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# Transaction Cost Analysis of Feed- in Tariff Schemes

The case of Solar PVs in the UK

**Evdoxia Kouraki**

Supervisors

Luis Mundaca

Brian Cloughley

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Tel: +46 – 46 222 02 00, Fax: +46 – 46 222 02 10, e-mail: iiiee@iiiee.lu.se.

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# Abstract

In order to exploit the renewable energy (RE) and climate mitigation potential, transaction costs (TCs) of implementing RE technologies need to be better understood and eventually scaled down. The objective of this thesis is to identify and analyze the nature of TCs borne by obliged parties under the recent "Feed-in Tariff" (FIT) scheme in the United Kingdom. In addition, the findings are compared with ones from the existing literature in order to examine their consistency and to explain potential divergencies.Taking as a case the small-scale solar PV projects, a number of sources of TCs were identified in the different phases of the life-cycle of the scheme including: i) planning, ii) implementation and iii) monitoring and verification phase. Results show that the most significant souces of TCs costs occur in the implementation and monitoring phases and are related to baseline development, administration and certification and monitoring activities. The actors who endure them are the obliged FIT energy suppliers and the authorities.The analysis also reveals that findings are generally consistent with other studies in the field. However, negotiations were not identified as a major source of TCs as in most of other cases. Standardization of the data collection process and of monitoring activities is suggested as a strategy that could front and potentially reduce TCs. Finally, it is concluded that several endogenous and/or exogenous factors determine the nature of TCs even under FIT schemes and consequently a further analysis which would include an estimation of their scale seem to be necessary.



**Keywords:** Renewable energy; solar PV; feed-in tariffs; transaction costs

# Executive Summary

It is generally argued that one way to tackle the consequences of climate change and to enhance a sustainable energy future is the implementation of cleaner energy solutions (IPCC, 2011). In specific, a transition to more sustainable energy supply systems and the mitigation of climate change can be achieved through the deployment of renewable energy sources (RES). At the same time, it is strongly considered that RES can provide several opportunities for a more sustainable economic development; can facilitate the access to energy and contribute to energy security (ibid). In simply words, it is becoming clear that RES will play a key role in the near future since they appear to be one of the most efficient and effective solutions for the achievement of sustainable development (Dincer, 2000).

In order RES to achieve the abovementioned objectives it is more than necessary to be driven by an effective policy or combination of policies (Mendonça, 2007). Specifically, renewable energy policies are essential for the improvement and maturity of RE technologies (RETs) and can help them to compete with other energy sources (like fossil or nuclear) in the market. In relation to electricity generation, one of the most widely used policy instruments for the diffusion of RETs is the Feed-in Tariff (FIT) scheme. In European countries like Denmark, Germany and Spain, FITS have been applying successfully and drove to a significant increase of RES electricity plants (Klein et al., 2010). In addition, various studies have concluded that FIT schemes are effective and efficient for deploying RE electricity since they provide long-term fixed prices and guarantee the purchase of all the electricity produced (IEA, 2008; IPCC, 2012; Klein et al., 2008; Ernst and Young, 2008).

However, even though the opportunities related to the introduction of RE seem to be great, there are also barriers and issues that slow the RE deployment into modern economies (Arvizu et al., 2011). One of the key barriers for the development of RET and policy instruments promoting RE deployment are Transaction Costs (TCs) (Mitchell et al., 2011). TCs can reduce the performance of RE policy instruments in terms of cost-effectiveness and environmental effectiveness according to Mitchell et al. (2011) and Stavins (1995). The possibilities of biases in policy designs and choices may increase in cases where TCs are not taking into account, while the validity of policy evaluations may decline (McCann et al., 2005; Mundaca et al., 2013).

To date, our knowledge about TCs is fragmented across different disciplines while there is not a comprehensive and complete analysis of TCs related to RE policies (Mundaca et al., 2013). As regards FITs, the number of ex post evaluations that identify and analyze the origin and scale of potential TCs is limited even thought there might be some areas of complexities in such schemes. Therefore, it is obvious that there is need for further research about the nature and measurement of TCs (Macher & Richman, 2008; McCann et al., 2005).

By using the recently implemented FIT scheme in the United Kingdom (UK) and the solar photovoltaic (PV) technology as a case study, the aim of this research is to improve our knowledge about the TCs associated with FITs. The UK FIT scheme was selected for two reasons. The first one is related to the fact that there is little research regarding its performance since the scheme was recently introduced. The second one has to do with the fact that the design of the UK FIT is different and more complex from others in Europe. Moreover, the solar PV technology is selected since it is most deployed as a result of the FIT programme. The main objective of this thesis is to identify the potential sources of TCs resulting during the different life cycle phases of the UK FIT programme and borne by the obliged parties and the authorities. Based on the available results, the study attempts to examine how these TCs affect the performance of the particular scheme. While by comparing the identified sources of TCs with results of similar studies, potential gaps or divergencies are recognized and explained.

For this study data was collected through a variety of sources and methods in order to adequately and objectively address the research questions. Background knowledge about transaction costs and their analysis was collected through literature review of peer-reviewed journal articles, related case studies and books. Whilst, key stakeholders involved were interviewed in order to get insights that could not be obtained by the literature. Supplementary, short interviews with experts in the field of RET policy instruments were conducted in order to confront the findings of the analysis part.

For the data analysis the theoretical basis used was transaction cost analysis (TCA), while an analytical framework developed by L. Mundaca (2007; 2013), which has been tested already twice, was selected in order to identify the sources of TCs throughout the scheme. In particular, based on this life cycle approach, TCs of a scheme can be identified and assessed during three main phases including: a) planning, b) implementation and c) monitoring and verification. In addition, in order to facilitate the identification of potential sources of TCs within the different phases of the scheme a categorization of them was used. According to the taxonomy, there are five main categories of costs: a) due diligence (search for and assessment of information), b) negotiation costs, c) approval and certification costs, d) monitoring and verification (M&V) costs and e) trading costs. Furthermore, the results of the analysis were compared with findings from similar studies in the field of RETs. Purpose of this comparison was to acknowledge similarities and divergencies between similar studies. After that the data of the UK FIT case were exposed to experts by asking them to confirm the results and express their views on the subject.

The analysis reveals that souces of TCs costs occur in all the phases of the scheme, including the planning, the implementation and monitoring. Moreover, TCs are related to baseline development, administration and certification and monitoring activities while; the actors who endure them are the RE generators, the obliged FIT energy suppliers and the authorities such as the Office of gas and electricity markets (Ofgem) and the Department of Energy and Climate Change (DECC). The comparison between the UK FIT findings and those from similar studies in the field shows that there are a number of similarities regarding the nature of the identified TCs. Nevertheless, in the case of the UK FIT scheme negotiation activities are not identified as a major source of TCs as in the other studies. Furthermore, in contrast to other studies, RE generators do not bear high level of TCs under the UK FIT scheme. Experts point out that the most significant TCs occur in the implementation and monitoring phases, while approval and certification costs as well as monitoring costs constitute the most significant sources of TCs. These TCs are borne mainly by the FIT licensees and Ofgem. Furthermore, some of them suggest that the preparation and design of the scheme should be considered as significant sources of TCs too. Strategies like standardization of the data collection process and of monitoring activities are suggested as ways that could front and potentially reduce TCs. However, the nature and the significance of TCs are very likely to differ even under FIT schemes because of a number of endogenous and/or exogenous factors. Therefore it is concluded that no valid generalizations can be made about FIT schemes and that further research remains to be done including a quantitive estimation of TCs under the particular scheme.

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## Abbreviations

| | |
|---|---|
| CFR | Central Feed-in Tarrifs Register |
| CHP | Combined Heat and Power |
| $CO_2$ | Carbon dioxide |
| DEA | Domestic Energy Assessors |
| DECC | Department of Energy and Climate Change |
| DNO | Distribution Network Operator |
| EEG | German Renewable Energy Act |
| ENA | Energy Network Association |
| EPC | Energy Performance Certificate |
| EU | European Union |
| FIT | Feed-in Tariffs |
| FOE | Friends of the Earth |
| GEA | Global Energy Assessment |
| GHG | Greenhouse gas emissions |
| IPCC | Intergovernmental Panel on Climate Change |
| kW | Kilowatt |
| LCT | Low Carbon Technologies |
| MBI | Market-based Instruments |
| MCS | Micro-generation Certification Scheme |
| MID | MCS Installation Database |
| M&V | Monitoring and Verification |
| MPAN | Meter Point Administration Number |
| MW | Megawatt |
| NGO | Non-governmental organization |
| NIE | New Institutional Economics |

| | |
|---|---|
| OFGEM | Office of Gas and Electricity Markets |
| PV | Photovoltaic |
| RAR | Rent-a-Roof |
| RE | Renewable Energy |
| REA | Renewable Energy Association |
| RES | Renewable Energy Sources |
| RET | Renewable Energy Technology |
| RO | Renewable Obligation |
| RPS | Renewable Portofolio Standard |
| TC | Transaction Cost |
| TCA | Transaction Cost Analysis |
| TCE | Transaction Cost Economics |
| UK | United Kingdom |
| UN | United Nations |
| UKBCSE | UK Business Council for Sustainable Energy |

# 1 Introduction

## 1.1 Background to the Research

Climate change is now recognized as one of the most important environmental problems worldwide, negative effects of which are not only relevant in the distant future, but already occuring, affecting billions of people and the whole ecosystem around the globe (OECD, 2011). Global warming, increase in ocean temperatures and ocean acidity as well as increased intensity and frequency of extreme weather events, are recognized as the main components of the ongoing climate change (UNFCCC, 2007). According to the latest report of the Intergovernmental Panel on Climate Change of United Nations (IPCC, 2011), global warming is "unequivocal". Moreover, in the report is expressed a high degree of certainty (over 90%) that anthropogenic activities associated with the release of greenhouse gas (GHG) emissions are responsible for the climate change. Even more alarming is the fact there are detailed projections which show that global warming will not only continue but will accelerate in the coming decades (IPCC 2007; UNFCCC, 2007).

Production and consumption of fossil fuel-based energy sources such as coal, oil and natural gas have proven to be the main contributors of today's high GHG emission levels. Carbon dioxide ($CO_2$) consists one of the main greenhouse gases with a share almost 77% in global emissions in 2004 (IEA, 2012). While, more than half of these emissions were caused by the use of fossil fuels (UNFCCC, 2009). In particular, by the end of 2010 $CO_2$ emissions were almost 40% higher compared to preindustrial levels (IPCC, 2011). Indisputably, it is impossible to keep atmospheric $CO_2$ concentrations at acceptable levels if our economies continue to depend mainly on conventional energy sources (Herzog et al., 2001). At the same time, the availability of these conventional energy sources diminishes since the reserves of fossil-fuels are limited and nonrenewable (Meadows et al., 2004).

According to the Global Energy Assessment (GEA 2012), developed countries need to reduce their GHG emissions by 60%- 80% below 1990-levels in order to achieve the 50% reduction in global emissions by the year 2050. It is generally argued that one way to tackle the consequences of climate change and to enhance a sustainable energy future is the implementation of cleaner energy solutions (IPCC, 2011). In specific, a transition to more sustainable energy supply systems and the mitigation of climate change can be achieved through the deployment of renewable energy sources (RES) (IPCC, 2011). RES are non-fossil energy sources such as wind, solar, geothermal, hydro, wave and tidal power as well as biomass and biogas (EU Directive 2001/77/EC). One of the main advantages of RE technologies is their low $CO_2$ emissions into the atmosphere compared with those from fossil fuels (IPCC, 2011). In addition, it is argued that RES can meet many times the world's energy demand since their theoretical potential is massive (ibid). According to the Special Report on Renewable Energy Sources and Climate Change Mitigation of IPCC (2011), **"**RE may provide a number of opportunities and can not only address climate change mitigation but may also address sustainable and equitable economic development, energy access, secure energy supply and local environmental and health impacts". Therefore, it is becoming clear that RES will play a key role in the near future since they appear to be one of the most efficient and effective solutions for the achievement of sustainable development (Dincer, 2000).

