investment environment. Policy recommendations for Belgium will follow after the policy comparison and analysis.

4.1 Policy analysis

4.1.1 Key investment determinants in real case

In this real case of Belgium, some investment determinants cannot be assumed to be as those in an ideal situation (see in section 2.3.3). In this regard, we should clarify the assumptions before policy comparison. They are examined in concrete terms in technological, economical and institutional domain, respectively (Table 4.1)

Domain/scenario	Ideal situation	Case of Belgium
Technology	-Abundant energy potential for all kinds of RE technologies -No problem with grid access and connection	-Big energy potential for onshore wind and biogas technology -Sufficient network capacity by far, but the future is uncertain
Economy	-Unlimited budget for RES-E support schemes -Electricity price is a correct market signal	-Limited (normally annually reduced) budget for RES-E support schemes -Unreasonable electricity price
Institution	-No administrative obstacles -Good information quality	-Complicated regulatory framework -Non-transparent and insufficient info
Other	NO	-Changeable public view on nuclear power; 'NIMBY' effect -Regime change

Table 4.1 Difference of key investment determinants between ideal situation and the case of Belgium (own creation)

In the real case, we find that in addition to the difference between key investment determinants there is also difference of policy assessment criteria between ideal situation and the case of Belgium. In the ideal case, all six policy assessment criteria are equally important, whereas in reality many countries treat these differently due to time, funding and other constraints or even did not take some of these six criteria into account. For instance, Belgium focuses more on the cost effectiveness in the short term instead of dynamic efficiency in the long term; the many efforts made to weaken the market power of incumbents emphasizes the importance of electricity market liberalization in Belgium, which can be interpreted by equity in some way; Belgium especially sets a floor price mechanism in its TGC scheme in order to reduce RES-E investors' revenue risks. Overall, Belgium seems more concerned about some of the six defined policy assessment criteria than others, regardless of policy type (Table 4.2).

Case/ Criteria	Effectiveness	Efficiency			Compatibility	Certainty	Equity	Institutional feasibility
		C*	D**	T***				
Belgium	√	√				√	√	

Table 4.2 Policy assessment criteria in the case of Belgium (own creation)

*Cost effectiveness **Dynamic efficiency ***Transaction & administration cost efficiency

√ : Belgium has paid much attention to these criteria

As shown above, there are many differences and special characteristics in the real-world case study. Every case is unique and every RES-E investment environment depends on the specific situation. This means that the policy performance in Belgium might be different from that assessed in the ideal situation (see in section 2.3.3). We will figure this out afterwards based on the following policy comparison of Belgian case.

4.1.2 Policy comparison of Belgian case

In this section, four RES-E policy instruments are evaluated separately for the case of Belgium. Performing the policy comparison serves two purposes: the first is to find appropriate ways to improve the performance of the RES-E support system; the second is to discover the difference between the theoretical policy performance (Table 2.9) and the policy performance assessed in the real case. In the process, we refer to the experiences and policy design of different countries.

Tradable green certificate (TGC)

Since Belgium has adopted the TGC scheme for several years to promote renewable energy, we take it as the first policy instrument to be evaluated based on its existing policy design.

As previously described in section 3.1, the development of renewable energy in Belgium is on track and the power generated through several kinds of RE technology (e.g. biomass, biogas, wind and solar) has increased at different speeds since 2004. In this regard, the policy effectiveness of the Belgian TGC scheme is acceptable.

As for the cost effectiveness, Figure 4.1 shows that the remuneration level for most RE technology in Belgium is sufficient enough and excessive profits are usually possible. However, it does not mean that the windfall profits are completely caused by TGC scheme, since even though Germany uses feed-in tariffs to promote the development of biogas power (in the intermediate phase), its remuneration level and profits are much higher than that of Belgium. In the Belgian TGC system, minimum technology-specific support is available. This indicates that the system gives equal opportunity to different RE technologies, which seems contradictory with the characteristic of the least-cost technology orientated nature of traditional TGC schemes. Anyway, this minimum technology-specific support not only increases the dynamic efficiency of the TGC scheme but also decreases the market risks for investors. What's more, policy makers are able to make policy support adapt to the dynamic environment by adjusting the floor price, while traditional TGC schemes can only change the quota obligation to indirectly influence the market and investment. This shows that the Belgian TGC system is more flexible. Transaction and administration cost efficiency is low, because Belgium has several isolated TGC systems and so many actors are involved. In other words, a number of elements should be designed in each region and responsible authorities must need to make more of an effort to clarify the complex TGC system.

The minimum support (floor price) of the Belgian TGC system is set, and the network operators (TSO, DSOs) are obligated to purchase the green certificates awarded by various Belgian regulators from any renewable energy generator requesting this. This kind of design has already reduced the market risks as that of FIT scheme, but policy revisions remain a kind of uncertainty which needs to be considered seriously. In Belgium, the TGC schemes are reviewed regularly and in the last decade there have been no large amendment except for frequent changes regarding solar power. Since the dramatic growth of solar power has led to an oversupply of green certificates in Belgium, policy schemes for the promotion of solar PV have been subject to several revisions and the relevant support level has been cut drastically for several years in a row. This will undermine the confidence of investors to a large extent. This 'solar PV event' implies that finding the right balance between policy flexibility and stability is an important issue for policy makers. Obviously, Belgium is not doing well and it is necessary to establish proper adjustments mechanisms.

Since the development of renewable energy is under the competence of regional administrations, several isolated TGC schemes were consequently created. As a market-based policy instrument, the TGC is supposed to work most efficiently with a large number of green certificate transactions. However, due to the certificate issuing base being designed differently by regions, market liquidity is quite low even in the Belgian internal certificate market. What's more, its four TGC systems are highly dissimilar in the support level, support duration and degression, floor price, penalty, and policy review, which makes the entire RES-E support system very complex. The Belgian RES-E support system also lacks clear provisions about policy combination, which will force investors to keep a wait-and-see attitude and subsequently delays the investment in renewable energy. Together, these characteristics of the Belgian RES-E support system has led to a poor performance of the TGC scheme in terms of policy compatibility.

In Belgium, the cost of green certificates is directly paid by energy suppliers, traders, or in case of "fall back" minimum prices, by the TSO and DSOs. But all these extra costs of RES-E generation are ultimately passed on to end consumers through surcharge tariffs. In the case of Belgium, It is obvious that the excess profits has not avoided efficiently. It is remarkable that windfall profits exist for all kinds of RE technologies rather than just for the cheapest technologies (Figure 4.1). Although minimum technology-specific support is set in Belgian TGC system, it only removes part of excess profits by increasing the certainty of remuneration. We have to take notice of the fact that most green certificates are traded with a value higher than the floor price in the certificate market. Even though policy makers could guarantee the minimum revenue from certificates, the revenue from selling electricity remains uncertain. Therefore, investors will pursue high profits by raising certificate prices close to the penalty level. Under such a situation, some RES-E investors can definitely generate excessive profits as a free rider during certificate trading. Considering the non-economic factors, Belgium stipulates that transmission system operators are obligated to provide non-discriminatory grid access to power generators, which guarantees the equity among energy producers. In the case of Belgium, we can say that policy equity of the TGC scheme is improved to an intermediate level.

Lastly, traditional TGC systems are already pretty complex by combining standard power markets and certificate markets, not to mention in the case of Belgium which operates several TGC systems simultaneously. In reality, its TGC scheme is indeed relatively opaque, which is reflected by the non-transparent information about the design of Belgian TGC scheme. Currently, of all EU member states only a few have adopted a TGC scheme and the relevant experiences show that incumbents were generally able to use TGC schemes to generate excessive profits (Verbruggen & Lauber, 2012). Hence we can see that TGC are not as attractive as FITs and it seems impossible to expand the application of the TGC scheme worldwide in a short amount of time. However, it might be because the development of renewable energy in Belgium is still on track and some incumbent companies prefer to enjoy these excess profits, so far no one has strongly questioned the TGC system and there is no sign of policy shift. This suggests that the institutional feasibility of the TGC scheme in Belgium is not too bad.

Feed-in tariffs (FITs)

As described before, compared with the TGC system, FITs is characterized by unpredictable investment results since the interplay of subsidy terms and investors' reactions is not exactly known. The RE targets are also set by member states with FIT policies but they are just indicative milestones on the intended development path of RE instead of an obligation given to electricity suppliers or producers. In general, since the FIT scheme could guarantee the revenue of RES-E investors as the floor price in Belgian TGC system does, the policy effectiveness will remain good in this case.

The cost effectiveness still depends on the right level of fixed rates by category. Belgium aims to mainly develop biomass and onshore wind technologies. In light of the bad performance of FITs in the case of biogas power in Germany, we cannot make sure that the cost effectiveness will remain the same if Belgium chooses to apply FITs. In most cases, the tariff rate is set to decline annually so as to incorporate technological learning. This means that when rates deviate from their optimal levels, adjustments can be made in a relatively short time. In general, categorizing RE supplies (technology-specification support) and applying proper FIT rates by category can promote innovation for several RE technologies in parallel, safeguarding dynamic efficiency (Jacobsson et al., 2009). Therefore, we estimate that the FIT scheme can keep an intermediate impact on dynamic efficiency in the case of Belgium. Compared with the TGC scheme, FIT has fewer elements to be designed by policy makers. In this regard, the transaction and administrative costs of FIT are low. However, in Belgium many actors are involved due to the existence of isolated RES-E support systems, and the information quality is not good enough. What's more, the policy shift would undoubtedly cause a lot of additional transition costs. Thus, it is difficult to ensure that the FIT scheme could maintain its relatively high transaction and administration cost efficiency should Belgium adopt it in future.

Since Belgium lacks a clear policy combination, FIT is estimated to perform just relatively better than TGC in terms of policy compatibility. The key factor of FIT's big success in deploying renewable electricity is its clear and robust solution for integrating RE technologies in existing power systems via its guarantee of a fair and safe return on investment. Specifically speaking, the purchasing obligation and fixed support level of FIT minimizes the market risks. Under such a system with calculable and limited risks even investors not specialized in electric power systems can become power producers (Verbruggen & Lauber, 2012). Therefore, numerous small investors actively participate in this sector whereas incumbents may show a lack of interest. This fits the objective of market liberalization of Belgium and to a large extent demonstrates the fairness of RES-E investment for investors. One thing to take notice of is that feed-in premiums are less uncertain than fixed feed-in tariffs schemes due to the fluctuant power price.

A well-designed FIT includes the policy design element of technology-specific support which allows a broad range of RE technologies to develop simultaneously. Excess profits are almost avoided under FIT scheme since every category of RE supplies can get an adjusted remuneration. Normally, the support rates are designed differently based on technology, commissioning date, installed capacity and nature of investor. Except for very special cases with restrictions, FIT is more attractive for new and small-scale RES-E producers than for intermediate and large producers when rates are differentiated by size. Overall, FIT could keep its high policy equity in the case of Belgium.

In general, FIT is transparent and predictable and its complexity is low. The advantage of FIT also becomes more and more obvious: growing experience with FIT has made it possible to help solve policy difficulties and make FIT well-designed, but in the real case it is not easy to change from the current TGC scheme, which has been in use for a few years, to a totally new FIT. There have been no calls for a RES-E policy shift in Belgium so far. On the contrary, as mentioned previously many incumbent companies support the existing TGC scheme.

Tendering

No European member state has chosen tendering for contracts as their main support scheme, but several countries, such as France and Portugal, have added it into their policy sets. In 2006 and 2007, France opened the tendering system for 216MW and 300MW biomass projects. However, there no obvious effectiveness occurred (Held, Ragwitz, Merkel, Rathmann, & Klessmann, 2010b). Maybe this is because France is still in the immature phase of biomass technology or there might be no legal provisions available for punishing project delays and suspensions.

In Belgium, it is difficult to estimate the policy effectiveness without information about relevant legal rules and punishment power. The policy efficiency is expected to remain due to the high cost effectiveness and low transaction and administration cost efficiency in the case of Belgium.

Bidders have to undertake high price risks during the tendering process and even the bid-winner who is awarded the contract faces potential revenue risks caused by the limited budget. Differing from the ideal situation, the impact of tendering on policy certainty here is assessed from investors' perspective (Table 4.3). In the view of policy makers, policy certainty cannot be measured owing to unknown punishment rules and there being no relevant experiences in Belgium.

In some cases, the tendering scheme is not welcome due to its low policy effectiveness, however in Belgium there is no particular opinion about it, or we can understand that the policy institutional feasibility is not bad.

Investment subsidies

Finland is the only European country to adopt investment subsidies as its main renewable energy support scheme. Figure 3.4 shows that the share of renewable energy in electricity consumption in Finland lags behind its 2010 RES-E target. So we estimate that investment subsidies will keep its intermediate impact on the policy effectiveness in the case of Belgium.

In fact, Finland provides sufficient support only for biomass power and mainly focuses on the promotion of this particular technology. This illustrates that the cost effectiveness depends on the specific setting for the support level in the case. In Belgium, regions have already designed their own subsidies for renewable energy investment as an auxiliary policy. The support level is set as a percentage of additional costs which differ by technology. What's more, small and medium size enterprises are usually offered a higher percentage. We can see such investment subsidies provide technology-specific support, which could increase the dynamic efficiency and policy equity.

Due to the lack of clear provisions about policy combination, the compatibility of investment subsidies in Belgium is not very good. As defined in the ideal situation, investment subsidies are a comparatively simply policy instrument in Belgium. Therefore, the transaction and administration cost efficiency is expected to remain the same.

With the fixed certain percentage, investment subsidies seem to ensure the revenue of investors and remove all market risks, whereas in reality the form of financing increases the policy uncertainty. In Belgium, subsidies for RES-E investments are financed through an annual limited budget. In other words, investors have to undertake special revenue risks caused by political decisions.

So far, no significant problems have been identified in Belgium concerning investment subsidies. There is no reason to stop with these, especially for promoting the less mature RE technologies.

Criteria/policy type		Feed in tariffs	Tradable green certificate	Tendering	Investment subsidies
Effectiveness		+++	+++	/	++
Efficiency	Cost effectiveness	++/+	+	+++	/
	Dynamic efficiency	++	++	/	++
	Transaction & administration cost efficiency	+	+	+	++
Compatibility		++	+	++	++
Certainty		+++/++	++	++	++
Equity		+++	++	+++	+++
Institutional feasibility		++	++	++	+++

Table 4.3 Policy instrument comparison in the case of Belgium (own creation)

Note: + = weak impact, ++ = intermediate impact, +++ = strong impact

4.2 Policy recommendation

This section will make some recommendations for the improvement of the current Belgian RES-E support system. First of all, based on the policy comparison above, we intend to make an analysis to conclude the performances and problems of Belgian RES-E support system. Then, as a second step, three options for improving the promotion system are introduced and compared.

4.2.1 Problem finding

By comparing the policy performance between in the ideal situation and in the case of Belgium, we clearly see that the Belgian TGC system has obtained better performance than the traditional TGC scheme. The key reason behind this is the establishment of technology-specific floor prices for green certificates. This reduces some of the revenue risks of investors and increases the dynamic efficiency and equity of the TGC scheme.

Compared with three other kinds of policy instruments, the Belgian TGC system works well enough on the policy effectiveness. But we have to pay attention to the floor price since in recent years it has led to excess profits for solar PV and an oversupply of green certificates. It is understood that end consumers have paid many unnecessary costs to reach the RES-E target, leading to low cost effectiveness which is not was expected to be the case.

According to the Belgian renewable energy action plan, the power generated from biomass and onshore wind is expected to experience a sizable growth in the decade to come in order to achieve the 2020 RES-E target. Since Belgium is not a leading country in the renewable energy sector, like Germany or Spain, it does not have the responsibility to pay more attention to less mature RE technologies and technology innovation. In other words, it makes sense that Belgium only aims to reach its obligatory EU target with least cost RE technologies. However, the technology-specific floor price might become an obstacle in this regard, as for instance solar power with certain high profits would absolutely be more attractive for RES-E investors.

As a result, the special policy design element of the Belgian TGC scheme could bring converse impacts on different objectives of policy makers.

In reality, most countries adopt more than one policy to promote the development of RE technologies, so it is possible to assess the policy compatibility in the Belgian case. In general, Belgium lacks clear and sufficient rules of policy combination, therefore no matter which kind of policy scheme is adopted, the compatibility will be not very good. Due to the existence of isolated TGC systems and lack of liquidity of the certificate market, the TGC scheme shows worse performance in this regard.

The performance of tendering and investment subsidies on certainty in the Belgian case is estimated differently from that in the ideal situation. There are two key reasons: these two schemes are financed by a limited budget determined by political decision; there is no experience or basis to predict the strategic behavior of Belgian RES-E investors regarding the tendering scheme (which leads to project delays and suspensions).

Lastly, in Belgium there is no call for changing the existing RES-E policy type even though FIT seems to be better based on the amount of successful experiences with the scheme. In fact, some investors prefer to keep the TGC scheme since it enables them to reap excess profits and avoid the risks caused by the policy shift which would otherwise occur. Therefore, even though TGC is a complex policy scheme with more transactions, the institutional feasibility of the Belgian TGC system is still assessed to be at the intermediate level. Overall, the four kinds of policy schemes show similar performance on institutional feasibility with consideration of both endogenous and exogenous aspects.

As this paper stated, the RES-E policy scheme can be evaluated in a more comprehensive and accurate manner with six policy assessment criteria instead of two, effectiveness and efficiency. In principle, a policy scheme is expected to perform well in all six aspects. If so, the most challenging and compelling problem for Belgium right now is to improve its policy performance on cost effectiveness, transaction and administration cost efficiency and compatibility. Moreover, there is also certainly room for improvement in other aspects. However, it is important to note that not every country has noticed the importance of all six assessment criteria, which explains why some countries have made policy revisions according to its policy assessment results which then led to no significant changes in outcome being observed. Even if country were to take all these into consideration, other problem still exist. As shown in Table 2.9, even in the ideal case no one policy could realize its optimal performance simultaneously in all aspects, so it is nearly impossible to design a perfect policy system for any country.

In fact, each country has its own objectives in the development of renewable energy and in most cases countries only focus on the impacts of policy scheme on their main objectives. Belgium is no exception and, as table 4.2 shows, it gives priority attention to effectiveness, cost effectiveness, certainty and equity. To have perform well on these criteria, Belgium chose to add a technology-specific floor price into the traditional TGC scheme. This special element seems similar to the fixed tariffs in FIT for RES-E production, but is not effective enough to make the policy performance good as expected. There are many reasons for this. For instance, low compatibility undermines the efficiency of the market-based TGC scheme; institutional feasibility has impacts on transaction and administration cost efficiency and policy certainty which are related to endogenous and exogenous aspects, respectively; non-economic barriers like information quality and administration procedures also influence the RES-E investment. This illustrates that it is necessary to consider all six policy assessment criteria and try to improve the policy performance on each of these. Besides this, improvement of the investment environment for renewable energy should cover all investment determinants in the institution domain instead of merely the RES-E support instrument.

4.2.2 Policy options

Next we will list three options for Belgium to improve its RES-E support system. Since most policy performances are evaluated by examining policy design elements, each option is expected to contain changes on some of these design elements based on studies of the experience of other countries[9]. The reference countries are selected based on several criteria: countries should keep a similar level of deployment in biomass and onshore wind technology and have better policy performance than Belgium in some policy assessment aspects.

Option one: improve current system

For Belgium, improving the current TGC system seems the most acceptable way to encourage better development of renewable energy in the future. Firstly, Belgium has implemented the TGC system as its main RES-E support scheme more than ten years ago. Policy makers have gained lots of experiences in the process, and RES-E investors and end consumers are accustomed to this system. Secondly, although a few revisions have been made on different TGC systems in Belgium, most of these are changes to numbers on elements like floor price and quota obligation. Even the large amendment made by the Flemish government on its TGC system in 2013 added only a few new concepts to influence the rules of issuing green certificate and the policy support period. These changes are insufficient to alter the characteristics of a market-based policy scheme. So to some extent we can infer that Belgium keeps its confidence in the TGC scheme. According to the policy performance of the current Belgian RES-E support system, we will focus on the possible solutions of improving the policy cost effectiveness, transaction and administration cost efficiency, and compatibility. The changes in theory can be divided into two categories: changes of values on existing variables and changes of rules. Based on the selection criteria above, two countries, Sweden and UK, are chosen as the reference countries for option one.

Compared with Belgium, Sweden and UK have a lot of differences in the specific policy design of the entire RES-E support system.

Firstly, both Sweden and UK announced an end date of their TGC schemes, and the UK has even already defined transition rules and is ready to apply a new scheme (FIT CfD) to replace their Renewable Obligation, while Belgium does not. We could understand this as follows: Belgium does not want to change its current TGC system or never considers this issue enough. It is notable that a long-term strategy plan could offer clear guidance for the future development of RES-E policy scheme, and therefore reduce policy certainty and transaction costs.

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[9] See Appendix B and C

Secondly, as aforementioned high risks require a higher remuneration to trigger RES-E investment. So reducing investors' risks is a possible way to increase the cost effectiveness. Compared with the UK, Belgium does not subscribe to the principle of not making retrospective changes in support policies for existing plants, which increases the risks of investors. The UK has set a cap on the total new built dedicated biomass capacity that can receive grandfathered support under the Renewable Obligation. In some way, it is conducive to cost control and rapid growth of investment in renewable energy in the short term since people will always pay more attention to special rules or limitations (e.g. capacity caps) and make respond quickly.

Moreover, it is necessary to keep regular policy reviews and revise the relevant values in time. Especially in Belgium, where the power price does not send a correct price signal to investors, policy makers should pay more attention to the power price and generation cost and then set the technology-specific tariffs to an appropriate level in order to efficiently decrease excess profits. Besides this, it is also important to adjust the penalty level, the eligible period for acquiring Green certificates and quota obligation according to certain and impartial rules at a proper time. In this regard, Belgium does not do as well as Sweden and the UK. For instance, Sweden stipulates that from 2005 the penalty equals 150% of the weighted average certificate price. However, setting annual quota with a certain formula in the Flemish region per 2013 seems like a good start for Belgium to improving the situation. In general, RES-E investors are more concerned about the uncertainties and risks caused by policy revisions rather than the policy revision itself. Therefore, policy revisions could be acceptable if it follows established rules and market participants are informed of proposed changes early on. Under such conditions, policy revision/shift can give investors enough time to consider a response and to a large extent decrease the investment risks. In a word, everyone is pursuing stability and predictability while tending to avoid uncertainties and risks. Unfortunately, in the case of Belgium, it keeps revising its policy scheme in a relatively ruleless and nonperiodic manner.

What's more, we have to admit that a crucial problem of Belgian tradable green certificate scheme, actually, is that four green certificate systems are working independently in the country and lack interaction. At present, Belgium uses two mechanisms for the issuing of green certificates at the same time. One is issuing green certificates to any kind of eligible technology and setting different guaranteed minimum prices for each of them like the Belgian federal authority and Flemish government do, and the other is issuing the number of green certificates differently to eligible technologies, like Belgian Walloon and Brussels Capital region and the UK do. No study has shown which way is better, but different regions in one country are recommended to adopt the same mechanism in order to improve the compatibility of the TGC schemes and increase the liquidity of the certificate market. Like Belgium, the UK has three independent Renewable Obligation schemes its different regions, but the difference is that all three types of certificates are issued by the same regulator and they are fully tradable and recognized in the whole country.

Lastly, as more and more RES-E support schemes are established, policy combination becomes a big problem. Few countries define clear rules of combining policy support for different kind of technologies. In the short term, it might be a proper solution for Belgium to require grant making authorities to ensure that the total amount of support is within the requisite aid thresholds as the UK does, which will help improve both the cost effectiveness and policy compatibility.

Normally, green certificates purchased by system operators at the statutory minimum price could be resold on the certificate market in Belgium but this is not the case in the Walloon region. It is hard to say whether this is good or bad since on the positive side resale of green certificates could increase the liquidity of certificate market and reduce system operators' cost in some way, while on the negative side resold certificates might further decrease its market price, causing more RES-E producers to choose to sell Green certificates at a statutory minimum price. Moreover, there are no experiences in this field from other countries. Therefore, we could only advise Belgium to keep a close eye on the effects of this mechanism on the policy performance.

Based on the analysis above, some changes are recommended and listed in Table 4.4 to improve the current Belgian TGC system. The table also shows the relation between the suggestions and policy assessment criteria.

Criteria	Changes of numbers	Changes of rules
Cost effectiveness	--adjust the technology-specific floor price with serious consideration of power price and generation cost --set proper cap on total volume for some technology eligible to receive support ----revise the period for obtaining certificates to a certain years in federal and Flemish system	--avoid retrospective changes on policy for existing plants --set certain and impartial rules for revisions on quota, penalty, etc. --establish mechanism or institutions to check the total support for a project and avoid the excessive subsidies
Transaction & administration cost efficiency		--define a clear long-term strategy plan including the end date of TGC and transition rules
Compatibility	--unify the rules of granting green certificates in the whole country and realize free trade of green certificates	--make clear and detailed provisions on policy combination

Table 4.4 Suggested changes to improve the current scheme (own creation)

Option two: change to a new scheme

There is no doubt that FIT shows better overall performance than the TGC scheme by far. Among the few countries with TGC schemes, Italy and UK have implemented FIT to promote some RE technologies and intend to replace the TGC system with FIT in the future (Table 2.8). This indicates that changing to a new scheme10 is also a possible way in which Belgium can try to improve the performance of its RES-E support system. Compared with Italy and UK, Belgium seems to have more advantages in the policy transition process. Since it has a technology-specific floor price defined in its TGC system, it will be easier to set the similar technology-specific tariffs in the new FIT scheme. However, market-based policy schemes are

[10] Here refers to FIT scheme.

still quite different from price-based ones, and in order to improve the poor policy performance, some major changes are inevitable. With regard to this option, several countries were selected as reference targets based on the same selection criteria as described above. These are: Luxemburg, Portugal, Hungary and the Netherlands.

Different from option one, option two requires us to think of changing the function mechanism before we look into the details. To be specific, it means that in theory renewable electricity will be not traded in the power market any more. In the new FIT scheme, the guaranteed purchase of power is the only way to obtain a return on RES-E investment. In this process, the responsibilities and obligations of some actors are certain to change. For instance, energy regulators will no longer be in charge of issuing and checking green certificates while network operator play a larger role in the FIT scheme.

In terms of further changes to the policy design, the following points should be taken into serious consideration.

First of all, the setting of tariffs in FIT scheme is usually more complicated than that of the technology-specific floor price in Belgian TGC system. To provide a proper support level and to a large extent reduce excess profits, the fixed tariffs in FIT vary based on the different technologies, capacities, commissioning dates, fuel mixtures and minimum efficiency. Luxemburg and Portugal have even been operating two or more FIT schemes simultaneously to distinguish the tariffs for different RES-E projects. In this regard, policy makers should put more effort into setting fixed tariffs under FIT scheme. Of course, if the tariffs are set appropriately, cost effectiveness will be improved a lot.

Secondly, the Netherlands and Portugal seem more inclined to put a cap on the total volume of electricity eligible for subsidies, and the former even sets an annual budget cap for each kind of technology in its SDE scheme. This could be applied to the Belgian case, contributing to its control of the growth of renewable electricity, avoiding the end customers' overburden and indicate the development pathway of RE technologies.

What's more, Belgium lacks rules of tariffs degression for projects during the entire support period. Normally, feed-in tariffs are at least required to be adjusted to the inflation rate annually, and countries like Portugal even define tariffs based on rather complicated formulas for both existing and new installations. To increase cost effectiveness, Belgium is therefore recommended to set clear rules for support degression for established plants as well as new plants. One thing to note here is that we recommend policy makers to perform regular policy reviews and make policy revisions according to certain rules or formulas, but the frequent and irregular revisions to the formula of calculating tariffs as seen in Portugal should be avoided.

Finally, as for the policy combination, it must again be stressed that it is most important for Belgium to clarify the combination rules and avoid excessive subsidies.

Based on the analysis above, some changes are recommended and listed in Table 4.5 to change from the current TGC system to a new FIT system. The table also shows the relation between the suggestions and policy assessment criteria.

Criteria	Changes of numbers	Changes of rules
Cost effectiveness	--distinguish the fixed tariffs for different RE technologies by more criteria (e.g. fuel mixture) --set proper cap on total volume or annual budget cap for RE technology eligible for subsidy	--set clear rules for tariffs calculation and degression --avoid frequent and irregular policy revisions
Transaction & administration cost efficiency		--change the responsibilities and obligations of relevant actors --clarify the rules of policy transition
Compatibility		--make clear and detailed provisions on policy combination

Table 4.5 Suggested changes to shift to new FIT scheme (own creation)

Option three: combine with other policy instruments

In addition to the FIT and TGC scheme, many other economic RES-E support instruments are available to each country, of which the tendering scheme and investment subsidies are most widely used. In Belgium, each region has adopted investment subsidies and designed the relevant programs with their own characteristics. In contrast, tendering is rarely applied in Belgium. In consideration of estimated policy performance (Table 4.3) in the case of Belgium, it is possible to increase the cost effectiveness through the implementation of a tendering scheme. Therefore, the third option will focus on the exploration of the feasibility of tendering and the improvements on investment subsidies in Belgium. All countries selected in option one and two are considered valid reference targets since they all have experiences in policy combination.