In order RE to achieve the objectives mentioned before it is more than necessary to be driven by an effective policy or combination of policies (Mendonça, 2007). Specifically, renewable energy policies are essential for the improvement and maturity of RE technologies (RETs) and can help them to compete with other energy sources (like fossil or nuclear) in the market (Dijk et al., 2003). Today, there is a wide range of policy instruments that can be implemented for the promotion of

RE in the energy systems (Langniss, 2003). Being one of the main contributors of the global GHG emissions, Europe in 2007 decided to adopt a new integrated plan called "the 20-20-20 targets" and committed to become a low-carbon economy. One of the main targets was to obtain 20% of the total EU energy consumption from renewable resources by 2020[1] (Europe 2020). In order to achieve this target, all the member countries had to develop national renewable energy action plans according to the EU RES Directive 2009/28/EC (Klein et al., 2010). In simply terms, all the EU member states introduced a number of policy instruments in order to encourage the deployment of RETs and favor the production of energy by renewable sources.

As regards the promotion of electricity production from RES, most countries of Europe have implemented Market-based instruments (MBI) in combination with "Command and Control" regulatory instruments (i.e. restrictions, penalties, fees etc.). MBI are also known as economic instruments or price-based instruments and receive increased attention in a number of countries the recent years (Huber et al., 1999). MBI are broadly defined as "regulations that encourage behavior through market signals rather than through explicit directives" in order to achieve specific environmental targets (ibid; Stavins, 2001).

As mentioned before, the opportunities related to the introduction of RE seem to be great however there are also barriers and issues that slow the RE deployment into modern economies (Arvizu et al., 2011). According to the latest IPCC report on RE, the major barriers for RE development and implementation can be categorized as market failures and economic, information and awareness, socio-cultural and institutional or policy ones (Moomaw et al., 2011). Specifically, market failures in the case of RE deployment result because environmental impacts and risks of conventional energy use are not fully internalized in the total costs (ibid). For instance, the negative impacts resulting from fossil fuel combustion are not included into the price of the electricity that they produce. In addition, due to immaturity of some RET, high RE system capital costs and uncertainty in future electricity prices some financial risks and economic barriers may appear for the potential investors. The fact that there is limited public and institutional awareness about the technical and economic issues of implementating RE projects is also considered a barrier (ibid). Frequently, the costs associated with the shifting from fossil fuels to RE sources are overestimated and this hinders the development of RE projects. Moreover, the fact that in many cases the knowledge or experience of RE policies is not the appropriate one constitutes an obstruction to the RE goal. Existing socio-cultural norms may also slow down the perception and acceptance of RE from the public (Arvizu et al., 2011). Besides this, there are institutional and policy barriers since the current energy market regulations are designed based on monopoly powers and promote large and centralized energy systems (ibid). Finally, the report addresses Transaction costs (TCs) as one of the key barriers for the development of RET and policy instruments promoting RE deployment (Mitchell et al., 2011). Even though RE projects are typically smaller compared to conventional fossil or nuclear projects, the TCs are unequally higher. Feasibility pre-studies and due diligence work is necessary for every investment, however the costs of these actions do not vary considerably with project size. Consequently, pre-investment costs like legal or engineering costs, consultants hiring etc. do have a proportionately bigger effect on the TCs related to RE projects. Due to lack of or insufficient information in RE markets, the RET project risks tend to be overrated while TCs can be higher than those related with fossil fuel technologies (ibid). Overall, is important to stress the fact that usually most of the barriers mentioned above are interrelated and hence, it is difficult to pick out only one of them for any RE project case.

[1] The other two aims of the EU "20-20-20" initiative are the reduction of GHG emissions by 20% and the improvement of energy efficiency by 20% by the year 2020.

## 1.2 Problem Definition

In general, the economic theory indicates the importance of TCs and the fact that they inhibit efficient exchanges in the markets (Dudek & Wiener, 1996). Specifically, as mentioned in the latest IPCC Special Report on RE (2011), one of the key deterrents for the development of RE projects is the existence of TCs. While according to Lof (2009) and Miller (2008), small scale low carbon technologies like RET are usually exposed to high TCs.

In relation to power generation, various studies have concluded that Feed-in Tariff (FIT) schemes are effective and efficient for deploying RE electricity since they provide long-term fixed prices, guarantee the purchase of all the electricity produced and are simpler than other RE policies (Dijk et al., 2003; IEA, 2008; IPCC, 2011; Klein et al., 2008). A FIT scheme can be defined as an economic instrument used to promote investments in small-scale RE projects by offering long-term purchase agreements for the sale of RE electricity (Cory et al., 2009). The major objective of this policy instrument is to generate an attractive and stable investment environment, in order to form markets, reduce costs, promote technological innovation and therefore to help each country to gradually transform into a low emission economy (Mendonça, 2011). According to IPCC (2011), the role of fiscal incentive policies like FITs are really significant for the spread of decentralized production of RE and the deployment of RETs since they create an "enabling environment". In the same report is mentioned that even though the FIT scheme is considered an effective renewable energy policy it might sometimes be necessary to be combined with other policies to be more effective and efficient (IPCC, 2011). More details about FITs and their design are presented in Section 3.1.

For Europe FIT schemes have been considered to be the main contributor to the success of RE markets in Germany, Denmark and Spain (Cory et al., 2009; Dijk et al., 2003; Klein et al., 2010). In addition, in 2009 the Department of Energy and Climate Change of UK realized that increasing the use of renewable energy will enable the country to recover some of its energy self-sufficiency and will create many economic and employment opportunities. As a result, a target that 1.6% of the UK electricity consumption will be delivered from small-scale RES by 2020 was set and the use of FITs for this purpose was decided (DECC, 2010; Walker 2012). Furthermore, the reviewed literature underlines that there is a number of ex ante and ex post evaluation studies that assess the performance of FIT schemes and the new markets that they create. The importance of such studies is high since they can reflect potential opportunities and challenges of FIT schemes and contribute to their improvement. According to Dudek and Wiener (1996), TCs are usually an afterthought to market transactions while in the case of environmental policies they are very rarely considered. Until today most evaluation studies do not analyze in detail the TCs for FIT schemes (Mundaca et al., 2013). Notably, it is argued that the majority of FIT assessments do not take into account the existence of potential transaction costs due to their simplicity compared to other renewable energy policies (ibid). Example consist the case of the UK FIT scheme where a comprehensive review was carried out after the first year of its introduction in 2011 without addressing TCs at all (DECC, 2011). In other words, such evaluations often assume that there are no costs (other than investment and direct project costs) during the implementation of renewable energy technologies and consequently their effects on FIT and its policy performance are not addressed (IPCC, 2007). As a consequence, the results of such assessments may undervalue the total costs associated with the particular policy instrument and deliver a misleading result. Therefore, in order to improve the evaluation of RE policies studies that provide a consistent analysis of the nature and scale of TCs is more than necessary (Mundaca et al., 2013).

According to empirical studies, the existence of TCs can have a negative impact on the performance of energy policies (Dudek & Wiener, 1996). In this way, TCs can reduce not only the economic efficiency and cost-effectiveness of a policy instrument but also its environmental effectiveness (Mitchell et al., 2011; Mundaca et al., 2013; Stavins, 1995). According to Kesicki and Strachan (2011) and Worrell et al. (2004) TCs should be estimated in order to determine if particular GHG emission reductions are cost-effective or not. At the same time, OECD (2002) proposes that further research must be undertaken regarding the different forms of TCs since their impacts are unknown. To date, our knowledge about TCs is fragmented across different disciplines while there is not a comprehensive and complete analysis of TCs related to RE policies (Mundaca et al., 2013). Additionally, there is limited literature on the quantification of TCs associated with policies that promote RE technologies (GEA, 2012; IPCC, 2007). In particular, a study in which the nature and scale of TCs of RE were addressed was the one of Skytte et al. (2003) in which the challenges for renewable electricity investments in the EU market were presented. The authors of this study tried to identify the nature of TCs related to planning, implementation and production phases of a RE project. In addition, Battjes et al. (2000) identified the sources of TCs under the Tradable Green Certificate scheme in the Netherlands and tried to estimate their scale. Finon and Perez (2007) also addressed TCs of RET by comparing and assessing Renewable Energy Sources in Electricity (RES-E) price- and quantity- policy instruments from a TC perspective.

In the case of FITs, the number of ex post evaluations that identify and analyze the origin and scale of potential TCs is also limited even thought there might be some areas of complexities in such schemes. Specifically, during the literature review only one study on TCs about FITs was identified which was conducted by Ole Langniss in 2003. An explanation to this might be the fact that TCs are widely thought to be low for FITs compared to other RE policies. In his study, Langniss (2003) identified the nature and estimated the scale of TCs related to the FIT scheme in Germany and compared them with those of the Renewable Portofolio Standard (RPS) in Texas. Nevertheless, he examined only the TCs associated with the activities during the implementation of the schemes and only from the perspective of the energy suppliers.

Consequently, it becomes clear that there are knowledge gaps regarding the nature and estimation of TCs related to RE policy instruments which are necessary to fill in (Macher & Richman, 2008; McCann et al., 2005; Mundaca et al., 2013). Moreover, in order to exploit the renewable energy potential, TCs of implementing RETs and concepts like FITs need to be better understood and eventually reduced.

## 1.3 Research Objective and Question

The present thesis constitutes a response to the scholars' calls regarding more research on TCs and their effects on RE policies like FITs (Macher & Richman, 2008; McCann et al., 2005; Mundaca et al., 2013). By using the United Kingdom (UK) as a case (details in Section 3), the aim of this research is to improve our knowledge about the TCs associated with FITs. Therefore, the main objective of this thesis is to identify the potential sources of TCs resulting during the different life cycle phases of the FIT programme and borne by the obliged parties and the authorities in the UK. Based on the available results, the study attempts to examine how these TCs affect the performance of the particular scheme. While by comparing the identified sources of TCs with results of similar studies, potential gaps or divergencies are recognized and explained. To this end, the following research questions are designed in order to guide the research.

1. What are the main sources of TCs of the FIT scheme in the UK? In which phases of the scheme's "life-cycle" most of these costs do occur and which actors bear them?
2. How do these TCs affect the development and implementation of RETs and thus the performance of the FIT scheme in the UK?
3. How do the identified sources of TCs compared to the ones from the existing literature? Is there consistency? What can explain the gaps or divergencies?

By accomplishing the abovementioned objectives, this study aims to contribute with knowledge that can potentially be used by policy makers to reduce TCs and improve the performance of the scheme.

## 1.4 Scope and Limitations

In order to explore TCs and provide empirical evidence of the nature of TCs, case study methodology was applied in this study. From the *geographical* point of view, the analysis focuses on the FIT scheme in the UK. The scheme was introduced just in 2010 in order to support the deployment of small-scale renewable. Until 2010, the major renewable support scheme of UK was the Renewable Obligation (RO). As a result, there is little research regarding the performance of the FIT programme in UK. In addition, the UK-style FIT is different from others in Europe. For instance, the tariffs are split into generation and export ones while in the German system there is only the generation tariff. Taking into consideration the abovementioned, it seemed that the UK is an interesting case study for exploring FITs in regards to TCs.