In regard to the tendering scheme, Belgium has almost no experiences except for the Ecological investment subsidy granted via tendering in Flanders. According to experiences and previous analysis, tendering is usually applied in order to promote the deployment of a fixed amount of RE technologies in the short term. Moreover, it seems to be the most efficient scheme to increase the cost effectiveness if everything goes well. For Belgium, tendering is certainly a way to go since Belgium has clear goals of promoting biomass and onshore wind technologies and needs big improvements in policy cost effectiveness as well. However, in reality the main problem with tendering schemes is that the winning bidder might delay or even suspend the construction of awarded RES-E projects. Therefore, in order to increase the cost effectiveness efficiently, relevant legislations and punishment rules should be established in Belgium to restrict investors' behavior. In addition to this, policy makers should spend time and effort to determine which eligible technologies are, tendering procedure, available budget and other elements before each call to tender.

At present, a few investment subsidies are available in Belgium and these are all region-specific. Like traditional investment subsidies, Belgian subsidy programs normally distinguish support levels by technology and nature of the beneficiary. Due to data limitations, it is difficult to come up with a proper percentage for investment subsidies programs to successfully increase cost effectiveness. Still, compared with other policy instruments, investment subsidies are a relatively simple scheme which contains few design elements. So far, we have not concluded on any suggestion on the improvement of Belgian investment subsidies. As aforementioned, both tendering and investment subsidies are financed by an annual limited budget which is determined by political decision. And until now there have been no experiences available regarding the reduction of the budget risk of investors. Nevertheless, policy makers could improve the policy instrument in other aspects. For instance, they should define clear provisions on the support level (certain percentage or max value per installation), the operation mechanism (tendering or first come first serve basis), and the eligible technologies. This will help investors better understand these policies and at that point choose a suitable one. Meanwhile, the transaction and administration cost will also be reduced. In this regard, Belgium is doing reasonably well already with its investment subsidies programs.

Lastly, FITs or TGC schemes are in generally allowed to be combined with other policy subsidies for investment. In countries like Hungary and the UK, although the support instruments could be accumulated, the support level of the main RES-E support schemes will be cut appropriately if other subsidies were obtained by developers, which contributes to an avoidance of oversubsidizing for RES-E investors and ensures a good competitive environment. Belgium is not doing well in this field, and it is advisable to add sufficient and clear rules of policy combination and establish proper mechanisms to decrease excess profits.

Besides tendering and investment subsidies, there are a number of other types of RES-E policy instruments like tax exemption and low-interest loans, and extra technology-specific policies like the Swedish support for wind energy and British support for bioenergy. It is possible for all of these policy schemes to work in combination with FIT or TGC, but this paper will not discuss it further.

Based on the above analysis, some changes are recommended and listed in Table 4.6 to combine TGC scheme with other policy instruments. The table also shows the relation between the suggestions and policy assessment criteria.

Criteria	Changes of numbers	Changes of rules
Cost effectiveness		--make legislations and punishment rules for tendering scheme
Transaction & administration cost efficiency		--determine eligible technologies, tendering procedure and capacity, and other elements before each call --establish proper mechanism to avoid over subsidies
Compatibility		-- make clear and detailed provisions on policy combination

Table 4.6 Suggested changes to combine with other policy schemes (own creation)

4.3 Conclusion

In this chapter, we first make a policy comparison among four RES-E policy instruments in the case of Belgium. The comparison results illustrate two things: the policy performance of RES-

E support instruments are influenced by the specific investment environment; and Belgium most needs to improve the policy performance on cost effectiveness, transaction and administration cost efficiency and compatibility. Based on the experiences of selected reference countries, the paper explores some possible solutions fitting the Belgian case. The suggested changes are elaborated upon in each of the above policy options. However, which option is the best one for Belgium? We will determine this by examining the pros and cons of each option as follows (Table 4.7).

As can be seen each policy option has its own advantages and disadvantages:

Improving the current TGC system is relatively easier to accept since people have grown accustomed to this scheme over the past decade. Moreover, it is possible to improve the policy cost effectiveness and compatibility through policy amendments. However, we have to know the Belgian TGC scheme has a number of variables (e.g. floor price, penalty, quota, support duration, etc.) which need to be adjusted, so it is quite difficult to achieve an optimum state taking all these variables into consideration. Of course, to make proper adjustments, it will inevitably take a lot of effort to monitor both electricity and green certificate markets. To some extent, it will increase the administration cost of the TGC system. We should also realize that market risk cannot be totally removed under the TGC scheme even if other elements are all set well, because the revenue risk caused by uncertain electricity prices in the power market will always exist. There is another potential challenge in the first policy option: since each region in Belgium has designed and applied its own TGC scheme for more than ten years and the development of renewable energy is under the competence of regional administration agencies, it will be difficult to unify these different TGC systems.

For the second option, there are a few reasons to support the policy shift to FIT scheme in Belgium: abundant successful experiences by other countries, existing policy design element similar to that in FIT, investment risks reduction and potential improvements on policy performance. On the other side, negative aspects also exist. The biggest problem with this option is the policy transition. To be specific, in the Belgian renewable energy development plan there is no statement that Belgium will shift its TGC scheme to FIT, which will undermine the confidence of investors on RES-E policy instruments or even policy makers. What's more, since FIT works totally different from the TGC scheme, it would take a lot of efforts to clarify transition rules and design new mechanisms and elements during the policy transition process.

As for the last option, since tendering and investment subsidies are suitable for the short-term and in fact the development of certain RE technologies, Belgium is recommended to apply these to realize its clear goals of developing biomass and onshore wind-sourced power in the coming decade. Tendering is the best instrument to increase policy cost effectiveness, and investment subsidies as a simple scheme which can efficiently reduce the transaction and administration cost. Therefore, Belgium could try to adopt these two kinds of schemes simultaneously. In view of existing investment subsidies in Belgium, this should not present a problem, whereas for tendering, there are some problems which will have to be faced. For instance, legislation and punishment rules for project delays and suspensions are necessary in order to guarantee the high cost effectiveness of tendering. In addition, administration cost will increase because a number of elements, such as eligible technologies, tendering procedure, and available budget, need to be defined prior to each tendering. A special feature is furthermore that the third option puts forward higher requirements for policy makers since they should design appropriate policy combination rules or mechanisms to avoid excessive subsidies. Lastly, the uncertain Belgian political landscape increases the risks of tendering and investment subsidies since these are financed by means of a national budget determined by political decision.

Option/Comment	Pros	Cons
Improve current TGC system	--Belgian own years' experience on TGC --wide acceptance in Belgium --improvement on compatibility and cost effectiveness --market liquidity and regional interaction increase	--lots of efforts needed to monitor both power and certificate market --a few variables needed to revise with corresponding adjustment rules --market risk cannot be totally removed --difficult to unify different TGC systems --less successful experiences from other countries under TGC scheme
Shift to new FIT scheme	--lots of experiences from countries under FIT --useful experiences in designing technology-specific floor price --low investment risks --improvement compatibility and cost effectiveness --relatively lower transaction and administration cost from a long-term perspective	--high transaction and administration cost during the transition process --clear transition rules and a few elements needed to define or revise --potential risks caused by such unplanned change --high requirements for policy makers in setting more completed tariffs rules
Combine with other policies	--no big problem in Belgian investment subsidies programs --suitable for short-term and fact development of certain RE technology --improvement on cost effectiveness, transaction and administration cost efficiency	--less experiences on tendering --legislation and punishment rules required for tendering --administration cost increase due to tendering --uncertain political landscape --high requirements for policy makers in designing policy combination rules

Table 4.7 Comparison of policy options in the case of Belgium (own creation)

Based on the above analysis, we would like to suggest that Belgium adopt both option one and option three. First, we have to reiterate that the purpose of this paper is to help Belgium improve its RES-E support system to reach the EU 2020 targets. According to the Belgian renewable energy development plan, biomass and onshore wind technologies are considered to be most promising the coming decade. At present, we are only several years away from 2020, so Belgium is more in need of an RES-E support system which is relatively stable and conducive to the successful promotion of certain RE technologies in a short time. Therefore, in order to improve the policy performance, Belgium should improve its current TGC system and investment subsidies on one side, and try to implement a tendering scheme on the other side. The detailed practices could be referred to the suggested changes in Table 4.4 and 4.6.

For the implementation of policy options, there must be much difficulties in the process. Policy maker has to take on new responsibilities and make big changes on policy instrument, which has never happened before. For instance, in order to increase the cost effectiveness and compatibility of RES-E promotion system, we advise Belgium to adopt a mechanism or establish institutions to check the total support for a RE project. To be specific, each organization should examine the subsidies which have already obtained by the RE project and then provide proper extra support following certain rules. To some extent, it implies that the administrative agencies should increase the cooperation between each other. In addition to the improvement on the existing promotion schemes, there is another bigger challenge for Belgian policy makers: add tendering scheme to the current RES-E support system. In practice, tendering scheme is recommended for promoting mainly biomass and onshore wind energy which are the most promising renewable energy in Belgium. Normally, the support from TGC scheme and from tendering cannot be accumulated since the bid winner can get certain support for power generation. What's more, policy maker has to determine the eligible technologies, capacity and other elements for tendering with consideration of the RES-E investment under TGC scheme before each tender. It is undeniable that the transaction and administration cost will increase due to the application of tendering.

To create an overall good investment environment for renewable energy not just economic, but also non-economic RES-E policy instruments should be taken into consideration. For Belgium, it is suggested to publish the assessment of RE potential in spatial planning, and not just suitable sites for installing wind turbines. The administration process for RES-E projects should be further simplified and standardized. To increase the consistency of information, it is advisable for Belgium to increase the administrative coordination, set up facilitators which provide systematic guidance and advice in RES-E investment all over the country. What's more, it should keep exploring how to ensure the transparency and objectivity of information. In terms of additional technical issues, Belgium is recommended to submit an additional medium-term development plan of its transmission network and review the plans more frequently. Moreover, although Belgium offers absolute priorities on grid connection and use for renewable-sourced power plants, it is more important to update and expand the electricity network as soon as possible. Lastly, to provide extra support for investment in bioenergy and wind power plants, several other policies can be adopted by Belgium: make a development plan for certain technologies and consider these in spatial planning; offer comprehensive information related to these technologies on a special website; introduce a remuneration mechanism to minimize local opposition towards new RES-E projects; and grant grid connection via tendering or make the priority of grid connection and use vary for each RE technology.

5. Conclusion

This section provides a summary of the findings from the entire thesis work. We will first present a thesis overview by addressing the main and sub research questions, and then make a reflection and propose some ideas for future study.

5.1 Thesis overview

With the influence of the nuclear phase-out and the obligation of emission reduction, the Belgian energy industry faces a significant challenge in in the decade. To be specific, Belgium will not achieve its 2020 EU target and even suffer from power shortages if it maintains the status quo. According to the Belgian energy development plan, renewable energy sources will play an important role in power generation in the future. However, the problem is that Belgium always spent too much on the promotion of renewable energy. What's more, many energy producers now take a wait-and-see attitude and remain reluctant to invest in RES-E due to the unstable investment climate. Therefore, this paper formulates the main research question as follows:

How can the renewable energy support system be improved to stimulate the investment in power generation from renewable energy sources in Belgium?

To answer the main research question, several sub-questions are formulated. In Table 5.1, the research sub-questions, according research frameworks/methodologies and methods are listed. In Part I, we first get to know that the electricity sector works as a socio-technical system and thus multiple factors influence the investment in renewable power generation. In Figure 2.6, the adapted multi-system framework clearly shows that the investment determinants could be divided into technology, economic, institution and actor domains. Among the four categories, this paper focuses on the institution domain, especially the RES-E policy instruments. In order to choose an appropriate policy scheme, we define six policy assessment criteria in consideration of neoclassical economics, new institutional economics and drawing lessons from other countries' experiences. In other words, the answer to sub-question 5 is the most important conclusion in Part I, since these criteria will contribute to determining the problem of the Belgian RES-E support system, which we aim to improve in Part III. In the case study of Belgium, the paper shows the current situation of the electricity sector in Belgium with the same adapted multi-system framework and introduces the history of Belgian RES-E policy instruments in Chapter 3. Part II ends with a discussion of the investment environment of renewable-sourced electricity in Belgium, which lays the foundation for the analysis and recommendations in Part III. For the last part, the answers to both sub-question 9 and 10 can be found in Chapter 4. The former sub-question focuses on the RES-E policy instruments, so the scheme is evaluated by the six policy assessment criteria after which we find that the biggest challenge and most compelling problem for Belgium at the moment is to improve its policy performance on cost effectiveness, transaction and administration cost efficiency and compatibility. Three options are introduced to improve the RES-E support system of which, based on the particularities of the Belgian situation, two are recommended. The latter sub-question concerns the general investment climate of renewable energy. The answer includes advices on Belgian non-economic policies which could be conducive to further stimulating the RES-E investment.

Research sub-question	Framework/Methodology	Method
Part I Choosing the proper policy		
1. How does the electricity sector work? What kind of factors influence the investment in renewable power generation?	Multi-system framework	Literature review
2. What are renewable energy support schemes and how do they work from neoclassical economic perspective?	Neoclassical economics	
3. What is the role of institution environment?	New institutional economics	
4. What are the success and failures of the policy instruments from practical experiences?		
5. What are the criteria to evaluate these policy instruments?	Neoclassical economics New institutional economics	
Part II Explaining the current situation in Belgium		
6. What is the status of RES-E and the power sector in Belgium?	Multi-system framework	Literature review & case study
7. What is the history of Belgian RES-E policy instruments?		
8. How is the investment environment of renewable-sourced electricity?		
Part III What should be done by policy makers		
9. Is the current RES-E support system is suitable for Belgium and what can be improved?	Neoclassical economics New institutional economics	Literature review
10. What should be done in other areas to stimulate the investment in renewable electricity?	Multi-system framework	

Table 5.1 Research overview

As the final results of this analysis, the recommendations for Belgium are specified as follows:

For the RES-E support system, we suggest Belgium improve its current TGC system and investment subsidies on the one side, and try to implement a tendering scheme on the other side. Table 5.2 lists the detailed changes to improve policy performance on cost effectiveness, transaction and administration cost efficiency and compatibility, respectively. It is worth noting that Belgium has never applied a tendering system before, so it warrants additional attention to combine its current system and tendering scheme. For instance, the government has to decide on an RE technology and how much capacity should be invested via tendering. It is most likely to be implemented in biomass and onshore wind energy projects, since these are the most promising energy sources in the Belgian energy development plan. Additionally, relevant legislations and punishment rules should be drafted in order to ensure the effectiveness of policy implementation. In general, although adding a tendering scheme to promote RES-E investments might increase the responsibilities of administrative agencies, it could improve the policy performance on each aspect Belgium needs in the event that everything is designed properly. It is certain that there will be some difficulties during the improvement process, but our suggestions could steer Belgium into the right direction on RES-E promotion system reform, know these barriers in advance and make appropriate decisions.