From the *technological* point of view, the thesis focuses on the case of solar photovoltaics (PV). The RET covered by the UK FIT scheme are five in total (solar PV up to a maximum total installed capacity of 5MW, wind up to 5MW, hydro up to 5MW, anaerobic digestion up to 5MW and micro Combined Heat and Power (CHP) up to 2kW (DECC, 2012). However, according to FIT Installations Statistical Reports published by the Office of Gas and Electricity Markets (Ofgem) solar PVs seem to have by far the highest installation levels since the FIT programme was introduced. In other words, it can be argued that the UK FIT has primarily incentivized the small-scale solar PV projects so far. Therefore, the scope of this study is narrowed to the technology that is most deployed as a result of the FIT, the solar PVs.

## 1.5 Targeted Audience

This thesis is targeted towards energy researchers, policy-makers, RE companies and suppliers, RE associations, consultants and any other stakeholders that are directly involved or interested in the UK FIT scheme. In addition, the targeted audience of this paper includes the Department of Energy and Climate Change (DECC) of UK and the Ofgem since the focus is on the UK FIT scheme. In general, the thesis is addressed to anyone who is interested in RE policies and TCs.

## 1.6 Structure of the Thesis

The thesis is structured as follows.

Chapter 2 provides the analytical framework used within the research. In particular, is provided information regarding the New Institutional Economics and the Transaction Cost Analysis while the methods of data collection and analysis are presented.

Chapter 3 describes the case of the UK FIT scheme. In specific, the background of the policy is presented as well as its design and implementation. A brief description of the scheme's early performance is also provided.

Chapter 4 highlights the research findings. The nature of TCs during the different phases of the FIT's life-cycle is presented. In addition, a comparison and critical review between the sources of TCs found within the UK FIT scheme and the ones identified by similar studies is provided. Expert views on the subject are also confronting the results of the analysis.

Finally, in Chapter 5 conclusions are drawn while suggestions for future research are given.

# 2 Analytical Framework and Methodology

## 2.1 New Institutional Economics and Transaction Cost Analysis

The New Institutional Economics (NIE) is described as "a new school of thought" that attempts to incorporate a theory of institutions into economics (North, 1990). Albeit often attributed to Coase - and his article "The Nature of the Firm" (1937), institutional economics were initiated by John R. Commons and the German Historical School (Thorstein Veblen). Commons (1934) established the transaction as being the basic unit of analysis to study economic organisation, which led to the development of the TCs analysis and became the main focus of the NIE School of economics. Other leading representatives of NIE are Douglass North (1990) and Oliver Williamson (1975) who introduced the term of NIE in 1975. The NIE focuses on how decisions and transactions made by market agents are frequently based on imperfect information, and also on how institutional frameworks influence the behaviour of these agents (Ménard, 2004). The role of institutions in regulating exchanges is central to both Williamson (1981) and North (1990) approaches to TC analysis, but at different levels. Williamson (1979) considers that the role of institutions and their arrangement is to minimise TCs, while North (1990) points out the existence of inefficient institutions.

The primary language of NIE is economics; however, it is an interdisciplinary movement that combines sciences such as political science, law, sociology and anthropology in order to better understand institutions and their impacts over time (Klein 1999; North 1993; Richter 2005). It is commonly said that NIE strives to broaden the spectrum of neoclassical theory rather than to replace it (Furobotn & Richter, 1991; Ménard & Shirley, 2005; Rutherford, 2001).

One of the fundamental elements of the NIE paradigm[2] is transaction cost analysis (TCA) which examines activities in the economic system, such as how they are formulated and executed, and their impacts on the performance of the projects and/or actors involved through transactions with involved market agents (Commons, 1931). The indicated transactions are frequently based on imperfect and asymmetric information, bounded rationality and lack of monitoring (Ménard, 2004; Mundaca et al., 2013; North 1990; Selten, 1990). According to Langniss (2003), by introducing TCA the scholars of the NIE seek to address problems related to incomplete information. In addition, transaction cost economics which constitutes the academic base of TCA focuses on the sources and the scale of TCs in order to identify policies to limit the existence of TCs and their magnitude (Mundaca & Neij, 2006).

A significant theoretical challenge in TCA is the fact that studies need to look at different constractual aspects of transactions (Ménard, 2004; Williamson, 1979). In specific, Coase (1937) limits his focus only on 'pre-contractual' activities such as search for information and inspection, while Williamson (1979) underlines the significance of post-contractual activities (e.g. operation, control and enforcement). On the other hand, Matthews (1986) and Furubotn and Richter (2010) have a more inclusive perspective since they take into account both of the abovementioned activities as well as the drafting of the contract (Mundaca et al., 2013). In addition, there are also different perspectives on how TCs are defined. The most general definition of TCs is the one of Arrow (1969). According to the economist, TCs are defined as "the running costs of an economic system". A more precise definition is given from Ostertag (1999) who states that TCs are

[2]Since 1970s, the NIE include the following core fields: Transaction cost economics, Property right economics, Economic contract theory and New institutional approach to history (Richter, 2005).

unmeasured, hidden costs not directly involved in the production of goods or services. According to Ostertag (1999), potential source of TCs could be considered the time devoted to identify a particular product on the market. Nevertheless, he argues that activities such as monitoring and maintenance should be considered production costs of a low carbon technology (LCT) and not a potential source of TCs. On the other hand, Matthews (1986) gives a different definition. He defines TCs as "…the costs of arranging a contract *ex ante* and monitoring and enforcing it *ex post*, as opposed to production cost". Based on this definition, Mundaca (2007) thinks that TCs can be defined as a subgroup of hidden costs and not as part of the actual investment and administrative costs. Langniss (2003) encloses costs derived from activities related to implementation of a RE mechanism into his definition of TCs. Other authors, such as Skytte et al. (2003) define TCs as costs occurring during the planning, implementation and monitoring phases of a project. Moreover, Skytte et al. (2003) define the TCs that emerge during the implementation phase as opportunity costs (e.g. lost time and resources). In the definition of TCs provided by reports on the Kyoto Protocol, pre-implementation, implementation and production phases of a RE project are included (Del Río, 2007; Michaelowa et al., 2003).

## 2.2 Transaction Costs and Renewable Energy Technologies

At the same time based on the different conceptual definitions of TCs mentioned above, evaluation studies that focus on TCs associated with LCTs like RETs carried out. Each of these studies examines the sources and /or the level of TCs under a specific RET scheme. For instance, in their study Skytte et al. (2003) examined the sources of TCs and tried to estimate their level under the RE investments in the EU market. Particularly, as sources of TCs were identified search and pre-feasibility studies, negotiation costs, approval and administrative costs as well as monitoring, enforcement and adjustment costs. Langniss (2003) identified the nature and tried to estimate the scale of direct TCs related to the FIT scheme in Germany and the Renewable Portofolio Standard in Texas and focused mainly on the perspective of the RE generators and the obligated purchasers. Activities like search for information, negotiations, application for certificates, calculation of obligated amounts, metering, auditing and reporting were some of the identified sources of TCs. Indirect TCs or governance costs were not included into his study. In addition, Finon and Perez (2007) addressed the sources of TCs related to RETs by comparing price- (like FITs) and quantity- (like RES-E quotas) policy instruments from a TCE perspective. Battjes et al. (2000) studied the case of the Tradable Green Certificate scheme in the Netherlands and provided estimates of their scale. In this case, TCs were identified as costs undertaken by obligated actors in addition to costs of meeting the obligation itself. Moreover, Kåberger et al. (2004) identified TCs related to administrative activities under the Tradable Green Certificate scheme in Sweden. Another study in which TCs related to RETs were addressed is the one carried by Ram and Selvaraj (2012). In the study TCs were referred as one of the key barriers to the development of RE projects n India. Finally, Nagaoka (2002) examined the case of sugar canes for electricity production in Brazil and found out that a main source of TCs was contract negotiation costs. All the above studies and their results regarding the sources of TCs are used to compare the findings of the UK FIT scheme in Section 4.2.

As regards the methods of data collection (Section 2.3) in the case of the UK FIT scheme, they were based on the theoretical basis of TCA as mentioned in the NIE. The selection of the methods for data analysis (Section 2.4) was based on the definition of TCs given by Matthews (1986) and Furubotn and Richter (2010). The particular definition can be described more holistic compared to other definitions of TCs since it includes ex-ante (i.e planning, preparation), implementation and ex-post costs (i.e monitoring, verification) related to a project. For that reason appeared to be the most appropriate definition in the case of the UK FIT scheme. More details regarding the employed methods of data collection and analysis are provided in the following subsections.

## 2.3 Methods for Data Collection

For this study data was collected through a variety of sources and methods in order to adequately and objectively address the research questions. Background knowledge about transaction costs and their analysis was collected through literature review of peer- reviewed journal articles, related case studies and books.

Literature analysis was also used for data collection regarding the UK FIT scheme. In specific, information about its design and implementation as well as its performance was retrieved from primary government documents and official reports. The UK Government makes many of its past and recent documents available at its ofgem.gov.uk website.

In addition, key stakeholders involved in the UK FIT scheme were interviewed in order to get insights that could not be obtained by the literature. This included the Office of Gas and Electricity Markets (OFGEM), Energy Network Association (ENA), Northern Powergrid Holdings Company and involved energy academic researchers (see list of interviewees after bibliography). The interviews were semi-structured and conducted by phone or through Skype. In cases of time constraints the interviewees corresponded to the questions through email. Main objectives of these interviews were to get a better overview of the FIT scheme and to identify the potential sources of TCs. Supplementary, short interviews with three experts in the field of RET policy instruments were conducted in order to ask their opinion about the identified sources of TCs under the UK FIT scheme and to confront the findings of the analysis part (see interview protocol in Annex A).

## 2.4 Methods for Data Analysis

In general terms, the theoretical basis used for the analysis of the data collected was transaction cost analysis (TCA). However, because of conceptual differences regarding TCs there is no clear method in order to identify sources of TCs. Therefore, an analytical framework developed by L. Mundaca (2007; 2013), which has been tested already twice, was selected in order to identify the sources of TCs under the FIT scheme in the UK. This analytical framework was developed for the analysis of TCs under the Tradable White Certificate schemes (TWC) and applied for the case of Energy Efficiency Commitment in Great Britain. The analytical framework is based on the life cycle approach of any programme that promotes LCTs. In particular, according to a life cycle approach TCs of a scheme can be identified and assessed through its main phases which (most of the times) are the following: a) planning, b) implementation, c) monitoring and verification and d) trading. Taking into consideration that the FIT scheme is a policy instrument that promotes the diffusion of LCTs, the selection of this particular analytical approach seemed to be a suitable one. Of course the phases of the life cycle model had to be modified since the FIT scheme differs from other energy policy instruments that promote LCTs. In particular, the trading phase excluded since activities related to trade do not take place during the UK FIT scheme. In Figure 2-1 are presented the phases based on which the analysis of TCs related to the UK FIT scheme was conducted.