Criteria	Changes of numbers	Changes of rules
Cost effectiveness	--adjust the technology-specific floor price with serious consideration of power price and generation cost --set proper cap on total volume for some technology eligible to receive support --revise the period for obtaining certificates to a certain years in federal and Flemish system	--avoid retrospective changes on policy for existing plants --set certain and impartial rules for revisions on quota, penalty, etc. --establish mechanism or institutions to check the total support for a project and avoid the excessive subsidies --make legislations and punishment rules for tendering scheme
Transaction & administration cost efficiency		--define a clear long-term strategy plan including the end date of TGC and transition rules --determine eligible technologies, tendering procedure and capacity, and other elements before each call --establish proper mechanism to avoid over subsidies
Compatibility	--unify the rules of granting Green certificates in the whole country and realize free trade of Green certificates	--make clear and detailed provisions on policy combination

Table 5.2 Suggested changes to improve the Belgian promoting systems for RES-E (own creation)

As for the non-economic policies, we suggest publishing the assessment of RE potential in spatial planning, and not just suitable sites for installing wind turbines. The administration process for RES-E projects should be further simplified and standardized. To increase the consistency of information, it is advisable for Belgium to increase administrative coordination, set up facilitators which provide systematic guidance and advice in RES-E investment all over the country. What's more, it should keep exploring how to ensure the transparency and objectivity of information. In terms of additional technical issues, Belgium is recommended to submit an additional medium-term development plan of its transmission network and review the plans more frequently. Moreover, although Belgium offers absolute priorities on grid connection and use for renewable-sourced power plants, it is more important to update and expand the electricity network as soon as possible. Lastly, to provide extra support for investment in bioenergy and wind power plants, several other policies can be adopted by Belgium: make a development plan for certain technologies and consider these in spatial planning; offer comprehensive information related to these technologies on a special website; introduce a remuneration mechanism to minimize local opposition towards new RES-E projects; and grant grid connection via tendering or make the priority of grid connection and use vary for each RE technology.

In this research, the case study not only gives good recommendations for Belgium but also affirms the following views on RES-E support policy:

- Each country has its unique investment environment, and the RES-E policy instrument in a real case works differently from that in the ideal situation
- It cannot be said which RES-E policy instrument is best regardless of the characteristics of specific case
- Policy performances depend more on the specific policy design than the policy type
- There is no perfect policy; in order to keep good performances in a dynamic market, it is necessary to perform regular reviews and make timely and proper amendments
- To obtain helpful and correct guiding suggestions from policy assessments, we recommend to evaluate the RES-E policy scheme in a more comprehensive and accurate manner with six policy assessment criteria, instead of just effectiveness and efficiency

5.2 Reflections

Next I will make a comprehensive reflection on the whole process of doing this thesis.

Scientific contribution: I have used a multi-system framework to simplify the investment environment and make it possible to get a quick overview of one country's power sector. Besides this, microeconomics and institutional economics are applied in the study. This is a meaningful step in the field of policy assessment. At the moment, most existing studies evaluate the policy scheme only on effectiveness and cost efficiency. Even though there are some which propose other criteria such as certainty and equity, these are mostly presented without a theoretical explanation. In this paper, I not only summarize and define six policy assessment criteria but also make explanation on each of them based on economic theories and practical experiences. In other words, I show why these policy assessment criteria should be considered in a more scientific manner. In addition, I have a new understanding on the four policy schemes and affirm some views on RES-E support policy.

Practical contribution: a major objective of this research is to answer the practical question: how to improve the renewable energy support system to stimulate the RES-E investment in Belgium. Thus, policy recommendations for Belgian policy makers are considered as the main practical contribution of this paper. What's more, other countries could also evaluate their RES-E policy schemes in a more comprehensive and accurate manner with six policy assessment criteria and find the right improving direction for the RES-E promotion system.

Research limitation: In this thesis, there are limitations for sure. Since society is dynamic and complex and the same time research time and information is limited, I have had to make some assumptions to simplify the study. For instance, there might be other investment determinants which I have not considered; the policy assessment criteria are defined based on certain theories and limited experiences; the policy comparison is made under the same conditions regarding technology and economic domain; and this paper only focuses on four main RES-E policy instruments. Even so, this study and the analysis results are still meaningful. The new policy assessment criteria could help each country better analyze its policy scheme and explore proper and effective solutions to improve the policy performance in the field of renewable energy.

Redo the research: even though I have answered all research questions and reached all research objectives, the research process was not going well. If I had to do it again, I would narrow the research scope. Even though the current paper focuses on the RES-E policy instrument, I have started the research from analyzing the general investment environment of renewable energy and put much efforts on it. To some extent, it makes my research difficult to concentrate on a very specific issue. As a result, I cannot make some very deep study on the practical implementation of policy improvement due to the time limitation. In addition, I would try to do the research with some quantitative methods. Of course, a premise is that data should be sufficient. If so, I could establish a model to simulate the investment behavior and reach some quantitative recommendations for improving RES-E promotion system, which seems more persuasive for readers.

5.3 Recommendations for future study

In the end, after completing this research I believe that the following ideas in the field of RES-E policy design are worth studying further in the future.

- Explore how to improve the overall investment environment to influence the performance of RES-E policy instruments

In this research, we have known that there is relation between some investment determinants and policy performance, but this is not enough. For instance, complicated administrative procedure and insufficient information can undermine the confidence of RES-E investors. However, we do not know which kind of information is most important and what kind of administrative procedure is most suitable for the implementation of policy instruments. Therefore, it is necessary to study further on the relations between investment environment/determinants and policy performance.

- Include additional types of policy instruments and perform case studies in other countries in order to verify and revise the policy assessment criteria

Due to time limitation, we only consider four RES-E policy instruments and one case study of Belgium. In reality, there are many other types of policy schemes likely tax exemption and low-interests loan. To provide more policy options for each country, we suggest to include additional policy schemes into future study. Of course, it is also essential to perform more case studies, no matter of France, Spain or other countries, since only the case study of Belgium cannot explain everything or get any definitive conclusion.

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Appendix

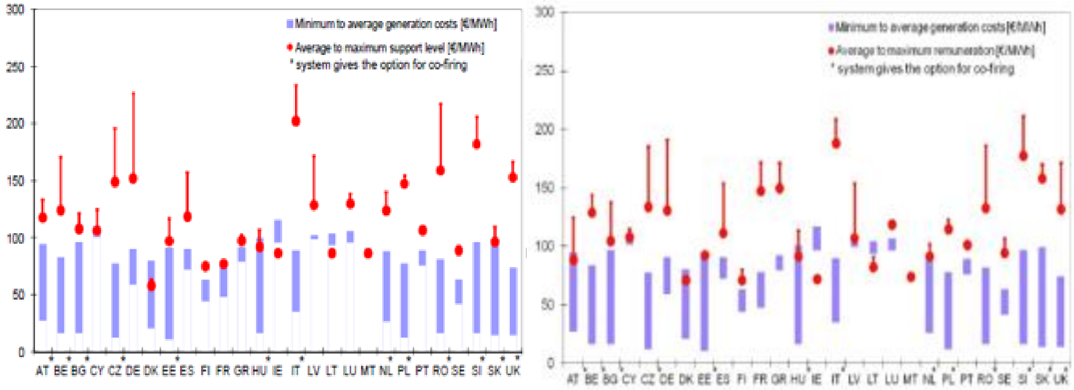

Figure 4.1a Support level ranges (average to maximum support) for biomass power plants in the EU-27 MS in 2008 (left) and in 2011 (right) (average tariffs are indicative) compared to the long-term marginal generation costs (minimum to average costs) (Held et al., 2010a; Steinhilber et al., 2011)

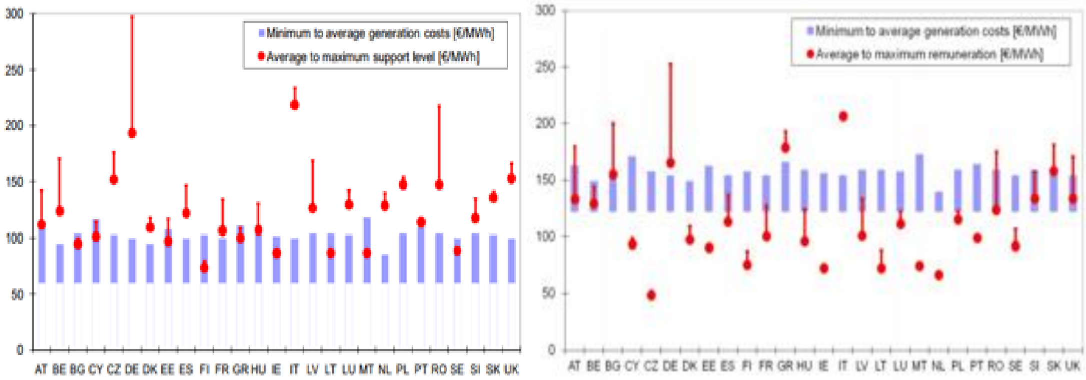

Figure 4.1b Support level ranges (average to maximum support) for biogas power plants in the EU-27 MS in 2008 (left) and in 2011 (right) (average tariffs are indicative) compared to the long-term marginal generation costs (minimum to average costs) (Held et al., 2010a; Steinhilber et al., 2011)

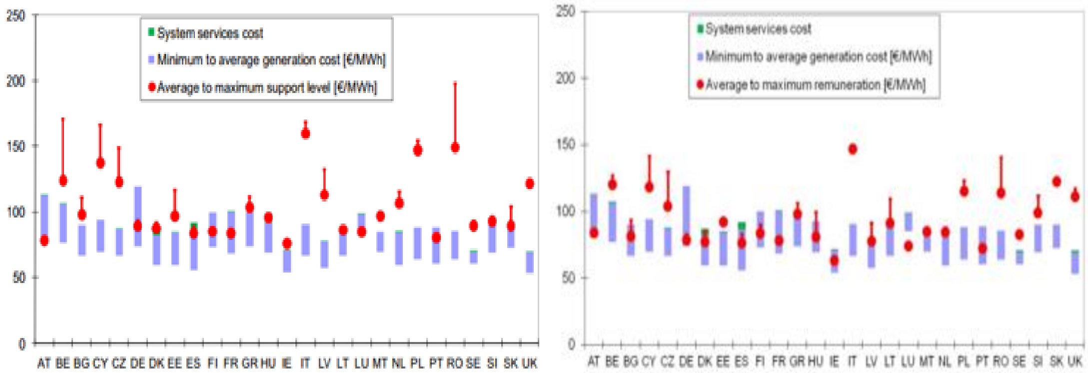

Figure 4.1c Support level ranges (average to maximum support) for onshore wind power plants in the EU-27 MS in 2009 (left) and in 2011 (right) (average tariffs are indicative) compared to the long-term marginal generation costs (minimum to average costs) (Held et al., 2010a; Steinhilber et al., 2011)

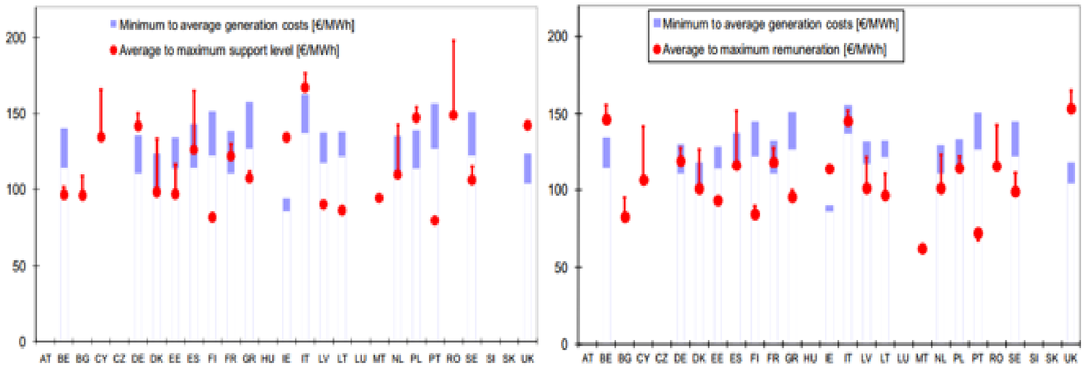

Figure 4.1d Support level ranges (average to maximum support) for offshore wind power plants in the EU-27 MS in 2009 (left) and in 2011 (right) (average tariffs are indicative) compared to the long-term marginal generation costs (minimum to average costs) (Held et al., 2010a; Steinhilber et al., 2011)

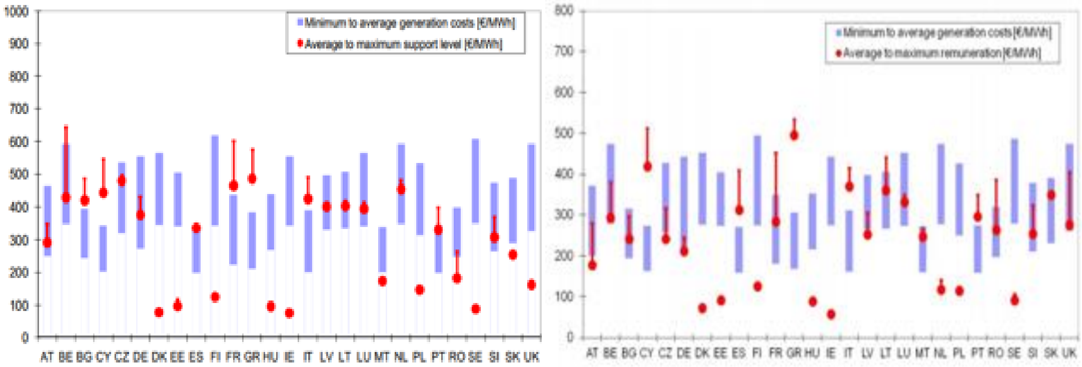

Figure 4.1e Support level ranges (average to maximum support) for Solar PV in the EU-27 MS in 2009 (left) and in 2011 (right) (average tariffs are indicative) compared to the long-term marginal generation costs (minimum to average costs) (Held et al., 2010a; Steinhilber et al., 2011)

Appendix A: Summary of the renewable electricity system in Belgium

		Federal	Flemish	Walloon	BCR
Energy structure	Electricity generation	Nuclear (50.4%), natural gas (33%), coal (6.3%), biomass (4%), hydro (1.8%), wind (1.4%)			
	RES-E structure	Solid biomass (40%), hydro (23%), wind (17.8%), biogas (7.8%), PV (7.7%)			
Different perspectives	Governmental objectives	Ensure security of supply based on diversification of geographical sources and fuels, environmental protection, accomplish EU targets; the three regions also outline their energy policy objectives (promotion of energy efficiency and renewable energy sources) in their climate and energy plan			
	Precise target	Install 2000 MW of wind power in the North sea (800 MW offshore by 2012); 20.9% of RES-E in 2020	6% of RES-E in 2010 (before 2008); 13% of RES-E by 2020	8% of RES-E in 2010; 12% of RES-E and CHP in 2012; Target for wind and PV	2.5% of RES-E in 2009; 3.25% of RES-E in 2012;
	Public acceptance	In February 2012, 58% of Belgians are in favor of keeping nuclear energy in the generation mix, but 62% favor reducing its share; moreover, since Belgium has high population density and limited space, the NIMBY effect seems more significant, especially like noise caused by wind turbines; Due to the lack of awareness campaigns, new biogas projects are faced with public protests			
Market liberalization		E market is legally fully opened in gradual steps in all regions in 2003-2007; the regulatory framework for E market is rather complex in consideration of four existing regulatory bodies; TSO: legally fully unbundled from supply/production companies; legal separation between companies involved in production, transmission and distribution of electricity was completed in 2007; in present, Electrabel still dominates most of the segments of the E market, but a few stipulations are already set to limit its share in TSO and DSOs and ease entry for new generators; Belpex (E spot market) is established in 2006, coupled with French and Dutch electricity market since 10.2007, but liquidity in the wholesale market is very thin (most is imported electricity due to trilateral market coupling); Belpex also fulfils the role of exchange platform for Flemish and Walloon green certificates; Belgian Forum for the Regulatory Bodies is set up to better co-ordinate the fragmented markets with different end-user prices and different levels of competition;			
Main RES-E support		Tradable certificate system with quota obligation			
Project selection (certificate	Eligible technology	Offshore wind energy	All (CHP benefits from a specific scheme)	All (including CHP)	All (including CHP)

granting)	Other requirements	A concession area and certificate of origin guarantee	Located in Flemish region New production plant	Certified by CWAPE; Maximum: 20 MW; energy saving requirements should be met	Certified by Brugel; 5% of CO_2 saving; Maximum: 10 MW; energy saving requirements should be met
Technology specification	Technology specification	Yes, guaranteed minimum prices differ by RE technology	Yes, guaranteed minimum prices differ by RES technology	No, same guaranteed minimum prices are for all RE technologies	No
Existing plants	Rules for established plants	/	Included; legislative amendment on green certificates in 2013 brings a few retrospective and retroactive changes for plants commissioned before 1.1.2013	Included; a big modification in 2008 changes the number of Green certificates granted to historic facilities (reduce following "q" coefficient)	/
Support level setting	Issuing base	Energy production: 1 GC/ MWh	Energy production: 1 GC/MWh	CO_2 avoided: 1 GC = 456kg CO_2 avoided Special rules exist for PV	CO_2 avoided: 1 GC = 217kg CO_2 avoided
	Cap on total volume	No cap set for TGC scheme, but most of the investment grants have a fixed budget per year			
	Penalty	/	From 2003-2004: 75 €/GC Until 1 April 2005: 100 €/GC Until 1 April 2012: 125 €/GC Until 1 April 2013: 118 €/GC From 1 April 2013: 100 €/GC	In 2003: 75 €/GC From 2004: 100 €/GC	100 €/GC
	Guaranteed minimum price	Variable according to technology	Variable according to technology (also refer to installation time)	Identical (€65/GC)	/
	Market price of GC	/	105-110*	74-90	91
	Banding factor	NO	YES*	NO	NO
Support duration & degression/ascending target	Scheme duration	2002-	2002-	2003-	2005-
	Period for which certificate is granted	Entire service life of installation (offshore)	Entire service life of installation	15 years	10 years

	Duration of the benefits from the guaranteed minimum buy-back prices	20 years for offshore wind turbines (10 years for other installations)	10 years (except photovoltaic: 20 years and 15 years since 2013)*	10+5 years*	/
	Duration of certificate life (banking) / support degression rate	5 years	5 years; 10 years – post 1 January 2013	5 years	5 years
	Ascending target	no	Ascending as pre-determined quota	Ascending as pre-determined quota	Ascending as pre-determined quota
Policy scale & combination	Recognition of certificates	Federal, Flemish, Walloon and Brussels certificates	Flemish certificates	Walloon certificates	Brussels and Walloon certificates
	International trade	NO	NO	NO	NO
	Other supports	1.Financing submarine cable by Elia for offshore wind project since 2005: max subsidy set for a project of 216 MW or more; financial contribution reduced proportionally for projects less than 216 MW; financed by a surcharge applied to the transmission tariffs 2.Federal tax reduction: available for 15.5% of investment costs for enterprises (since 2004 for PV,	1.Financial support for demonstration project since 1992: 35% of investment costs (with a max of €150,000) for industry and tertiary sector 2.Support for solar (2002-2007): grants 65% of total investment cost for PV; fixed annual budget; phased out (start in 2005) with the established of TGC scheme for solar PV in Flanders; two year transition phase (2005-2007) 3.Ecological investment subsidy	1. Subsidies for renewable energy investment since 2005: annual limited budget; overall amount of the subsidy and the exemption from real estate taxes is available at most 50% of admissible additional costs for SMEs, 20%-30% for large enterprises, additional costs differ by technology; max amount of subsidy over a 4-year period and the period for tax exemption are stipulated for companies in different sizes; certain sectors excluded (e.g. energy sector); reviewed and improved on	1. Subsidies for renewable energy in tertiary sector buildings since 2007: subsidy covers 40% of investment costs only for companies of the service and industrial sectors; eligible technology focuses on small-scale plants, including solar energy, hydropower, biogas, geothermal, etc.; installed system must directly meet the buildings energy needs 2.Grants for solar energy since 2007: offer €3 per peak watt with a max grant of 50% of investment cost

		wind turbines and hydropower plants) and up to 40% for households (since 2002 only for PV); maximum budget per installation is capped; the scheme is reviewed in every financial year; application is performed once per year at the time of filling the annual tax return 3.Federal support for PV on public buildings: tender for roof concession for PV; allocated €1.5 billion for setting up PV on roofs of other federal public buildings not covered by tender * A regular consultation process between the federal authorities and the regional authorities — who are in principle competent for matters of renewable energies and the rational use of energy—on fiscal aspects of energy issues takes place in the frame of the Federal Regional Energy	via tenders since 2004 (amended in 2007 and 2012): from 2007, at most 40% of additional costs for SMEs, 20% for large enterprises (percentages are adjusted during the years), additional costs differ by technology; from 2013, subsidy amount per project determined by several factors; list of eligible technologies and additional costs subject to review before any call for projects (3 times per year); annual budget is set; subsidy bonus can be granted to companies with certain conditions; technologies that are also supported with CHP or Green certificates are excluded 4.Provincial and municipal grants for solar energy: various schemes offered by different governments	several occasions since its entry in force. 2.Solwatt program since 2008: grants for the installation of small-scale PV systems for households, very small enterprises, self-employed workers and private entities; 20% of investment cost with a limit (€3500) 3.Advance granting of green certificates: installations with 10 kW or less approved by CWaPE; number of certificates granted estimated over a production period of 5 years (with a max of 40 certificates)	for households; in addition, various communes also offer additional subsidies 3.'enegry premiums' for feasibility studies on installation using RE sources: amount to 50% of their costs in collective housing, services and industrial sector *investment premiums above are guaranteed until the annual budget is spent, and are revised and optimized annually

		Consultation Group			
	Policy combination	Generally speaking, the support schemes for production (TGC) and investment are coexistent and can be granted cumulatively; the guaranteed minimum price scheme established by the Federal authority is compatible - but not cumulative - with the green certificate schemes in place in the Regions; the accumulation of support schemes for investments set up at the federal level and TGC scheme is allowed, but companies may not receive the benefit of regional investment aid with aid obtained under other regional legislation (e.g. TGC scheme); a Federal-Regional working group seeks to improve the coherence between tax deductions and regional premiums			
Policy payer & rights and obligations for system actors	Payment principles	Costs of the green certificate scheme are paid by the electricity suppliers and traders and, in case of the “fall back” minimum prices, by the TSO and DSOs. In case of the federal and Flemish mechanism, only the net balance between the purchase price for GC paid by TSO/DSO and the selling price on the market is financed by surcharge. Finally, all extra costs are passed to consumers through surcharge tariffs			
	Issuing body for certificate	CREG	VREG: also responsible for verifying compliance with the quota obligation	CWAPE: also responsible for verifying compliance with the quota obligation	Brugel: also responsible for verifying compliance with the quota obligation
	Public service obligation	TSO Elia: purchase Green certificates from installations after July 1, 2003 and younger than 10 years at federal minimum price (offshore wind, water or currents, and solar before August 1, 2012)	LTSO Elia: purchase Green certificates at Flemish minimum price (70 kV – 30 kV) DSOs: purchase Green certificates from green plant less than 10 years' service*	LTSO Elia: purchase Green certificates at €65	LTSO Elia: purchase Green certificates at €65
	Rights to Green certificates resale	TSO Elia: Yes	LTSO Elia: Yes DSOs: Yes	LTSO Elia: NO	/
	Quota obligation	/	Target: electricity supplier Quota: pre-determined for each year until 2012; from 31 March 2013, the number of Green certificates needed to be	Target: electricity supplier and DSO Quota: pre-determined for each year until 2020	Target: electricity supplier Quota: pre-determined for each year until 2025

			submitted is determined by the formula*: C=Gr * Ev * Btot		
	Free choices to sell Green certificates	-Statutory minimum price to Elia -Sell to one of the regional green markets	-Bilateral certificate market in Flemish -Green certificate exchange (Belpex) -Statutory minimum price to TSO or DSOs	-Bilateral certificate market in Walloon and Brussels -Green certificate exchange (Belpex) -Statutory minimum price to TSO Elia or LTSO Elia	-Bilateral certificate market in Brussels -Sell to Elia
Policy Revision		No periodic revision for TGC scheme, but a number of mechanisms were set up to ensure regular feedback; investment grants are periodically revised			
		In 2005, minimum price for off-shore wind is modified; in 2012, federal green certificate scheme is amended, in specific it abolishes the minimum price system for green power certificates granted pursuant to regional laws in order to avoid a rise in transmission tariffs (e.g. federal support is changed to be only available for photovoltaic facilities commissioned before 1 August 2012)	A study carried out every 3 years to estimate the need for exploitation support to ensure the acceptable profitability of projects; a rule of guarantying the ROI of PV at 5% since 2013; minimum price for different RE technologies are amended for several times (especially for solar PV, the minimum price has been lowered for the third year in a row); in 2013, several new concepts are introduced to the TGC system	A detailed analysis of the technical and economic characteristics of the different electricity production chains is performed every 3 years; an annual assessment of green certificates market is conducted, and projections on the development of new medium-term installations (5 years) is made; quota was corrected twice and established until 2020 in March 2012; from 2013, lower minimum price and fewer number of Green certificates will be granted for PV; the growth rate of quota (precise target) is augmented from 1% to	Adapt GC system in 2011; a rule of ensuring payback period up to 7 years for PV through annual revision; in 2012, number of Green certificates granted for solar power is reduced

				3.65% from 2012, in order to reach a target of 30.5% RES-E in 2016; a new regime is expected to replace TGC scheme for new PV	
Administration issues	Spatial planning	No official guidelines available for local administrative bodies; development of wind energy is affected by restrictions (e.g. military limitations and dense population)	A list of suitable sites for establishing wind turbines provided by public authorities;	/	/
	Administrative procedures	Federal authority grants authorizations for projects in excess of 25 MW; for granting of environment permits, Regions are responsible and they divide the installations into three categories (the requirements of environment authorization differ by the category); in Walloon region and Brussels Capital region, "single permit" is created to serve both as environmental permit and building permit; the building permit is obtained from regional or local authorities, depending on the project type; typically average 7 permits are required; administration procedures in Belgium differ partly between the three regions with their own criteria and requirements; no official guidelines available for local and regional administrative bodies; Flemish and Walloon Region adjust the administrative procedure in various ways to take RES specificities into account, but Brussels region considers technology characteristics but not RES specificities in particular;			
		too long lead-times for wind power projects especially for offshore wind projects; time schedules for applicants are not directly published; four authorizations required for offshore wind projects, and the time schedules for permit processing are defined; for	Special administration rules are established for biomass, wind and solar energy under certain conditions (e.g. for biomass, total dust emissions are set, and burning of some kinds of biomass is exempt from an environmental permit); wind turbines in rural areas allowed to	Solar energy under certain conditions are permitted regardless of the provisions of sub-regional plan (waiver of planning permission); simplified permit procedure provided for RE projects located on the same premises; evaluation of "first come, first served" principle (call for investors at fixed intervals) for wind	A few studies and reviews are performed to simplify the administration procedures; solar panels and boilers are exempted from authorization; processing time limits for environmental permits (same as single permit) are defined, differing by project category; authorization procedures consider

		other projects (on land) in more than 25 MW, a mandatory time-schedule is also established for the processing of individual authorization; offshore wind project is subject to a special authorization system, whereas for other RE technologies, their peculiarities are not considered in the authorization process;	be authorized directly but the policy is very restrictive; solar energy is not subject to a building permit and an environmental permit); processing time limits for urban development permits and environmental permits are both defined (specific rules differ by project category); rules on authorization differ by technology and capacity of the installation; biomass boilers in building up to 300 kW and most of solar panels are exempt from authorization; environment and construction permits depend on different authorities	turbines; the obligation to register the principal network infrastructure in advance protracts application procedures for investors; processing time limits for urban development permits, environmental permits and Single permit are both defined (specific rules differ by project category and technology); rules on authorization and assessment criteria for the project establishment differ by technology and capacity of the installation; in Walloon region, subsidizes are available for consultants for regional and urban planning;	the specific features of the installation, but not the peculiarities of the RE technologies; simplified granting procedures for environmental permits are introduced for small-scale wind turbines, hydropower and low capacity biomass installations (solar panels are exempted from the environment permit);
Information transparency & sufficiency		Regional authorities play the principal role in providing information on facilities and renewable energy in general, local authorities develop awareness programs, and Regions as well as the Finance FPS (federal level) provide information on the conditions for granting support; For information on RES-E supporting measures: fiscal supporting measures is disseminated by means of pamphlets, website of FPS, tax return forms, call center and regular information campaigns; green certificate systems are specified in websites of regulatory bodies and the regional and federal energy administrations; regional premiums for investment are spread by energy service points, facilitators, permanent training, etc.; but how the support value calculated is yet unknown (e.g. none is aware of the assumptions and calculation method used for computing the minimum price of green certificate for offshore wind). Furthermore, three regions support the weather forecast for renewable energies, which forecasts the weekly solar and wind energy potentials. The websites of the Regions offer various simulators for assessing the benefits and cost effectiveness of systems using RE sources; every administrative entity responsible for the dissemination of information relevant to its authorization via various channels			