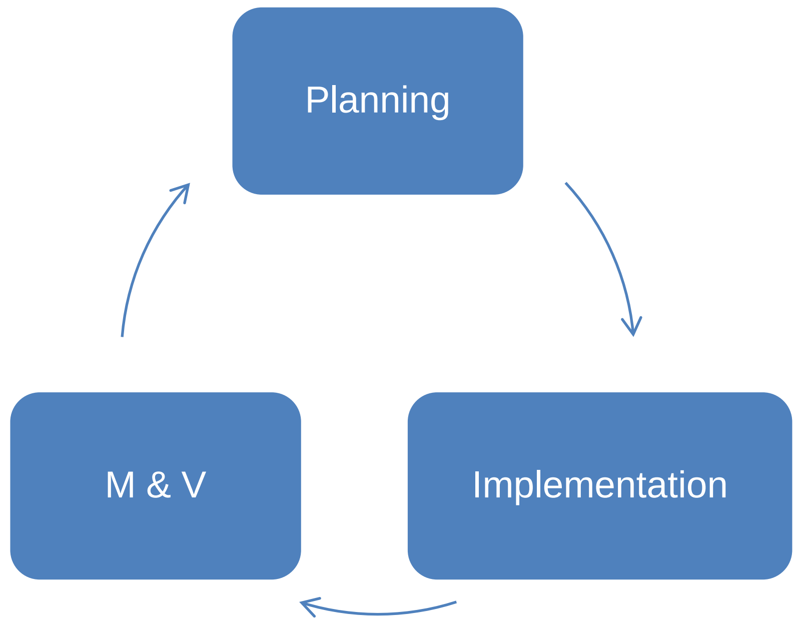


*Figure 2-1 Life cycle of FIT Scheme*
*Source: Based on the framewotk of Mundaca et al. (2013)*

Additionally, in order to facilitate the identification of potential sources of TCs within the different phases of the scheme a categorization of TCs seemed to be necessary. As mentioned before, for the case of FITs in UK was decided to be employed the most inclusive definition of TCs given by Matthews (1986). Therefore, the selected taxonomy of TCs should be built on the approach of Matthews. The taxonomy being selected was the one developed by Mundaca, Mansoz, Neij and Timilsina (2013). The particular taxonomy of TCs was not only developed based on the conceptual approach of Matthews (1986) but also is applicable for policies that promote LCTs including RETs. According to the taxonomy, there are five main categories of costs: a) due diligence (search for and assessment of information), b) negotiation costs, c) approval and certification costs, d) monitoring and verification (M&V) costs and e) trading costs (see Table 2-1). At this point, it is necessary to mention that the type of trading costs is not applicable in the case of the UK FIT scheme since there trading activities do not take place under the scheme. Mundaca et al. (2013) acknowledge that in some cases the categorization of TCs based on the project life cycle might be difficult. This is due the fact that sometimes a type of costs may be found in all phases of the life cycle of the project (e.g. due diligence, search for information). Nevertheless, the particular classification was developed in order to better clarify the typology and scale of TCs of RETs like the UK FIT scheme.

Supplementary, the results of the analysis were compared with findings from similar studies in the field of RETs. Purpose of this comparison was to acknowledge similarities and divergencies between similar studies. After that the data of the UK FIT case were exposed to experts by asking them to confirm the results and express their views on the subject. The analysis of data is presented in Section 4.

*Table 2-1 A categorization of TCs that are applicable to LCTs*

| Cost Category | Type of Costs |
|---|---|
| **Due Diligence Costs** | Costs associated with information collection and research of a LCT and its policy, financial, technical and legal aspects. |
| **Negotiation Costs** | Costs for coming to an agreement such as time spent negotiating, subcontracting of consultants' fees, bargaining costs etc. |
| **Approval and Certification Costs** | Costs generated in cases where the transaction must be approved by a government agency before its operation (e.g. public bureaucracy costs) |
| **Monitoring and Verification (M&V) Costs** | Costs that arise when there is need to develop and implement an enforcement strategy in case of no-compliance (e.g. metering costs, energy audits etc.) |
| **Trading Costs** | Costs generated in cases where there is a trade of certificates or quotas (e.g. fees paid to brokers for performing the trading of certificates) |

*Source: Based on information from Mundaca et al. (2013)*

# 3 Case Study – FIT in the UK

## 3.1 Policy Background

The feed-in tariff is defined as a guaranteed price policy which usually considered one of the most effective policy mechanisms for accelerating the deployment of renewable energy (Mendonça, 2007). In the literature, FITs are also called renewable energy payments or standard offer contracts. The basic principle of this renewable energy policy is that any RE electricity generator can sell its electricity at a fixed price for a long-term period under particular terms depending on technology type and size, location etc. (Fouquet & Johansson, 2008). The first time that a FIT scheme implemented was in the United States (California) in the early 1980s (Gipe, 2010). Since 1980s, the FIT scheme is widely used all over the world and principally in Denmark, Germany and Spain where it has been applying successfully and drove to a significant increase of RES electricity plants (Cory et al., 2009; Klein et al., 2010). According to o UNEP (2012), more than 65 countries and 27 states in the world were implementing FIT policies by 2012. More specifically, FITs have driven 64% of the global wind and 87% of solar PV capacity from 1990 until 2012 (UNEP, 2012). From 2002 the UK's main support scheme for renewable electricity projects was Renewables Obligation (RO). Under the RO licensed electricity suppliers were required to source a specified proportion of electricity to their customers from renewable sources (Ofgem, 2013).[3] The particular scheme proved to be intended only for professionals in the energy sector and complex for households or small businesses (Toke, 2007).

A campaign that promoted the FIT scheme as a more effective policy for the deployment of small-scale renewable compared to the existing ones started by Dr. David Toke, in 2007. Significant role to the spreading of the campaign played the Renewable Energy Association (REA) and Friends of the Earth (FOE) with their unofficial support (D. Toke, personal communication, 8 July 2013). During the campaigning of the scheme a number of events and speeches were carried out while plenty of articles were written. For instance, a book about FITs with the title *"Feed-in Tariffs – Accelerating the deployment of renewable energy"* was published by Mendonça (2007) and was sent to ministers, NGOs and other interested parties in UK. As a result of that campaign, the UK government started a discussion on reforming the RO scheme and introducing a FIT scheme for small-scale renewable energy generation. In 2008, a new department called the Department of Energy and Climate Change (DECC) was launched by the government. While few days after its launch, the introduction of a FIT for small-scale RE (with generation capacity up to 5MW) was announced in the Energy Act report (Energy Act 2008, chapter 32). According to the Energy Act 2008, the FIT was decided to start being implemented from April 1st 2010.

As mentioned above, in 2008 the UK government produced for the first time a comprehensive low carbon transition plan for the country. This plan determined the road map that should be followed for the national transition from 2008 until 2020. According to the plan, the EU committed at the UN Conference in Copenhagen (2009) to reduce its GHG emissions to 20% below 1990 levels by the year 2020. As an EU country the UK had to contribute to the achievement of this target. Thus, the government put in place the target to cut the UK emissions to 18% below 2008 levels and over one third (34%) below 1990 levels by 2020 (DECC, 2009a). Specifically, with the composition of this plan "carbon budgets" were allocated to all the major UK government departments.

[3] This proportion (known as obligation) is increasing and set every year by the Ofgem.
Further information about the RO scheme can be found at Ofgem's website:
http://www.ofgem.gov.uk/Sustainability/Environment/RenewablObl/Pages/RenewablObl.aspx

In parallel with this transition plan was published the UK Renewable Energy Strategy document with more detailed plans about renewables. In the document it states:

> "To meet the challenge of climate change, we need to save carbon in every sector of the economy – this will mean a rapid transition to renewable energy. This Strategy shows how we can reach our goal of 15% of energy from renewables by 2020 almost a seven-fold increase in the share of renewables in scarcely more than a decade" (DECC, 2009b).

Besides this, in the UK Renewable Energy Strategy the target of 30% of electricity from RES by 2020 was set (DECC, 2009b). Within this target there is an aspiration that 6TWh or 1.6% of the UK electricity consumption will be delivered from small-scale (non – RO) RES by 2020 (DECC, 2010; Walker 2012). Emphasis is also given on the fact that the abovementioned target should be met in a cost effective and sustainable way. Furthermore, in the document it is mentioned that increasing the use of renewable energy will enable the UK to recover some of its energy self-sufficiency and will create many economic and employment opportunities. Moreover, it is stated that experience with existing policy measures (such as RO) suggests that there was a need for a simpler and more accessible systems, which the public can engage with. Therefore, part of this strategy was the introduction of the right incentives for households, businesses and communities to promote small-scale clean electricity generation. According to DECC (2009b), the simplicity and income certainty of a FIT scheme seemed to be the most appropriate tool for the support of distributed renewable energy as well as for the encouragement of those outside the energy business to take up renewable generation. Specifically, in the strategy is mentioned: "FITs will support micro- and small-scale renewable electricity projects, where generation takes place either on-site or locally … through this 'clean energy cash-back' scheme we will, for the first time, provide support for distributed renewable energy that is comprehensive and long-term" (ibid). As regards the expected outcomes of the scheme, the government's consultation report mentioned that: "It is expected that by 2020 the scheme will support over 750,000 small scale low carbon electricity installations and will have saved 7 million tonnes of carbon dioxide". Moreover, according to the first FITs comprehensive review in 2011 the specific scheme is also designed to contribute to other low carbon goals. In specific, the scheme aims to:

- involve people directly in the transition to a low-carbon economy and bring climate and energy issues in everyday life;
- contribute to the development of a supply chain that will give the opportunity to households through cost effective measures to reduce their energy use and emissions; and
- facilitate the adoption of carbon reduction measures, especially those related with the energy efficiency improvement of buildings (DECC, 2011)

This first comprehensive review about FITs for solar PV (DECC, 2011) published 18 months after the introduction of the scheme and did not refer TCs or to potential sources of TCs. The findings of the review had to do with the successful deployment of the scheme and in particular for solar PV installations. Moreover, the review addressed the fact that installation costs for solar PV systems had fallen dramatically since the start of the programme and that the returns to new PV generators were higher than the intended. Therefore, it was proposed a reduction to the generation tariffs for solar PV installations, an introduction of energy efficiency requirement for getting the standard rate for solar PV as well as the introduction of multi-installation tariff rates for aggregated solar PV schemes. All these policy modifications were applied to the new solar PV installations with eligibility date on or after 1April 2012 (DECC, 2011). In 2012, the second comprehensive review of the FIT scheme was published which addressed non-PV technologies and scheme administration issues (DECC, 2012). In this document suggestions for the improvement of data collection were asked in order to become more cost-effective. That was the only case where TCs were mentioned indirectly in a review.

## 3.2 Design and Implementation

In general terms, the UK FIT scheme is designed to offer long-term guarantee of payments to RE developers for the electricity they generate and to accelerate the deployment of small-scale low carbon electricity generation technologies of a capacity size up to 5MW located in England, Wales and Scotland (Ofgem, 2011). For the deployment of large-scale projects (more than 5MW) the RO programme continues to be implemented according to the DECC (2009a).

### 3.2.1 How the Scheme Works

Since the scope of this study is limited to the solar PVs which is the most deployed because of the FITs (Mendonça, 2011), a quotation of an example about the FIT process at this point might be helpful. If a customer wants to install a small-scale PV (up to 5MW), the first thing he should do is to contact a Micro-generation Certification Scheme (MCS) - accredited installation company. The company will undertake the necessary actions and discuss technical and financial issues with the customer in order to find out the best system option. After that, an appropriate system is agreed, installed and connected to the electricity grid. The customer registers the installation to the MCS Installation Database (MID) and gets a certificate with a unique number confirming MCS compliance. After that, this certificate should be sent to a FIT licensed electricity supplier if the electricity generator wants to get FIT payments. In addition, if the PV installation is attached or wired to provide power to a near building, the installer is obligated to provide an Energy Performance Certificate (EPC) which has been issued no more than 10 years before with a rating between A and D in order to meet the eligibility requirements. In cases where the EPC rating is below level D than the generator will receive a set lower tariff rate which will remain for the duration of the contract even if the EPC rating is improved afterwards. After gathering the necessary certificates mentioned above and other documents (like an initial meter reading), the RE generator sends an application for FIT payments to a licensed electricity supplier (usually is called FIT licensee). The date when the FIT licensee receives a complete application from the RE generator is called eligibility date. This date determines from when a generator is eligible to receive FIT payments for the electricity produced. If the installation is up to 50kW then the FIT licensee checks if the generator is eligible for the FITs scheme and registers the installation to the Ofgem's Central FIT Register. In case where the installation is over 50kW, the generator registers the installation with the Ofgem. After the completion of the registration, a contract between the FIT licensee and the RE generator is signed up. In order to get the FIT payents, the RE generator has to submit his meter reads every quarter to the FIT licensee. The FIT licensee pays the generator a generation tariff for all the electricity produced and, where applicable, an export tariff for the surplus electricity exported back to the national grid. For installations with capacity less than 30kW, the exported electricity is deemed at 50% f generation. The FIT payments are offered by the electricity suppliers usually on a quarterly basis and the tariff period is 20 years. [1] The FIT payments change over time depending on the deployment levels of the eligible technologies. In particular, the degression mechanism for new solar PV installations takes place on a quarterly basis while the degression rate can vary between 3.5% and 28% per quarter (Ofgem, 2013c).In addition to the received generation and export payments[4], the generator also beneFiTs by reducing his energy bills. Electricity produced by the solar panels will feed directly into the generator's house; hence imported electricity from the grid will be decreased. Lastly, all the FIT licensees are required to submit sales and payment data to Ofgem every quarter. By doing so helps Ofgem to administer

[4] Household generators do not pay Income Tax on the generation and/or the export tariffs they receive since they use the RET to produce electricity mainly for their own.

better the scheme, to calculate and make/receive the appropriate levelisation payments to/from every FIT licensee. The levelisation process takes place every quarter and in the end of every FIT year. If the amount of the FIT licensee's market share contribution exceeds his FIT contribution then he is required to make a levelisation payment to Ofgem's Levelisation Fund. In the opposite situation, the FIT licensee will receive a levelisation payment from Ofgem. An illustration of the FIT scheme operation is given in Figure 3-1 (Ofgem, 2010).

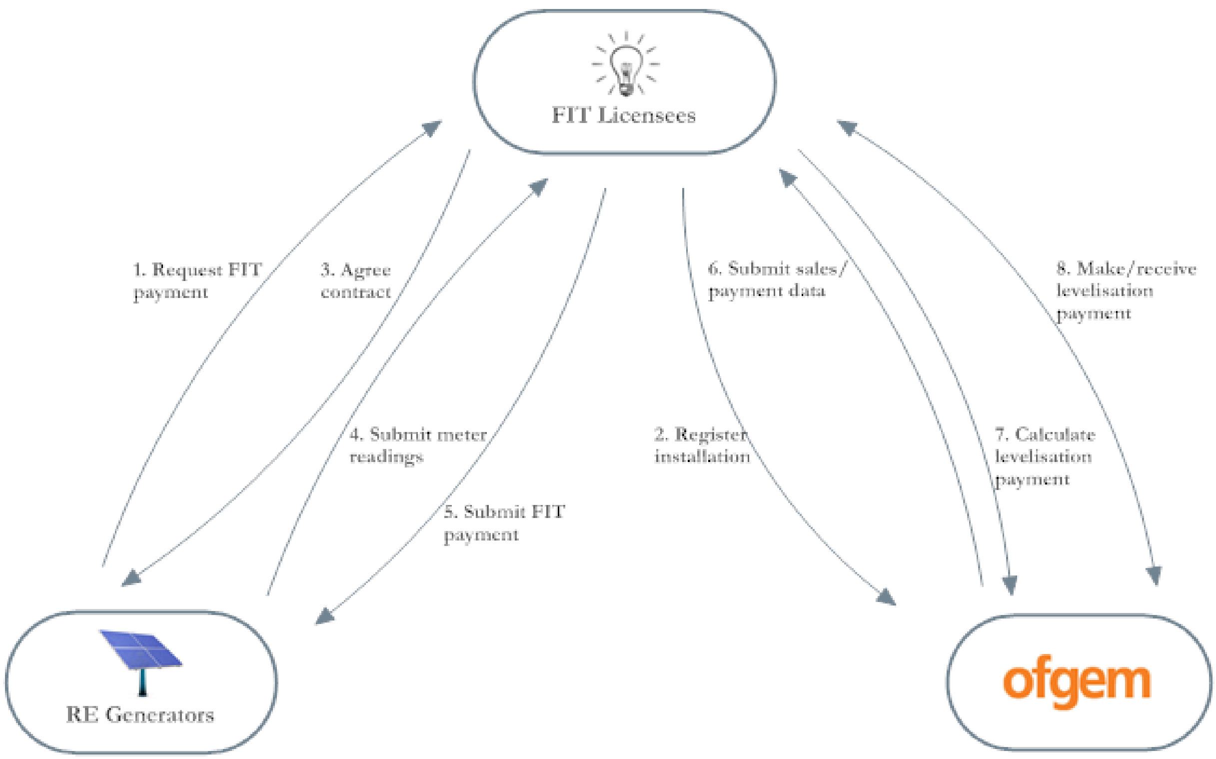


*Figure 3-1 How the FIT scheme works*
*Source: Based on information from Ofgem E-Serve, 2010: "Delivering a Successful GB Feed-in Tariff – An Ofgem Operational Perspective" Presentation by Keith Duncan, 25 October 2010.*

### 3.2.2 Generation and Export Tariffs

From a design perspective, the UK FIT scheme is different from other FITs being implemented in Europe (Mendonça, 2011). First of all, the UK FIT scheme is applied only for the deployment of small-scale projects with a total installation capacity up to 5MW while for instance the German one is for all scales. The RET covered by the UK FIT scheme are five in total including: solar PV up to a maximum total installed capacity of 5MW, wind up to 5MW, hydro up to 5MW, anaerobic digestion up to 5MW and micro Combined Heat and Power (CHP) up to 2kW (DECC, 2012). Additionally, a fact that makes the UK scheme unique is that the FIT Licensees should make two kinds of tariff payments to the accredited installations that use renewable electricity technologies. In other words, FIT payments are splint into two kinds, the "generation" and "export" tariffs (Ofgem, 2013a).

Once a renewable small-scale system has been registered, the FIT Licensee pays the RE generator a generation tariff which is a set rate for each unit (kWh) of electricity generated - whether the generator feeds it into the grid or uses it. The generation tariff is the main payment of the UK FIT scheme and is paid on the basis of actual meter readings provided by the generator and not on estimated generation (Ofgem, 2013a). The level of these payments depends on: a) the type of RE technology, b) the capacity of the system and c) the date of installation and is guaranteed for a certain period (up to 20 years) (Cherrington et al., 2013). Also, unlike other FIT systems, the generation tariff payments are index-linked to inflation. In simply terms, the payments remain stable in real terms also in cases where the value of the national currency changes (DECC, 2009d). Examples of FIT generation tariff levels during the years for small solar PV systems are given on Table 3-1. Specifically, one can notice that a big drop-off on solar PV payment levels took place between years 2 and 3. The DECC decided to reduce the level of the payments since the number of PV installations was really high while the installation costs of such systems has dropped dramatically (DECC, 2011).

In cases where the FIT generator exports electricity back to the grid, the FIT Licensee pays him an export tariff for each unit. In other words, export tariffs are bonus payments for every kWh of surplus electricity that a RE system exports to the grid (Ofgem, 2013a). Unlike the generation tariff, the level of the export tariff is the same for all the technologies (ibid). While the level of the tariff is index-linked like the level of the generation tariff in order to track the retail price index. For domestic systems with installed capacity up to 30kW where there is no smart meter installed, the exported electricity is deemed to 50% of the electricity generated (Secretary of State, 2013). Of course, if a generator believes that his exports are higher than 50% of the total output he is allowed to install an export meter and get paid on the metered level of exports (Ofgem, 2013b). The aim in the near future is that smart meters will be widely used from the UK households but to date an export meter is installed only for systems above 30kW (EnergySavingTrust, 2013). For the FIT year 1 and 2 the value of the exported electricity was set by the Secretary of State at 3.30 pence per kilowatt hour while for the FIT years 3 and 4 was set at 4.64p/kWh (Ofgem, 2013b).

In general, the generation tariff is higher than the export one and this because the DECC considers that rewarding of on-site use more likely can change the energy use behavior (Mendonça, 2011). See Table B-1 in Appendix that presents the FIT generation and export payment levels for PV eligible installations for the FIT year 1 (i.e. April 2010 to March 2011).

*Table 3-1 FIT Payment Levels for Solar PV systems with installed capacity up to 50kW*

| **System Size** | **FIT Year 1 (2010/2011)** (pence/kWh) | **FIT Year 2 (2011/2012)** (p/kWh)* | **FIT Year 3 (2012/2013)** (p/kWh)* | **FIT Year 4 (2013/2014)** (p/kWh)* | **Duration** (years)** |
|---|---|---|---|---|---|
| **≤4kW** | 36.1 | 37.8 | 15.44 | 15.44 | 20 |
| **4-10kW** | 36.1 | 37.8 | 13.99 | 13.99 | 20 |
| **10-50kW** | 35.5 | 35.5 | 13.92 | 13.03 | 20 |

*Adjusted by the Retail Price Index

** The tariff lifetime has been reduced, in the end of the FIT Year 2, for solar PV from 25 to 20 years for all the new installations

*Source: DECC (2011) and http://www.FiTariffs.co.uk/eligible/levels/*

### 3.2.3 Key Actors of the Scheme

Under the UK FIT scheme a number of actors are required to get involved such as DECC, Ofgem, Gemserv, electricity supply companies (FIT Licensees) and of course the electricity generators. To begin with, DECC is responsible for the design of the scheme as well as for its legislation. It also sets the tariff rates for every FIT year and is responsible for the policy (Ofgem, 2013c). The administrator of the FIT programme, who is responsible for overseeing the whole scheme, is Ofgem (The Office of Gas and Electricity Markets). Ofgem administers day to day functions in relation to the scheme and organizes and run the Central FIT Register (CFR), which is a database of the accredited installations (Ofgem, 2013c). This database was formed in order to ensure compliance, to identify errors and to facilitate switching (Mendonça, 2011). Ofgem is also obligated to publish statistical information from the CFR such as the total number of installations that receive FIT payments every year. In addition, the particular office administers the levelisation process that takes place quarterly and annually. During this process, the Ofgem should determine whether a Licensed Electricity supplier will have to make a levelisation payment or will receive one. In order to determine this, the market share contribution and FIT contribution of each Licensed Electricity Supplier is calculated and compared. The FIT contribution includes the following payments and costs: a) generation payments, b) net metered export payments, c) net deemed export payments and d) qualifying FIT costs (Ofgem, 2013a). The qualifying FIT costs are defined as the administration costs incurred by FIT licensees for each new or ongoing installation. The value of these costs is determined annually by the Secretary of State (Ofgem, 2012). Detailed information about the level of qualifying FIT costs is given on Table B-2 in the Appendix. Moreover, Ofgem accredits installations with a capacity above 50kW or micro and small scale anaerobic digestion and hydro installations. Finally, the office is responsible for ensuring that suppliers comply with the FIT scheme requirements (Ofgem, 2013c). The key duties and functions of Ofgem under the FIT scheme are summarized in Table 3-2 below.