		(e.g. advisers); information about the costs and timetable of grid connection is provided in various ways, depending on respective region; no transparency in the billing of the costs of green certificates to consumers; public have no ability to obtain objective and latest information			
		tariffs for grid connection are published by CREG, and the parameters for determining these tariffs are also available;	Different campaigns are launched for citizens to raise their awareness on green energy; Flemish regulator has made available on its website a page dedicated to the environment-friendly electricity generation, with a list of suppliers and green electricity producers and the price of green certificates, as well as the link to its green certificates relational database management system;	Obligation to state specific information on the cost of green certificates on the bills; a system of energy service points is set up; facilitators are established, providing guidance on technologies, financial assistance and related administrative procedures; a campaign on energy performance of building is under way for citizens; Walloon regulator certifies the quota obligation every three months and publishes information about green certificates;	Facilitators similar to ones in the Walloon region are established; information brochures, success stories, technical guides are all available on the website; a cycle of annual conferences (interactive workshops) on RE are organized for citizens;
Additional technical issues	Grid connection and access	A 10-year period of the development plan for the transmission network is adapted every 4 years by TSO, considering both the promotion of RE and energy supply security; the network operators in regions must draw up plans for the adaptation of the network, and these plans are approved and monitored by the regulators; tariffs is non-discriminatory and transparent; different tariffs and several categories of customers are established to ensure that consumers themselves are responsible for the costs they generate; Elia creates a single grid access contract that is used in the three regions; new multi-annual tariff-setting mechanism for transmission and distribution was introduced in 2007; many projects cannot be connected at an acceptable cost due to overcapacity in the grid at some connection points.			
		Priority grid connection but insufficient due to imprecise terms in the respective laws; non-discriminatory access to grid; priority in case of grid	In the Flemish Region, the connection costs are limited to the costs of linking up to the nearest network of sufficient voltage, even if the network	The time-limits are specified by the technical regulations; priority access exists;	Priority is given to the processing of applications for connection, for capacity reserves or for the execution of connection works;

		congestion and dispatching (restrictions on RE producing units will be imposed only as a last resort); no rules on sharing the costs between initially and subsequently connected producers; grid is built mainly to transport power from large centralized plants, so grid adaption is required; time schedule for processing connection applications in transmission network is established	operator requests connection at another place or voltage; within a time limit (differ by capacity of the installations), applications for grid connection must be informed about the outcome, connection conditions and schedule; no distribution guarantee but distributor has limited means to prevent distribution (only installations with 2.5 MWA or more can be disconnected under certain circumstances); high penetration of CHP put pressure on the distribution system		

(Commission, 2010; IEA, 2008-2012; "Renewable Energy Industry Roadmap towards 2020 - Belgium, Czech Republic, Hungary, Luxemburg, the Netherlands, Sweden, Portugal and UK," 2010)

Appendix B: Summary of the renewable electricity system in Czech Republic, Hungary, Luxemburg and the Netherlands

		Czech Republic	Hungary	Luxemburg	Netherlands
Energy structure	Electricity generation	Coal (60%), nuclear (32%)	Nuclear (42%), natural gas (31%), coal (17%)	Natural gas (90.5%), hydro (3.7%), biomass (3.2%), wind &PV (2.7%), half of E-supply: import	Natural gas (60%), coal (27%), biomass (7%), nuclear (3.5%), wind (2.8%)
	RES-E structure	Hydro (54%), biomass (31%), biogas (7%), wind (7%)	Solid biomass (78%), wind (15.6%), hydro (6%)	Hydro (38%), biomass (34%), wind (21%), PV (7%)	Solid biomass (44.5%, mostly co-fired in coal plants), wind (42%), biogas (11%)
Different perspectives	Governmental objectives	Balanced energy mix, strengthen co-operation of E-network and energy security, (but in fact government is not in favor of RES since they are not fully aware of such benefits)	Enhance regional integration and energy security, climate protection, rural development	Enhance regional market and energy security; open market to competition; adjust policies	Reach EU targets; transform to a more sustainable energy system
	Precise target	8% RES-E in 2010, and 14.3% by 2020, no technology-specific targets	3.6% RES-E in 2010, and 10.9% by 2020, specific targets for hydro and solid biomass	5.7% RES-E in 2010; 11.8% by 2020	9% RES-E in 2010; 37% by 2020
	Public acceptance	Low (even unsupported by authorities)			
Market liberalization		Legal unbundling of T&D companies, common grid codes & commercial codes, continuous E-trading, special institution for anti-competitive	Fully opened of retail market; abolish long-term PPA;, more efforts dedicated to monitor market competition; Act on reducing market abuse	Fully open since 2007; Legally unbundling of TSO; unrequired legally unbundling of DSOs; all customers free to choose	TSO: a state-owned company with ownership unbundling and the majority owner of short-term electricity and gas trading; fully liberalized of retail market

		behavior	capability; competitive and regulated wholesale market coexist (low market liquidity); no spot market until 2010; state-owned firm dominates E-generation and possess TSO and exchange platform; price gap influencing retail price	supplier; small market; competition in the wholesale market depends on the availability of electricity import;	since 2004 various markets available between wholesale buyers and sellers for electricity transaction; high liquidity in wholesale market
Main RES-E support		1.FITs since 2002 2.Green bonus since 2005	1.Old FITs (2001-2007) 2.New FITs since 2008: with a separate scheme defined for new wind energy projects 3.New FITs expected to take effect not before July 2012	1.FITs since 1994 (amended in 2005, new tariffs in 2008) 2.Premium for RES-E (2001-2008) 3.Investment subsidies	1.MEP (feed-in premium): 7.2003-8.2006 2.OVMEP: 12.2006-5.2007 3.SDE (feed-in premium): 4.2008-2011 4.SDE+ (feed-in subsidy): Since 2011
Project selection (certificate granting)	Eligible technology	All	1.All (including cogeneration plants running fossil fuels) with capacity over 100 kW which is removed in 2005 amendment 2.All (exceed 50 kVA) 3.all (each with mix and max plant size)	1.CHP, wind, biomass and PV; hydro and bioenergy included after 2005 amendment 2.Wind, hydro, biomass and biogas less all than 3 MW and PV less than 50 kW 3..For private individuals: PV and micro CHP with size condition; for companies (including SMEs): multiple	1.All (large-scale biomass included since 2005) 2.Fermentation installations based on animal manure 3.Vary yearly (different categories) 4.All (including CHP, except co-firing of biomass)

				RE sourced and CHP; for community: bioenergy and PV; for agricultural operation: biogas plant	
	Other requirements	Wind : more than 20MW Small hydro: up to 10MW	2.For producers eligible after Jan 1, 2008: electricity generated could only be from RES or waste or from both; in case of using mixed fuel, min 30% RES or waste should be ensured as energy fuel 3.special criteria or bonus defined for biomass and biogas	1.Tariffs in 2005: min and max system size set for each technology expect PV New tariffs: available for installations after Jan 1, 2008 and max system sizes set for some technology 2.under FITs from 1994 to 2005 3.for private individuals, investment subsidies available for investment between 1.1.2008 and 1.12.2012;	MEP: only for installations established after 1.1. 1996 SDE: limit of system size depends on subsidy category, For all main schemes above: guarantee of origin must be proven by applicants Minimum efficiency is required for MEP/OVMEP/SDE
Technology specification		Differ by technology type and commissioning date	1.Same for all technologies 2.Differ by technology, installed capacity and commissioning date 3.differ by technology (details not decided)	1.New tariffs more differ by technology and capacity 2.differ by technology 3.Differ by technology and site's quality (wind)	1.differ by technology and plant size (for biomass) 2.only one kind of technology 3.differ by technology, capacity 4.same for all technologies
Existing plants	Rules for established plants		2.for "older" power plants before 1.1.2008, tariff adjusted annually as that under old FITs		

Support level setting	Issuing base	€/MWh	€/MWh	€/MWh	€/MWh
	Cap on total volume	no	1.no, except 330 MW of wind energy projects (already granted under old FITs) 2.in 2009, first call of 410 MW new wind development was announced (wind turbines may only be connected to the grid after 1 January 2008 via a tendering process and receive feed-in tariff)	no	1.No, but for onshore wind: max 18000 full load hours in ten years since 12.2006 2.Max number (kWh) eligible annually for subsidy, budget cap : €326 million 3.A cap on total volume of electricity for subsidy per calendar year; yearly budget cap set by technology 4.One capped budget for all eligible technologies From 2015, budget will be €1.4 billion for all instruments (including SDE and MEP obligations)
	Penalty	/	/	/	/
	Guaranteed minimum price	Differ by technology type and commissioning date; FITs: support level determined by connection time,	€cents/ kWh until 2007 2.Differ by several factors (technology, commissioning date, load and capacity); no upper limit for producers who get eligibility prior to 1 January 2008, but max 50 MW for off-take at subsidized rates for ones eligible	1.New tariffs more differ by technology and capacity; additional bonus available for biogas, solid biomass and wood waste 2.differ by technology 3.Differ by beneficiary, technology and site's quality	1.differ by technology and plant size (for biomass); max €0.097 per kWh 2. €0.097 per kWh 3.min value is zero, max values differ by technology, capacity 4.four subsidy thresholds (first come first serve basis)

			after that date	(wind), even decided on case by case basis	
	Market price of GC	/	/	/	/
	Banding factor	/	/	/	/
Support duration & degression/ascending target	Scheme duration	no	Undecided for new FITs	2.31.12.2001-1.3.2008 3.Investment subsidies: For private individuals: since 2001, current period (2008-2012); for company: since 2004 until 1.12.2013; for SMEs, since 2004; for communities, since 2005; for agricultural operation: since 2007 and last 7 years	As listed in major RES-E support SDE: tendering is opened up for a specified number of months each year, and opening-up period may differ per category and per annum.
	Period for which certificate is granted	/	/	/	/
	Duration of the benefits from the guaranteed minimum buy-back prices	FITs: 20-30 years Green bonus: 20-30 years, but each year with a new value determined by Energy Regulatory Office	1.unspecified; the eligibility period equals to the lifetime of the installation eligible 2. HEO specifies the amount and period (around 10 years) of electricity eligible for FITs based on ROI for each project 3.15 years (expected)	1.New FITs: 15 years after the first feed-in into the electricity grid; 20 years for renewed or extended biogas station 2.Solar PV: 20 years Other systems: 10 years 3.onetime financial grant	MEP: max 10 years, except for CHP OVMEP: 10 years SDE: 12-15 years SDE+: max 15 years
	Duration of certificate life (banking) / support	Tariffs or bonuses adjusted annually based on inflation	1.FITs rates adjusted yearly in line with inflation rate	1.New FITs: constant during the whole support period	3.SDE(+): for a project with a subsidy grant, the basic

	degression rate	from 2% up to 4%	2. For new entrants (eligible after 1.1.2008), on top of inflation rate, tariff decreases 1% per year		amount and the basic energy price do not change; but subsidy amount = basic amount – electricity price, so premium may vary year to year due to changeable electricity price
	Ascending target	/	/	/	/
Policy scale & combination	Recognition of certificates	/	/	/	/
	International trade	/	/	/	/
	Other supports	Investment subsidies: 1.State program since 2002: coordinated by the Ministry of Industry and Trade and the Ministry of the Environment (so it is divided into two parts); each part of the program offers different levels of support to different beneficiaries (budget caps set in some cases); one year program (every call is for specific technologies) and evaluated annually 2.EU structural funds (2007-2013): multi-year plans; include	Investment subsidies (not technology-specific): 1.EIOP (2004-2009): all technologies; amount granted depends on project size (between 125 million HUF and 300 million HUF per project) 2.EEOP (2007-2013): certain total budget; cap for investment aid is 20 MW; two-year action plans adopted; calls are announced continuously; include a few sub-schemes each of which defines the grants range, eligible technologies and	Diverse communities have their own promotion schemes for private individuals.	Tax schemes (run throughout the year)： 1.EIA since 1997: annual budget ceiling (revised annually), financed by national budget, refer to EIA energy list (updated annually), generic support (44% deduction of investment costs from taxable profits) for tax-paying entrepreneurs, certain conditions in terms of investment scale for eligible projects

		OP Enterprise and Innovation and OP Environment (both programs set different support level for RE technologies and relevant budget limit); promoted RES-E technologies depend on each call (generally, all) 3.tax exemptions since 2005: exempt from income taxes for 5 years; certain eligible technologies	applicants (e.g. "Increasing the Use of Renewable Energy Sources" offer 10% to 80% of aid intensity via tender schemes for biomass, biogas, geothermal, small scale wind turbines up to 50kW 3.NEP (2000-2009): provide non-refundable aid to different RE technologies; one year program via tender scheme; max subsidy intensity 25% or max HUF1 million per dwelling; possible to combine soft loans from Energy Saving Credit Program 2008 4.For household-scale micro plants less than 50 kVA: covered by other regulations (FITs)		2.MIA since 2000/Vamil since 1994: certain yearly budget, included in national budget, refer to same environment list (revised annually), support differ by categories, certain conditions in terms of investment scale for projects Green funds scheme since 1995: loans at lower interest rates for qualified project, financed by government budget, support differences depend on projects not project category, most RE projects are eligible (except offshore wind, biomass restricted to clean wood and energy crops)
	Policy combination	FITs and Green bonus (annually) cannot be combined; producers that generate RES-E for their own needs only are entitled to the payment of the premium; other support measure and FITs or Green bonus can be cumulated	FITs: possible to combine with other investment aid (despite former structural funding schemes before 2008), but the support will be cut properly	FITs and investment subsidies could be accumulated	(OV)MEP/SDE could be combined with EIA, green financing, and MIA/Vamil MSK test controls the state aid for environment protection Combination of MIA and Vamil: possible EIA and Vamil: possible