*Table 3-2 Summary of Ofgem's Key Responsibilities under the FIT Scheme*

| Ofgem's Role in the FIT Scheme |
|---|
| • Accreditation of eligible installations<br>• Establishment and operation of the Central FIT Register<br>• Calculation of FIT payment rates<br>• Compliance functions<br>• Periodic & annual levelisation<br>• Facilitate switching of generators<br>• Information and guidance<br>• Reporting (e.g. the total number of FIT generators registered on the CFR, FIT payments made etc.) |

*Source: Based on information compiled from the FIT guidance for renewable installation, Ofgem, 2013c; The Ofgem website; The FIT: Annual Report 2010-2011published by Ofgem (2011); FIT presentation "Delivering a Successful GB Feed-in Tariff – An Ofgem Operational Perspective" by Keith Duncan, 2010*

Another key actor of the scheme is Gemserv. Gemserv is the licensee for the Micro-generation Certification Scheme (MCS). According to the guidance for renewable installations published by the Ofgem (2013c), the MCS is an internationally recognised quality assurance scheme which certifies micro-generation technologies that produce electricity or heat from renewable sources. In the case of the FIT scheme, an MCS certification must be granted to an installation in order to be eligible for FIT payments. Gemserv is a consultancy company that was licensed by the Secretary of State for Energy to certify installations of small scale electricity renewable generators across the UK and to grant the MCS mark (Mendonça, 2011). Further, Gemserv oversees the MCS and certificates product and installation companies to the MCS standards. Today there are plenty of certification bodies like Gemserv in the UK, fact that enabled more installation companies to be certificated.

Additionally, a party that plays a main role under the FIT scheme is the electricity supply companies which under the legislation are called "FIT Licensees". According to the first FIT Annual Report published in 2011 by Ofgem, licensed electricity suppliers operating in the UK with more than 50,000 domestic customers are required to become mandatory FIT licensees and to make FIT payments to eligible generators. Mandatory FIT licensees cannot exit the scheme unless their status changes[5]. Smaller energy companies with less than 50,000 domestic customers can elect if they want to become voluntary FIT licensees and make FIT payments. Voluntary FIT licensees are obligated to remain in the scheme only for the duration of the FIT year in which they enter. Both mandatory and voluntary FIT licensees are called FIT licensees. The main obligations of the FIT licensees are summarized in Table 3-3. At this point it is worth to mention that energy companies do not make any profits during the implementation of the scheme. In particular, Dr. Toke stated: "FIT licensees do not make money out of the FIT; marginally they lose money because it is taking income away from their own power plants" (personal communication, 8 July 2013). During the first year of the scheme there were 25 registered FIT licensees (Ofgem, 2011) while today there are 29 (Ofgem, website). A list of the recent registered FIT licensed suppliers is presented in the Appendix (Figure B-1). If a small licensed electricity company does not elect to become a voluntary FIT licensee, then is known as a non-FIT licensee. Even though non-FIT licensees do not make FIT payments to eligible generators, they are required to contribute to the costs of the scheme (e.g. make levelisation payments) based on their market share. A summary of the actors involved and their actions during the implementation of the scheme is presented in Figure B-2 in Appendix.

*Table 3-3 The FIT Licensees' Obligations*

| **Main Responsibilities of Mandatory & Voluntary FIT Licensees** |
|---|
| • Accreditation of generator less than 50kW<br>• Registration of eligible installations onto the CFR in a timely manner<br>• Management of application process<br>• Examination of the data accuracy placed on the CFR<br>• Calculation of FIT payments based on the information held on CFR<br>• Payment of tariffs<br>• Inform Ofgem about FIT payments<br>• Verification of generation and/or export meter reading at least once per two years<br>• Assistance of FIT applicants about the scheme- Customer service<br>• Levelisation payments |

*Source: Based on information compiled from the FIT: guidance for licensed electricity suppliers, Ofgem, 2011; the FIT guidance for renewable installation, Ofgem, 2013c; FIT presentation "Delivering a Successful GB Feed-in Tariff – An Ofgem Operational Perspective" by Keith Duncan, 2010*

Other actors being involved indirectly into the FIT scheme are Domestic Energy Assessors (DEA), electricity distribution companies and companies that install solar panels for "free" (i.e. they take the FIT payments and give the residents free day-time electricity). DEA are organizations that can produce the required Energy Performance Certificates that RE generators need in order prove the energy efficiency of their home and to get the standard rate of FITs (EnergySavingTrust, 2013). Electricity distribution companies are entities that distribute electricity in UK licensed by Ofgem. In some cases these distribution operators are owned by energy companies that take part to the FIT scheme (Energy Networks Association website). The only

[5]In the UK there are six large energy supply companies which are legally obliged to make the FIT payments: British Gas, EDF, E.ON, N Power, Scottish Power and Scottish & Southern Energy (SSE).

case where an electricity distribution company is involved (indirectly) is when a project needs a new or upgraded connection to the electricity network (Bird, personal communication). Lastly, since the FIT scheme was launched Rent-a-Roof (RAR) schemes appeared as an alternative method of installing a domestic solar PV system. In specific, under these schemes several companies offer "free" solar panels, in exchange for a proportion of the tariff payments. In other words, these companies install, maintain and insure a PV project on the roof of a householder that cannot afford to install the system himself (Mendonça, 2011). According to the Energy Saving Trust which is a social enterprise and the dominant energy and carbon advisor in England, the share of the RAR schemes in the UK PV market was almost 20% in 2011 (ibid). All the abovementioned actors have an indirect involvement with the UK FIT scheme and hence, their activities under the scheme are limited.

## 3.3 Early Performance

So far, it seems that the FIT scheme has been successful in empowering people to get involved in local, green energy generation. Particularly, the scheme has been really successful in increasing the small –scale PV installations (Cherrington et al., 2013; Mendonça, 2011; Walker, 2012). According to the first FIT Annual Report (Ofgem, 2011), there were 30,201 total installations during the first year of the scheme (from 1 April 2010 to 31 March 2011) while the total capacity of all installations was 108.3 MW. In addition, the technology with the largest installed capacity was solar PV with 77.7 MW (71.7 % out of the total capacity) and 28,556 installations (94.4% of total installations), followed by wind with a capacity of 18.9 MW (17.5%) and 1,339 installations (4.43%). The number of solar PV installations during the first year was far ahead of what was projected, therefore the DECC reviewed the scheme. According to projections before the start of the scheme the total capacity of solar PV would be 137 MW within the first two years. However, already in September 2011 the installed capacity of PV was 255 MW and significantly above the projections. The reason behind this was the fact that the FIT rates for solar PV were attractive and much higher compared to the installation costs of the technology and consequently the financial returns to the RE developers were more than 5% on investment. Moreover, Gill Owen who used to be non-executive board member of Ofgem stated that in the case of solar PV the tariff rates were high resulting to lower TCs related to the scheme. Therefore, the uptake of domestic PV installations was not so suprising (personal communication, 8th July 2013). As a result, the DECC announced reductions of the tariffs for all new PV installations with total installed capacity more than 50kW in order to provide the intended 5% rate of return on capital and to avoid overcompensation. In particular, the report stated: "…the number of solar PV installations is far ahead of projections. If this trend were allowed to continue, the affordability of the whole FITs scheme would soon be under threat. In the light of this budgetary risk we consider that it is necessary to seek views now on proposals for new tariffs for solar PV." (DECC, 2011). The old (2011) and the proposed generation tariffs for solar PV retrieved from the consultation document on FITs for solar PVs (DECC, 2011) are presented on Table B-3 in Appendix. Specifically, the impacts of this trend could unfold in two sides according to DECC (2011). Firstly, the generators would be overcompensated and the consumers that finally pay the FITs through their bills would be discriminated. Secondly, this trend would drive to a breach of the funding envelope for FITs and consequently the availability of FITs for non-PV technologies would be limited (ibid). At this point it is important to mention that several respondents to this consultation mentioned that the decision of the Government to reduce the solar PV FITs did not take into account the existence of peripheral and maintenance costs which did not reduce throughout the years (DECC, 2011).

A comprehensive statistical overview about the performance of the FIT scheme during its three years of implementation is given by the last report published by Ofgem, the 12th issue of the "Feed-in Tariff Update Quarterly" (Ofgem, 2013d). According to the report, from the 1st of April 2010 to 31st of March 2013, 379,530 renewable installations with a total installed capacity of

1,792.46 MW were registered under the FIT scheme. In particular, within the first year of the scheme were registered almost 30,000 renewable installations (Ofgem, 2011) while during the second year the registered installations were 217,741(Ofgem, 2012) and in the third year 131,864 (Ofgem, 2013d). Figure 3-2 presents the collective increase in both the number of installations and the total installed capacity registered within the first three years of the scheme. What can be noticed from the figure below is that newly registered capacity is increasing more rapidly than the number of installations being registered.

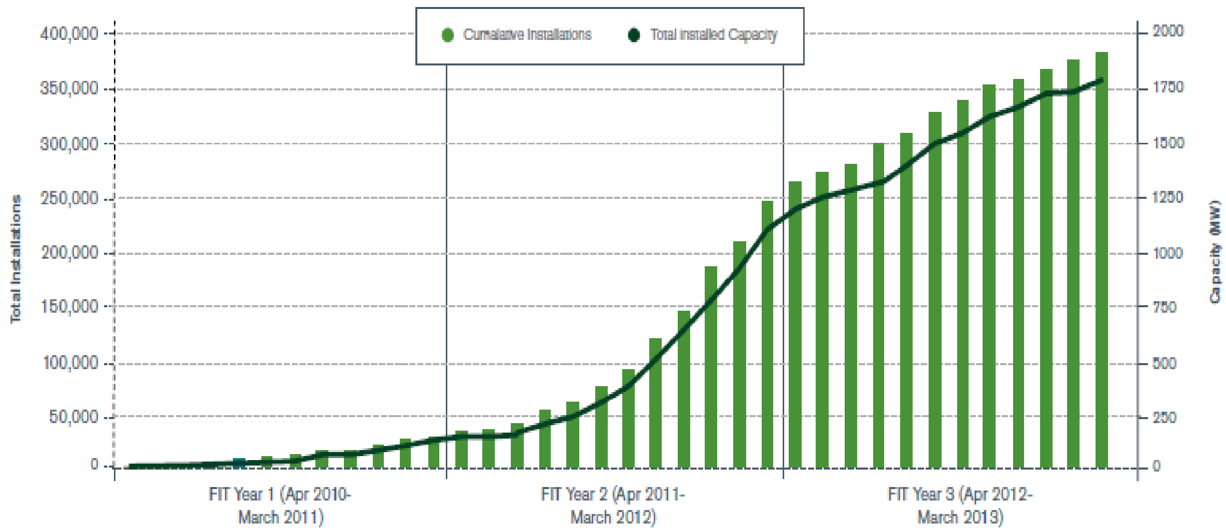


*Figure 3-2 Registered FIT installations by number and total installed capacity (1 April 2010 - 31 March 2013) Source: Ofgem (2013d)*

Furthermore, according to the report solar PV technology is the most dominant under the FITs both in terms of the number of installations and installed capacity (Ofgem, 2013d). A reason for that the fact that it is easier and cheaper for a householder to install a solar PV system on his roof rather than to install a wind turbine. In particular, solar PV installations constitute almost 89% (1585 MW) of the total installed capacity and 98.5% (374,014) of the total number of installations under the scheme. In the second place is wind technology which accounts for 7% (133 MW) of total installed capacity and for 1.2% of all installations (4,644). As regards the other technologies, anaerobic digestion and hydro installations account for 2% each of the total installed capacity while micro CHP installations constitute almost 1% of the installed capacity. Figure 3-3 illustrates the breakdown of the total number of installations registered by technology type for the period 1 April 2010 – 31 March 2013. The figure demonstrates that solar PV installations represent the largest part of installations, with 98.5% of the total. Wind technology makes up the 1.2% while the rest FIT eligible technologies constitute the remaining 0.3%.

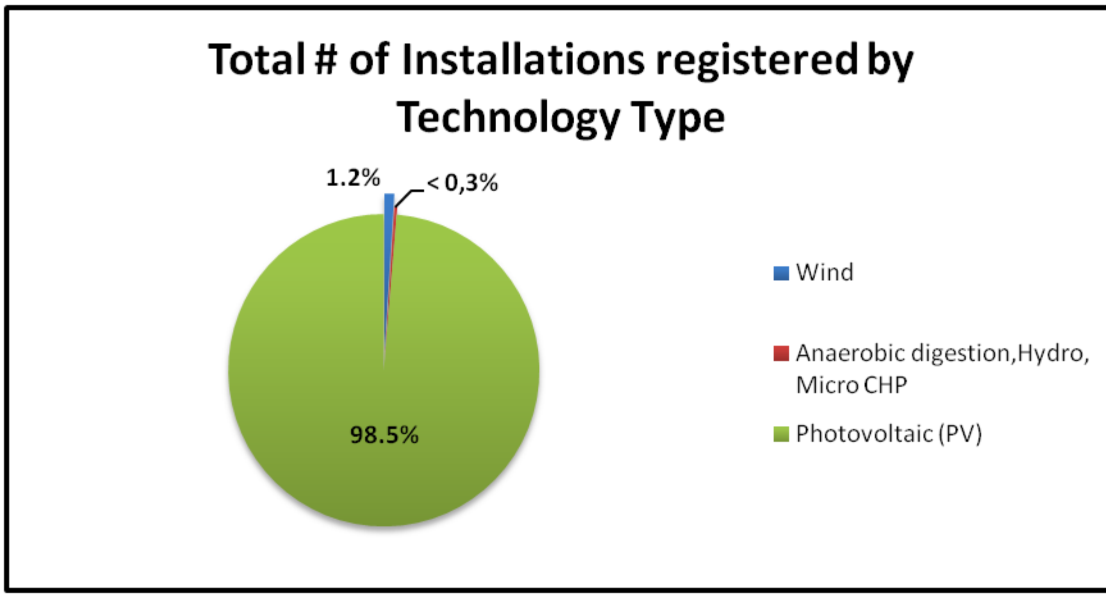


*Figure 3-3 Total number of installations registered by technology type for 1 April 2010– 31 March 2013 Source: Ofgem (2013d), modified*

In Figure 3-4 the total installed capacity by technology type for April 2010 – March 2013 is illustrated. Additionally, the largest share of the total FIT installations and the total installed capacity consists from domestic installations. In specific, domestic installations make up almost 97% of the total installations and 68% of the installed capacity. Domestic installations are followed by commercial, industrial and community installations. From a regional point of view, the highest total installed capacity is founded at the South of England and in particular at the South West. Once again solar PV installations constitute more than 85% of the total installed capacity in every region. Scotland is the only region where PV installations make up only 50% of the installed capacity while wind and hydro account for 35% and 15% respectively (see Figure B-3 in Appendix).

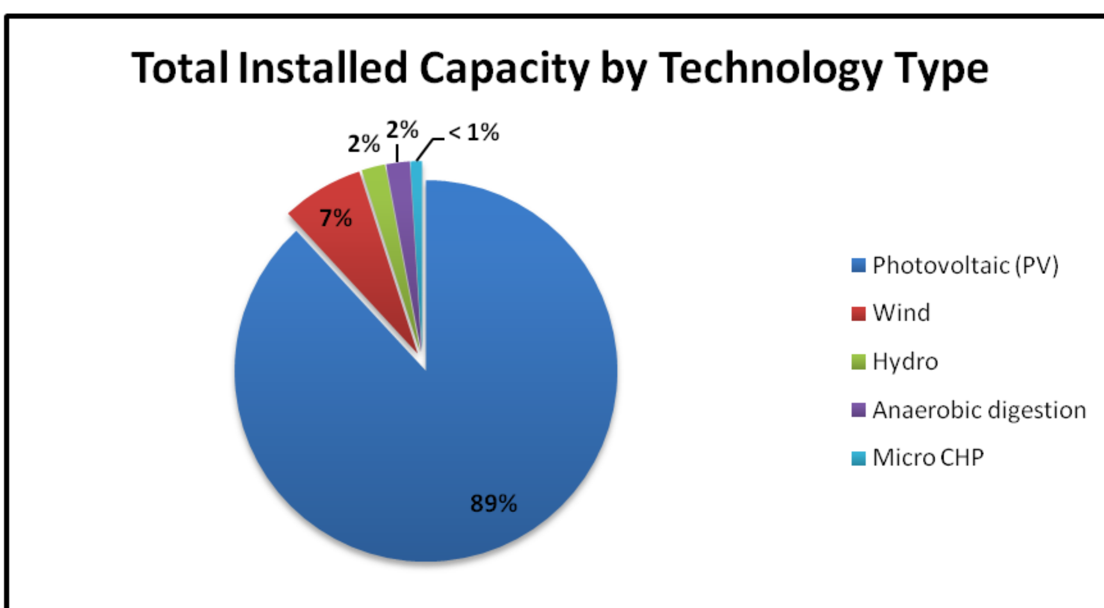


*Figure 3-4 Total installed capacity by technology type for 1 April 2010– 31 March 2013 Source: Ofgem (2013d), modified*

So far, it is evident that the FIT scheme in the UK has positive impacts on the green energy industry since almost 30,000 RE projects have been installed under the scheme as of 31 March 2013 (Ofgem, 2013d). Furthermore, according to the figures published by Ofgem the most deployed RET (both in terms of number of installations and installed capacity) under the scheme is the solar PV panels. While from a regional point of view, southern areas of UK acquired the highest installed capacity of RE generation. Nevertheless, Ofgem's report (2013d) mentions that the popularity of the scheme seems to decline. In specific, the total number of installations has dropped significantly the first quarter of 2013. Potential reason of this drop could be the degression that the DECC made to the FIT payment levels for installations registered after the April of 2012. The decline in the number of registered installations might indicate that the RE market is stabilizing especially for the case of solar PVs. To sum up, from the deployment statistics so far it seems that the predicted contribution of electricity from FIT projects 1.6% out of the UK 2020 electricity supply is a task at hand (Walker, 2012). However, nobody can predict with certainty if this target will be achieved since tariff levels might be adjusted from the DECC (ibid).

# 4 Research Findings

## 4.1 Nature of TCs in the FIT

As mentioned in the previous section, TCs can fall into five general categories: search for information costs, negotiation costs, approval and certification costs, monitoring and verification costs and trading costs. In the case of the UK FIT scheme, the categories of negotiation and trading costs were not identified since the particular policy instrument does not involve trading activities (i.e. trading of certificates) while the level of the FIT tariffs are fixed for each technology and set by the Government. The rest types of TCs where found in different phases of the life cycle of the scheme including: i) planning, ii) implementation and iii) monitoring and verification. Table 4.1 summarizes the sources of TCs during the life cycle of the scheme. It is also important to mention that in the analysis are addressed not only TCs borned by the obliged actors but also those borned by the authorities (i.e. DECC, Ofgem).

Before moving to the identification of the nature of TCs during the different phase of the UK FIT life cycle, a general and simple analytical model is presented to comprehend the potentially negative impacts of TCs in markets and hence in RET markets that policies like FITs promote. The model was developed by Dudek and Wiener in 1996 and in accordance with it, the existence of TCs increases the buyer's costs and/or lowers the supplier's (net) price and shifts the demand and supply curves. As a result, the new equilibrium quantity traded will be lower than the one would be in the absence of TCs (Dudek & Wiener 1996; Krey, 2004; Stavins, 1995) (see Figure 2-1). In the case of no transaction costs, the equilibrium of supply (S) and demand (D) emerges at $Q_{opt}$ purchases as outlined in Figure 2-1 below. Nevertheless, if either the buyer or supplier or both bear TCs, the equilibrium quantity will be lower than $Q_{opt}$. In the existence of TC borne only by the buyer (illustrated by the demand curve $D_{tc}$) the traded quantity will be $Q_1$. If the TCs are borne by the supplier (illustrated by the supply curve $S_{tc}$) the traded quantity will be $Q_2$. If the TCs are borne by both, then $Q_3$ will be the traded quantity. Generally, as TCs increase, the gap between buyer's cost and supplier's gain widens while the traded quantity will decrease (Dudek & Wiener, 1996).

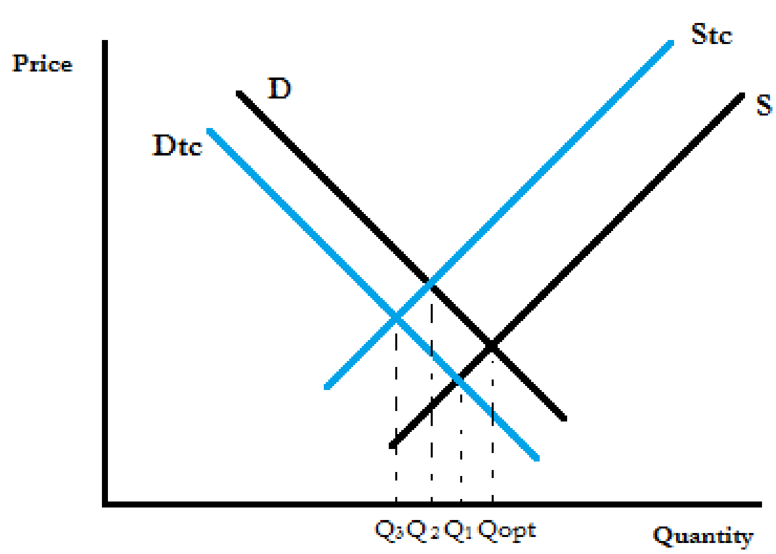


*Figure 4-1 Supply and demand in the presence of transaction costs*
*Source: Dudek and Wiener (1996) modified*

### 4.1.1 TCs related to Planning

Before identifying the sources of TCs related to the planning phase it is important to clarify that the planning phase is divided in two parts. The first one contains planning activities related to the preparation of the scheme by the DECC and the Government. While the second part, has to do with the planning activities that the obliged parties must undertake before the implementation of the scheme. In simply terms, the sources of TCs during the planning phase are examined both from the side of the regulator which is the DECC and the obliged parties.