					EIA and MIA: not possible
Policy payer & rights and obligations for system actors	Payment principles	End consumers pay higher electricity prices by a surcharge to TSO or DSOs	FITs: finally paid by consumers EEOP&EIOP: mainly financed by EU funds, and small portion from domestic co-financing NEP: national budget and community funds	1.FITs: financed by compensation mechanism, and required contributions differ by user type via bills 3.Investment subsidies: funded annual budget	1.Financed by annual levy on all connections to electricity grid 2.Financed by national budget 3.Financed by direct government budget, but through the levy from 2015 4.fianced through a levy on electricity bills of consumers
	Issuing body for certificate	/	/	/	CertiQ: issue guarantees of origin
	Public service obligation	Obligatory purchase of RES-E by grid operators under both schemes	Obligatory purchase of all electricity under FITs by TSO, MOT scheme (mandatory off-take) for recipients of electricity	Obligatory purchase of RES-E by network operators	/
	Rights to Green certificates resale	/	/	/	/
	Quota obligation	no	no	no	no
	Free choices to sell GC	/	/	/	/
Policy Revision		Both of the schemes (FITs and Green bonus) are revised annually, support level adjusted to technical and economic parameters but not lower than 95% of previous	1.tariff rate is fixed until 2007; capacity limit on eligible technology removed in 2005 2. tariff levels are set annually on the basis of inflation and technical progress; plan to	1.FITs: regularly checked; amended in 2005 and 2008; new tariffs for new installations decline 0.25% per year for all RE technologies expect PV (3%	MEP: new rates established every year SDE: subsidy basic amount and categories are revised annually SDE+: budget raised from

		year; established tariffs or bonus should ensure 15 year return on investment in power plants generating RES-E	replace FITs by TGC and so report the progress to government every two years	per year) 3.Investment subsidies: regularly checked, several times of revision or update	€1.5 billion in 2011 to €1.7 billion in 2012; extra support round added
Administration issues	Spatial planning	No spatial planning for RES-E development, but a guideline available for assessing the territory (wind and PV power plants); some regions have adopted regional plans that hinder the development of wind power plants;	No national regulation on installation of RES power plants; a comprehensive survey of the feasibility of incorporating additional wind power capacities in the electricity system is required annually; laws on spatial planning are available; consultancy network is set for green economy development;	RES options not included in national spatial planning	Spatial Planning Act; government coordination scheme for large-scale projects; provinces and municipalities designate areas for renewable energy in spatial planning
	Administrative procedures	Many administrations involved and less co-ordination; time-consuming EIA procedure; building permit (30-60 days); unreasonable lead-time for most RE projects; no clear guidelines; minimum five permits required for biogas and biomass installations, and six permits for onshore wind ones; simplified but less effective procedure for small-scale	Very complicated; involve a lot of authorities; establish rules on cooperation and data exchange; no clear guidelines; simplified procedures for small-scale installations (except wind turbines), especially solar; several qualifications available for case handler; trainings often overlap and lack of coordination; one-stop shop is in progress; hydro, geothermal and wind	Authorization process and timetable is clear; issuing building permit decoupled from national authorization; authorization procedures differ by different classes (technology); simplified process for small-scale plants at local level and for special class at national level; planned guidance; no targeted training	Involve many institutions and slow decision-making process; some Acts established regulate the administrative procedures, especially licensing; a large number of different licenses required (with different criteria, procedures, etc.); procedural steps for licensing differ by license type; single point of contact assisting applicants; authorization periods are set;

		installations; administrative guidance and training available for local authorities in various forms, but not enough and case handlers are apparently in opposite to certain renewables; administrative procedures do not consider RES specificities;	power plants above certain capacity are obligated to do an environmental impact assessment		specific procedures/rules for certain installations; HBO course about authorization for renewable energy
Information transparency & sufficiency		No specific strategy, misinformation dissemination, information publish in many forms; state program grants available for information dissemination and awareness raising; information available only for certain permitting processes; no explicit information on times for grid connection;	Non-transparent regulated prices; no guidance on RES investment and procedures; unclear preferred options for future E-supply; support for information dissemination and green awareness-raising are available via tendering; consultancy network and online platform; insufficient information on RES for people; grid connection procedures contained in certain regulations; information on authorization process provided through authorities' customer services;	No accurate energy forecasts; comprehensive information on authorization and licensing are available in one website; Myenergy: provide information and basic advising; Myenergy "Infopoints": a regional support point; locally regular information and awareness-raising campaigns; information available to all relevant actors in different forms; connection costs and requirements published by grid operators	Some Acts specify information about authorization process; information available in many forms and programs for different target groups; a number of foundations exist for market players to work together to publish and collect information (net benefits, costs, efficiency) about RES system; for citizens, access information via website or helpdesk, possibly raise questions to government by post, information events and relevant articles in local newspapers; legal obligation of TSO: publish transparent info

					on the grid connection
Additional technical issues	Network development, Grid connection and access	Priority connection, access and dispatching; no connection and support for the capacity above defined targets; connection costs depend on connection type and capacity; ten-year investment plan by system operators with annual update;	wind turbines may only be connected to the grid after 1 January 2008 via a tendering process; grid operator is obligated to enter into a grid connection contract; network license given with preference to RES-E; priority access and dispatching; ten-year long-term and three-year medium-term plans prepared by TSO annually;	Obligatory five-year plan made by system operators; guaranteed network access under objective and non-discriminatory condition; free charge for the use of grid for the system under FITs; priority dispatching; no priority grid connection	Seven-year plan made by TSO; submit quality and capacity document every two years by system operators; technical regulations set for system operation (Netcode); non-discriminatory network connection and transport; priority for the transport of sustainable electricity in case of transport capacity shortage; non-adjustable RES-E takes priority over adjustable RES-E

Appendix C: Summary of the renewable electricity system in Sweden, Portugal and UK

		Sweden	**Portugal**	**UK**
Energy structure	Electricity generation	Nuclear (44.4%), hydro (45.3%), conventional (9.3%), wind (1%)	Natural gas (28.4%), hydro (23.1%), coal (18.8%), wind (17.5), biofuels (5%), oil (5%)	Natural gas (46%), coal (29%), nuclear (16%), biofuels and waste (4%), wind (3%), hydro (1%)
	RES-E structure	Hydro (88%), bioenergy (10%), wind (1.4%), solid waste (0.6%)	Hydro (49.7%), wind (37.6%), solid biomass (10%)	Wind (37%), hydro (24.8%), biogas (21%), solid biomass (17%)
Different perspectives	Governmental objectives	Phase out oil and other fossil fuels; climate change mitigation target; reach EU targets	Secure energy supply, protect environment, enhance market competition, reduce high energy	Mitigate climate change, more secure and low-carbon energy system; ensure public safety and cost-effectiveness

			dependence	
	Precise target	60% RES-E in 2010; 62.9% RES-E by 2020; 10 TWh/year from wind power production by 2015;	45% RES-E in 2010; 55.3% RES-E by 2020; technology-specific targets for renewables	10% RES-E in 2010; 31% RES-E by 2020; Northern Ireland: 40% by 2020; Scottish: 100% by 2020; additional 25GW from offshore wind by 2020
	Public acceptance		Local resistance against wind power is negligible	
Market liberalization		Fully liberalized; network regulator: transparent and fully independent from the government; TSO: fully unbundled; common Nordic retail market; most electricity is traded on the Nord pool spot market;	All-Iberian electricity market (MIBEL) launched in 1.2004, and single market operator created in 2006, daily market available since 7.2007; consumer free to choose supplier since 9.2006; fully liberalized since 2007 with the termination of pre-existing PPAs; regulated and free markets operate in parallel; last-resort supplier; licensing limits: cap capacity for any market participant; highly concentrated of ownership of generation	Rather illiquid wholesale financial market; six vertically integrated groups dominate power generation and supply; generation and supply are unbundled from transmission and distribution, separately licensed by Ofgem; a single wholesale market system for Great Britain introduced under the British Electricity Trading and Transmission Arrangements (BETTA) in April 2005, replacing previous separate trading arrangements in three areas; generators sell electricity to suppliers through bilateral contracts, over-the-counter (OTC) trades and spot markets; three exchange providers exist in British electricity market; competition was being stifled by a combination of tariff complexity, poor supplier behavior and lack of transparency; there are seven transmission owners (TOs) but sole system operator;
Main RES-E support		1.TGC in 1.5.2003-31.12.2035 2.Environmental bonus (energy tax	1.FITs since 1999, modified in 2005 (update calculation formula) and 2007	1.Renewable Obligation (RO) since 2002: effective in 2003 in England and Wales, and

		reduction) for wind power	(add new technologies and support limits) 2.Tendering since 2005: include obtaining connection to network 3.Micro-generation law in force since 2.2008 4.Mini production law since 2010	Scotland, followed by Northern Ireland in 2005; buy-out fund as a special element 2.Electricity market reform (EMR): feed-in tariffs (FIT CfD) expected to start by 2014 3.feed-in tariffs in Energy Act 2008 since 4.2010: applied in Great Britain
Project selection (certificate granting)	Eligible technology	TGC: for all, excluding waste and certain bio oils; including peat in CHP; certain large existing hydro plants	1.All (wave energy and CSP included since 2007) 2.wind, biomass 3.general regime: any type of micro-generation up to 5.75 kW Bonified regime: solar PV, wind, hydro, biomass and fuel cells up to 3.68 kW 4. utilizing only one type of RES-E technology excluding cogeneration micro production general regime: up to 250 kW Bonified regime: up to 20 kW	1.all (From April 2011, ROCs are awarded for the renewable portion of the fuel regarding RES-E using biodiesel produced using methanol derived from fossil fuel sources) 2.large-scale projects 3.small-scale solar PV, wind, hydro and anaerobic digestion (up to 5 MW) and micro-combined heat and power of up to 2 kW
	Other requirements		1.capacity cap for some technology (e.g. hydropower plant up to 10MW) 3.4.Micro and mini producers cannot inject more than 50 % of the power mentioned in the purchasing contract; Bonified regime only be accessed	1.Hydro with more than 20 MW: only stations commissioned after 1 April 2002; certain requirements for co-firing biomass; since April 2010, RO in GB focuses on large-scale project but in Northern Ireland still covers RE projects in any size; from April 2013, support for generators

			under certain conditions: compliance to energy efficiency measures; Certain quality standards must be met by RE technologies to be eligible to get support from tendering and micro production scheme	of 1MW and above ROC will be conditional on meeting the sustainability criteria; CHP plants should be accredited under the CHP Quality Assurance scheme. 3.accredited through either MCS scheme or the RO
Technology specification		No technology-specific bands	1.3.4 all differ by technology and size	1.technology-netural since 2002 but differ by technology and region since 4.2009 3.differ by technology and capacity
Existing plants	Rules for established plants	Plants start up before the establishment of TGC: entitled to certificates until the end of 2012 (special plants entitled until the end of 2014)	1.In terms of modification in 2005, previous FITs were maintained for existing facilities and those already under licensing process	1.Existing Renewables Obligation will continue for existing projects supported by the scheme (principle of no retrospective change)
Support level setting	Issuing base	1GC/MWh	€/MWh	ROC/MWh
	Cap on total volume	1.no	1.For some technologies, a cap to the total electricity production per installation eligible for FITs is set 2.Tendering: 1800 MW for wind power in three phases (2006-2008); 100 MW (15 stations) for biomass power in 2006 3.bonified regime: 25 MW/year set in 2010, 10 MW in 2012; 15.12 MW in 2014; capped production/year/kW installed is set separately for different technologies	1. A cap of 400 MW on the total new build dedicated biomass capacity that can expect grandfathered support under the RO; since April 2006, a limit 10% (12.5% in 2010) is set on the proportion of ROCs from co-firing of biomass with fossil fuel that an obligated party may use towards its obligation, but certain “energy crops” excluded from the cap 3. Tariff level allocated at the time of registration will only be paid if the generator remains within that level of output expected

			4.bonified regime: 50 MW/year set in 2011, 30.25 MW in 2014	
	Penalty	SEK 175 per certificate in 2003; SEK 240 per certificate in 2004; From 2005, 150% of weighted average certificate price	/	Adjusted to RPI: GBP 34.3/MWh in 2007/2008; GBP 36.99/MWh in 2010/2011 Buy-out fund: revenues from penalty are recycled to suppliers in proportion to the number of ROCs submitted
	Guaranteed minimum price	1.No 2.differ by onshore and offshore wind power (SEK/KWh)	1.differ by technology and plant size 2.defined in the tender procedure 3.general regime: depend on purchasing contract bonified regime: in 2008 reference feed-in tariff (€650/MWh), PV (100%), wind (70%), hydro and biomass (30%) for the first 5 years, then actual FITs in force for next 10 years; in 2014 €218/MWh for all RE technologies except PV (€66/MWh) for first 8 years, then €115/MWh (PV: €145/MWh) for next 7 years, also with special ratio of different technologies; after the first 10 MW, the tariff is reduced by 5% for each of the following 10 MW of capacity. 4.general regime: depend on market, no special tariff	1. From 2027, Department of Energy & Climate Change (DECC) will fix the price of the ROC for the remaining 10 years of the RO at its long-term value and buy the ROCs directly from the generators 2.guaranteed price with a long-term contract; generators receive the wholesale electricity price, topped up to a contracted level; while, if prices rise above this level, the difference would be reimbursed 3.fixed payment per MWh produced rather than feed-in; tariffs differ by technology and capacity

			Bonified regime: in 2011 reference tariff of €250/MWh; in 2012 €215/MWh, starting with special ratio of different technologies and capacity; in 2014 €159/MWh for all RE technologies except PV	
	Market price of GC	SEK 295 in 2010; SEK 293 in 2009; SEK 247 in 2008; SEK 195 in 2007; SEK 191 in 2006; SEK 216 in 2005		£50.72 in 2009; £47.65 in 2010; £40-45 in 2013/2014
	Banding factor			Technology banding starts in 4.2009, banding levels differ by technology and region, "grandfathering" banding levels exist
Support duration & degression/ascending target	Scheme duration	1.TGC: 2003-2035 2.Environment bonus:1994-2009	1.applicable until a certain capacity target is attained Other schemes: undecided	1.RO: 2002-2037 (close to new generators in 2017) 2.EMR: FIT CfD expected to start by 2014 3.FITs since 4.2010 (close to new entrants in 2021)
	Period for which certificate is granted	1.Plants built before 5.2003 lose eligibility for certificates by 2014 (for hydropower by 2010, for solar and geothermal by 2012); Max 15 years	/	1.For generators accredited before 26.6.2008: until 2027; for ones accredited after that date: 20 years
	Duration of the benefits from the guaranteed minimum buy-back prices	/	1.Max 25 years (15 years for most technologies) or for a fixed amount of electricity output, depending on which limit is achieved first 3.4.bonified regime: 15 years	3.depend on the technology (10, 20 or 25 years)

	Duration of certificate life (banking) / support degression rate	1.Certificates can be saved for own future years' needs or for sale 2.bonus amount per kWh steadily decreased until phased out in 2008 for onshore wind power and in 2009 for offshore wind power	1.tariffs defined on monthly basis based on rather complicated formula for both existing and new installations	1. "grandfathering" banding levels; Bank ROCs: possible for one year 3."grandfathering": tariffs remain at the same generation tariff level for the whole support period, subject to an annual inflationary linked adjustment *"grandfathering" not apply to some biomass and bioenergy projects in GB and Scotland
	Ascending target	Ascending as pre-determined quota	/	Ascending as annually published quota
Policy scale & combination	Recognition of certificates	/	/	Three types of certificates are fully tradable and recognized in the whole country
	International trade	Trade with Norway since 1.1.2012	/	no
	Other supports	For wind power: 1.Network since 2008: support by means of information /education activities, networking and economic support 2.Grant for local authority land use planning in 2007-2010: financed by fixed annual budget 3.Funding for pilot projects in 2003-2007 and in 2008-2012: SEK 350 million/period; borne by national budget; annual feedback to government; focus on large-scale projects; via tendering	1. RECS (Renewable Energy Certificate System): market-oriented support mechanism based on green certificates and guarantees of origin for hydropower 2. Investment subsidies for all RE technologies (2007-2013): Offer 35% of total investment, applicable only to SMEs to a maximum of €250,000 per project 3. Financial incentives for all RE technologies (2007-2013): offer 100% reduction on interest rates, applicable only to SMEs to a maximum of €75,000	1.EMR: carbon price floor (CPF) guarantees a fair price on carbon and emission performance standard (EPS) limits the amount of carbon emission from new fossil-fuel power plants; both expected to start by 2013 2.Climate change levy since 2001: RES-E generation is exempted from the climate change levy on electricity (£4.70/MWh in 2010/2011), but no guarantee for the duration of project's lifetime 3.Bioenergy Capital Grants scheme (five rounds provided since 2002): earlier rounds focus on large-scale biomass power stations, later ones emphasis on small and medium sized projects; GBP 71 million available; funded by domestic

		4. Vindlov.se since 2013: website with information about permit procedures 5.Reduced real estate tax (0.2%) For solar PV: annual state subsidies set (2009-2011) with certain condition For large offshore wind farms: grants available (2003-2012) Tax reduction in public buildings (2005-2007): 30% (70%) of total cost of approved projects (solar cells) Tax system: include energy tax, CO_2 tax, and sulphur tax (revised in 2009); electricity production is exempted from energy and CO_2 tax; biomass and peat used for electricity production are tax-free.	per project loan for 5 years and 2 years for capital " carência" 4. Fiscal Incentives for all RE equipments purchased within the national territory: a reduction VAT rate (21%)	ETF since 2008 4.Bioenergy infrastructure scheme: round 1 in 2003 and round 2 in 2008; grants for biomass producers and small- and medium-sized enterprises; max grant per beneficiary (GBP 200,000) and total budget of £3.5 million available 5. Biomass Action Plan in 4.2006: a five-year capital grant scheme for biomass heat and CHP systems; 10 million to 15 million pounds over the first two years 6. Microgeneration strategy: Low Carbon Buildings Programme (LCBP:2006-2010) offers capital grants funding for the installation of microgeneration technologies in two phases with budget limit funded by domestic ETF since 2008 7.a number of other mechanisms operated at devolved administrative level
	Policy combination	Electricity certificate scheme and other subsidies can be cumulated	/	Generators have a one-off choice to opt for the FiT CfD or the RO during the transition period (2013-2017); projects with 50kW-50MW could choose RO or FITs, but under 50kW only eligible to receive support from FITs; RO and other support schemes can be cumulated, but for small-scale RES plant receiving feed-in tariffs, the possible additional grants is not entirely clear;

				grant making authority is responsible for ensuring that the total amount of support is within the requisite state aids thresholds
Policy payer & rights and obligations for system actors	Payment principles	1.cost of Green certificates: included in electricity bill paid by end-users 2.bonus is returned to producers through a regulated contract, but ultimately paid by households	1.tariffs borne by Last-resort supplier, ultimately reflected in the electricity tariffs paid by consumer 3.paid via electricity bills	1. cost of ROCs: pass to end consumers by suppliers 3.paid directly by energy suppliers by a levy on electricity tariff and indirectly again by consumer
	Issuing body for certificate	TSO: issue and cancel certificates SEA: monitor the electricity certificate market, and decide on penalties	TSO: issue certificates	Ofgem (regulator): administer three obligations (RO for England and Wales, ROS and NIRO); in charge of issuing three types of renewable obligation certificates including GBROCs and NIROC separately and checking certificates
	Public service obligation	Quota-bound suppliers submit Green certificates on 1 April of each year	Last-resort supplier: obligated to purchase all electricity generated by special regime generators	1.Licensed electricity suppliers submit ROCs to Ofgem on 1 April of each year 3.large electricity suppliers is obligatory to pay directly to generators under FITs
	Rights to Green certificates resale	/	/	/
	Quota obligation	Target: electricity suppliers and certain users Quota is predetermined for each year until 2035	no	Target: electricity suppliers Obligation level (ROC/MWh) is published each year differently by three RO systems and with headroom mechanism since 2009
	Free choices to sell GC	For certificate-trading, producers could sell Green certificates bilaterally or through brokers;	/	RES-E generators can sell ROCs to suppliers, traders or brokers;

Policy Revision		TGC: revised in 2007, 2011, 2012, and 2013	1.FITs: the formula revised many times, tariffs updated at suitable intervals (no specified time horizon), reflecting the updated investment and operational costs of each technology, inflation and energy price 2.no pre-determined period or launch routine 3.4.bonified regime: cap of total amount eligible per year is revised for several times; feed-in tariff revised on a yearly basis, adjusted to the cost of equipments; some rules for tariff adjustment are set before, but they are not implemented for long period (e.g. reduced every year by €20/MWh for new micro production from 2010 and discounted by 7% per year for new mini production)	1.RO amended several times with statutory consultation; technology banding introduced in 2009, and banding levels reviewed every 4 years separately by three RO systems (new banding levels for 2013-2017 are proposed); Obligation levels set annually with formula from DECC; headroom also revised regularly; penalty adjusted annually with the retail price index 2.EMR: no retroactive tariff adjustment in FIT CfD 3.tariffs is under periodic reviews to coincide with RO (amendment in 2011 reduces the support for solar PV sharply, but for new scheme entrants only and so not imposed retrospectively); tariff degression (differ by technology and scale) applied for new installations from 2012 onwards
Administration issues	Spatial planning	Municipalities obligated to consider sites for wind power plants in SP (financial support for evaluation is available since 2007), and they can entitle "priority areas", where renewable are given priority treatment over other interests;	Pre-identified potential locations for key technologies of the Portuguese energy strategy; Municipal Master Plan (MMP) integrating the RE equipments and systems as a guidance available for local and regional administrative bodies (MMP should be reviewed every 10	A suite of six national policy statements (NPSs) approved in 2011 provide guidance on how decision makers should consider applications for development consent, and local planning authority should ensure their development plans are in line with NPSs; DECC funds 9 studies to identify and maximize opportunities for

		Planning and Construction Act and Environment Code govern the spatial planning; government agency publishes guidelines and provides support to local and regional authorities for the planning issue; special funding for municipalities with regard to energy and planning	years, but not all of them have complied); difficult to obtain permissions for areas that have been devastated by forest fires or in areas with a high risk of forest fires;	development of RE and low carbon energy technologies in England, Scotland also develops a similar assessment of RE potential; planning policy/framework is created in each region to guide planning authorities; devolved administrations (Wales, Scotland and Northern Ireland) set policy on planning in their respective nations, and planning applications are determined in accordance with the development plan; for better coordination of competences, regions are expected to quantify RE resources and RE development plans of devolved administration are aligned; unhelpful zoning approach for wind energy development
	Administrative procedures	Approval procedure reviewed annually; New planning and construction act since 2011 is simpler and clear (permitting timetable is specified); simplified processing with specific rules for wind farms (removed duplicate examination); limits for licensing and notifiable installations are specified for wind power plants; enhanced coordination between authorities, especially for wind power; complex administrative	Lengthy and complicated administrative process; special regime generation is subject to different licensing requirements and benefits from special FITs; special procedure: minimize local opposition towards new wind projects by providing remuneration (2.5% of the monthly payment) to municipality; procedures do not specify by technology but a simplified licensing regime (one-stop shop scheme via electronic platform)	Planning and Energy Act 2008 enables local planning authorities in England and Wales to set their own requirements for RE technologies and establishes an infrastructure commission to streamline application process to RES projects with more than 50MW in these two areas, meanwhile sets up independent body to examine applicants with specific rules within a statutory time limit; time frame is also set for dealing with planning applications in Scotland; Localism Act increases local involvement in and benefit from infrastructure development; a few legislations

		procedure: different authorities examine different categories of installations, and procedures for licenses and registration regulated through different sources of laws; lack of concrete deadlines adds complexity to the administrative procedure; authorization procedure is between 1 and 3 stages, and timetable for processing varies greatly across the country (depend on specific situation); the time to gain consent for projects is still unacceptable for developers; simplified procedure for small-scale installations at municipal level and no specific regulation at federal level for these; SEA trains municipalities' energy and climate advisors; clear responsibilities of authorities at different levels; no specific training for case handlers; lead time depends on the size and type of the plant; 2-6 permits is required, depending on the size and the technology of the installed plant;	and application procedure set for micro and mini generation; available legislations about licensing for plants with capacity limit and procedures for granting permission; simplify the licensing procedure for new equipment in existing wind plants; DGEG centralizes the licensing process, including environmental licensing but except construction permission granted by respective municipality; government Simplex Program in 2007: reduce the time duration of licensing procedures; a common platform for intervention from participants from diverse areas of governance is promoted during EIA process; professional training provided by licensing entities to case handlers; more than six permits are needed; timetables for large-scale systems are not communicated in advance;	available about the authorizations, certification, licensing procedures and spatial planning in different four areas, and pretty clear responsibilities of authorities related to consenting and licensing decisions also but quite complex considering national, regional, devolved and local levels; "one-in-one-out" rule for reducing regulation; end of "tick-box" regulation and enhance co-regulation and improve professional standards; public enabled to challenge regulations; licenses for electricity generation activities in Great Britain are granted by the sole responsible body (Ofgem) but environmental licenses are granted by different regional environment agencies, northern Ireland is a special case; local planning authorities should only ask applicants to provide information that is relevant, necessary and material to their planning application; no one-stop shop; horizontal coordination between local authorities and other permitting agencies is provided through the opportunity for statutory consultees to comment on planning applications; authorization procedures consider the specificities of different RE technology; Town and Country Planning grants automatic planning permission for

				'permitted development' subject to certain constraints (eligible technologies differ by region but most are domestic micro generation), and indicates a timetable for administration process (but the timetable is not representative); generic training is provided by DECC to planners, planning inspectors and councilors on renewable energy policy and technical issues, training is also available for case handlers for offshore RE developments and for local planning officer in Wales
Information transparency & sufficiency		Prices and volumes of certificate transactions available on the accounting system website; Swedish constitutional law: all governments responsible for providing information on their activities, principle of public access to official records; despite complex administrative procedure, enough information on the authorization process, funding and instruments available on websites, from information centers, municipal energy and climate advisors and via a few other forms; most information is available for wind power, e.g.	Sufficient information about tendering; abundant information about licensing available on DGEG's (regulator) website; all energy vendors obligated to provide a detailed and clear bill to each consumer; besides DGEG on national level and regional authorities, many energy agencies available for communicating and disseminating information on a local level; information on RES support instruments is available on websites of different bodies involved in the sector, meanwhile media campaigns, seminars and other events are possible	Primary Authority scheme: one local authority becomes a single point for advice and guidance, ensuring the regulatory consistency and greater confidence given to investors; information and guidance on the application process is provided by the responsible decision making authorities in a variety of forms (e.g. Environment Agency publishes guidance for environmental permits on its website; guidance setting out the minimum criteria for completing license application is available on Ofgem's website; Planning Portal website has a guide on the permitted development rights for householders, including microgeneration right; national, regional and local guidance are published to guide the planning

		Vindlov.se (an Internet-based manual about wind power); Swedish contact point: simplify the procedures for companies; general public receives information primarily from municipal energy and climate advisors who receive support from SEA; annual national campaign, publications and newsletters are also available for awareness-raising; costs for grid connection are transparent;	for the launch of new programs; a campaign to disseminate the NES 2020 is created to raise awareness of citizens; 350 legislative documents cover information about administrative process;	application for each RE technology); information about support measures is available to the public by on DECC's website; information and advices on renewable energy and carbon reduction are provided to communities, households, and businesses and organizations by different companies, organizations and websites; at local level, some tools are created to provide further information in order to help increase the use of RE (e.g. quick check tool for biogas, carbon calculator in Wales); information about grid connection like cost and timetable is provided by Ofgem and TSO;
Additional technical issues	Network development, Grid connection and access	Common grid planning in Nordic power system; grid connection time is normally quite short in a range between 2-6 months, but exceptionally it limits the establishment of large wind farms; a joint database (with all known connection RES projects) between major grid owners; all grid companies must produce annual risk and vulnerability analysis and action plan related to the security of energy supply; treat entities equally and so	A grid connection of 800 MW at Sines is reserved for clean coal technology; allocation of grid connections for PV has been frozen in 2005; two ways of obtaining a connection point to the network: Prior Information Applications (3 times/year) or by tenders (no pre-determined period or launch routine); TSO and DSOs present development and investment plans for short and medium term (5 and 10 years), and review them regularly; costs between initially and subsequently connected	Before May 2009, gird connection was done with "invest then connect" approach, and since that date Ofgem has adopted "connect and manage" approach; Ofgem regulates the expenditure of transmission and distribution network operators through five-yearly price controls; Electricity networks strategy group vision 2020 is available in Scotland for grid reinforcement; guaranteed access to gird for electricity produced from all types of generators; no priority in case of grid connection and congestion; rules for sharing costs between initially and subsequently connected producers to distribution network are

		no priority grid connection; guaranteed access to grid, transmission and distribution but no special priority; no priority dispatching; threshold effects; holder of grid concession must provide information about tariff and timetable for processing of applications; same cost of grid connection for any kind of technology and any producer;	producers differ by two categories with certain rules; meetings are held between network operators and promoters before grid connection; priority in grid connection and congestion; guaranteed access to networks and priority dispatching except hydro and cogeneration; RES-E producers do not pay transmission and distribution tariffs	set out in electricity regulations (original connectee will receive a payment from the second comer); Renewable generators are subject to the same charging mechanisms as non-renewable generators by the Transmission and Distribution Networks (smaller generators in Scotland under certain conditions may be entitled to 25% discount on transmission network charges; charging mechanism of distribution network varies depending on the voltage level which generation station is located on); financial compensation is given to RE generators when their generation is restricted by the transmission network; some penalties exists for late DSO connections