To begin with, the response of the UK to FITs can be characterized relatively slow compared to other EU countries if we consider that it was introduced in 2010. According to an energy expert of Birmingham University, D. Toke, before 2007 very few people in the UK knew what the FIT was about, including people from the academic world and industry (personal communication, 8 July 2013). This implies that there was need to search for information about FITs and how they already work in other countries. In order the final design of the UK FIT scheme to be decided, a consultation for proposals took place from July until October of 2009. During this consultation process on FITs, responses from individuals, organizations, trade associations, licensed electricity suppliers, technology manufactures and installers, consultancies and academia were received (DECC, 2009d). In addition, the DECC cooperated with Ofgem, licensed electricity suppliers and trade associations in order to develop a draft with the main elements of the scheme. Again, DECC consulted licensed electricity suppliers as well as the UK Business Council for Sustainable Energy (UKBCSE) to specify the roles of electricity suppliers (ibid). Therefore, it is clear that during the preparation of the scheme DECC has to undertake a number of activities that requires time and resources. In other words, the preparation period included TCs related to search for information and consultations which are borne by the DECC. These sources of TCs can be described critical since all the activities mentioned above were necessary for the development of the FIT design. DECC was contacted in order to provide further details regarding this preparation phase and its potential TCs. Unfortunately, the DECC receives a great amount of similar requests so it was not possible for them to respond within the thesis timeframe.

Regarding the planning phase from the prespective of the obliged parties, sources of TCs are described below. Primarily, transaction costs are identified in relation to the search for information, in particular for renewable electricity generators. These actors have to search for information and choose the most suitable technology for their case. Additionally, they have to identify a suitable MCS - accredited installation company operating in their region in order to get a MCS certificate. During the planning phase, the MCS – accredited installation company undertakes a pre-study consisting of technical and financial investigations in order to find out the best system solution. These detailed pre-studies can be regarded as potential sources of TCs.

TCs also arise from the search for a Domestic Energy Assessor (DEA) who can produce the required Energy Performance Certificate (EPC) and the search of an electricity supplier who will pay the FITs. Additionally, if the installation has a total installed capacity greater than 30kW then an export meter is required in order to receive FIT export payments. In this case, the FIT generator has to contact a Distribution Network Operator (DNO) for an export meter point administration number (MPAN) and to appoint a meter operator for the installation of an export meter. After gathering all the appropriate documents and certificates, the electricity generator should send his FIT application to the energy supplier that he has chosen. Only in the case in which the installation capacity is more than 50kW, the generator has to register his installation directly with Ofgem and then to provide his energy supplier with a ROO-FIT Accreditation reference in order to request FIT payments. Furthermore, there is the case of RAR schemes that mentioned in Section 3.2.3. If a domestic householder wants to get FIT payments but cannot afford to install a solar PV system then he should search and contact one of the companies that offer “free” solar panels, in exchange for a proportion of the tariff payments. This might also contain TCs related to the search for information and some negotiation costs borne both by the RE generator and the specific company. Moreover, some TCs might be generated if the house where the PV system installed be sold. In such a case the old and new owners would have to inform the energy supplier for potential changes and to agree a contract. Nevertheless, since the share of RAR schemes in the UK PV market is small, TCs associated with them will also be of low importance.

The UK FIT scheme mainly depends on the regulation and most of the transactions are fixed by law. As a consequence, the identity of obligated FIT suppliers is also fixed by law and RE generator can find all the registered FIT licensed suppliers at Ofgem’s website. Thus, costs arising due to the need for information on the credibility of the obligated energy suppliers are very low. In general, due diligence mainly occurring during the preparation of FIT application is identified as the main source of TCs, particularly for renewable-electricity generators.

### 4.1.2 TCs related to Implementation

During the implementation phase, the first source of TCs is related to the assessment of the acquired information. After receiving the FIT applications from the generators, FIT suppliers have to undertake a number of eligibility checks (i.e. cross-reference the installation with the MCS database, assess installation against the energy efficiency criteria and multi installation rules, check installation location address etc.) in order to confirm the eligibility of the installation (Ofgem, 2013b).

After ensuring that the information provided by the FIT generator is accurate, the FIT supplier collects the necessary data and prepares the appropriate documents in order to gain the approval from Ofgem and to register the installation to the CFR. According to official information from FIT suppliers’ websites it may take 8-12 weeks for the suppliers to assess and approve an application and send back a FIT acceptance plan with the terms and conditions to the generator. In this case, TCs are identified in relation to the approval and certification procedures. At the moment it seems that the number of the legally obliged energy suppliers is limited since the mandatory FIT licensees under the UK FITs are six. Thus, the administrative costs are distributed in few hands and consequently TCs become higher. At this point worths to mention that when the DECC (2012) asked consultation about the tariff levels and some issues related to data collection most of the FIT electricity suppliers responded that individual installation data should be collected centrally. However, some of them mentioned that must be economically viable and not to pose too much of a burden. While others expressed that their main concern was the costs related to the collection of this data and that it would be more cost-effective if smart meters had a wide application (DECC, 2012). On the other hand, DECC stated its future intention to consult with all the FIT licensees and to find out the potential cost or the burden that this data collection could place on them (ibid). Additional sources of TCs can be considered the time and management needed in order to gain approval for RE installations from Ofgem and to register the installation. Furthermore, due to regular changes of the FIT regulations (e.g. reductions in the (solar PV) tariffs levels every three months (DECC, 2011)), FIT licensees have to calculate and make FIT payments in accordance with new information.

During this phase, negotiation and bargaining costs were not identified as a significant source of TCs since the terms of the contract and the tariff rates are set by the Government. In other words, no time or negotiation process is spent between generators and FIT suppliers negotiating the level of FIT generation payments. Only in the case where the generator does not have an export meter there is a possibility of negotiation between the actors for the export payment level. However, most of the FIT licensees deem the export payment as 50% of the electricity generated since

Ofgem has advised them to do so. In addition, the time period on which the FIT payments should commence is fixed by the Ofgem and hence the FIT licensees have to make the payments on a quarterly basis.

As regards the RE generator's and FIT supplier's activities related to the transaction during the implementation phase between them and the grid electricity distributors are very limited. According to the Energy Networks Association in the UK, no financial transactions take place between grid electriciry distributors and energy companies as a result of the FIT scheme (R. Le Gros, personal communication, 15 August 2013). In addition, the electricity distribution company Northern Powergrid confirmed that they have a little direct involvement with the FIT scheme, which is operated by the electricity supply companies (J. Bird, personal communication, 1 August 2013). In particular, for the case of small-scale electricity installations where the output of the project is less than 3.68kW for a single phase supply, the installer only need to notify the electricity distribution company about the project. The company's Head of Sustainability, Jon Bird, mentioned: "Northern Powergrid's involvement is only concerning whether the project needs a new or improved connection to our network. It is for the installer to make arrangements with the energy supply company to be paid the FIT and the value of the electricity exported. We have no involvement with that process." Thus from the grid electricity distributors' point of view, there are no activities under which TCs can be generated.

Overall, in the implementation phase of the FIT scheme TCs were identified in connection with searching for and assessing information and approval and certification procedures. These TCs are mainly borne by the FIT licensees. The fact that most of the TCs costs are borne by the FIT licensees was also confirmed by the Senior Manager of the Governance & Renewables Compliance Environmental Programs at Ofgem. During our interview, Mr. Duncan mentioned: "The FIT licensee is the one required to process and register the FIT application so it will be the FIT licensee who will face most of the TCs" (K. Duncan, personal communication, 15 July 2013). Unfortunately, Ofgem does not track nor keep such information. Nevertheless, the Secretary of State (2013) recognizes only one category of costs called "administrative or qualifying costs" which the FIT licensees can claim from Ofgem. The level of the qualifying costs that FIT licensees can claim for each generator are determined by the Secretary of the State and are differentiated based on the type of the licensee (large or small) and the type of the generator (ongoing or new). These costs are included to the calculation of the levelisation payments made by Ofgem. Further information about the level of these quantifying costs can be found on Table B-2 in the Appendix.

### 4.1.3 TCs related to Monitoring

Before identifying the nature of TCs in the monitoring phase it is important to mention that there is always a discussion in the literature whether or not monitoring costs are sources of TCs. In particular, some studies consider metering costs as part of the implementation phase and do not analyze them separately. For example, Michaelowa et al. (2003) included monitoring costs into the implementation phase of the Clean Development Mechanism (CDM) and defined them only as costs to collect data.

In the case of the UK FIT scheme, monitoring and metering can be described as the dominant activities that take place. Monitoring and verification costs which are also known as "metering costs" take the form of the time and/or resources needed to audit and assure the policy's compliance. In the case of the FIT scheme, metering costs are mainly borne by the FIT licensees and Ofgem which administers the scheme.

Particularly, one of the main responsibilities of the FIT licensees is to ensure that the data submitted to Ofgem are accurate and to update or amend the CFR with new information.

Moreover, they have to assess in a regular basis the generation and/or export meter readings that they receive from the generators against expected generation. According to Ofgem (2013a), they are obliged to verify generation and/or export meter readings at least once every two years with onsite visits while desk based investigations should be proportionate to the degree of abnormal readings. In order to secure themselves against making FIT payments to ineligible installations, FIT licensees have to spend time in order to ensure the eligibility of the FIT generators. Besides this, FIT licensees have to spend time and resources for ensuring their compliance to regulation amendments. These costs of changing strategies, due to changes in regulations are called adjustment costs according to Dijk et al. (2003).

As regards Ofgem, TCs are generated due to approval procedures of the RE installations and monitoring the ongoing participation of participants. Ofgem has to calculate the FIT contribution of each licensee and combine it with their electricity sales data (periodically and annually) in order to ensure an equal distribution of the scheme's costs among the FIT licensees and make the appropriate levelisation payments. Additionally, in a periodic and annual basis, Ofgem has to monitor FIT licensees' compliance with the FIT Order requirements. Part of this monitoring procedure is sample reviews and inspections of the processes that FIT licensees follow. By doing so, Ofgem aims to verify the FIT licensees' compliance. These audits may include checkings whether: a) FIT licensees are making the necessary checks on the MCS in order to verify claims of certification and/or accreditation for eligible Installations, b) FIT licensees' arrangements for checking information provided by the FIT generator are appropriate or c) FIT licensees' levelisation processes are robust (Ofgem, 2012). Furthermore, every year, Ofgem review a sample of FIT generators and registered installations in order to examine the levels of compliance. While at least once per year an independent organization is used to confirm the information given by FIT licensees. The expenses borned by Ofgem to insist on compliance in cases where discrepancies are discovered are called enforcement costs (Dijk et al., 2003).

At the same time, Ofgem has to annually report on the FIT licensees' compliance, the total number of FIT generators registered on the CFR, the number of MWh generated and the FIT payments made to generators during the year. In addition, supplementary reports/reviews and adjustments of the FIT scheme (i.e. degression of FIT payments) are published whenever is necessary.

*Table 4-1 Identified sources of TCs under the UK FIT scheme*

| FIT Phases | Sources of TCs | Actors bearing TCs |
|---|---|---|
| Planning | Search for information<br><br>Consultations for the desing of the scheme | DECC (Regulator) |
| | Search for and assessment of acquired information:<br>– Search for technology solutions<br>– Search for certified installation companies<br><br>Application preparation | Renewable-electricity generators |
| Implementation | Application assessment<br><br>Approval and certification costs<br><br>Administrative costs<br><br>Calculation of FIT payments-Billing<br><br>Paying | FIT Licensees (energy supply companies) |
| Monitoring & Verification | Auditing of meter readings and FIT payments-metering costs<br><br>Adjustment costs | FIT Licensees (energy supply companies) |
| | Monitoring FIT licensees' and FIT generators' compliance:<br>– Random checks<br>– Hiring third parties for auditing<br><br>Enforcement costs<br><br>Cost recovery & levelisation<br><br>Annual reports and assessments | Ofgem |

## 4.2 Contrasting Results with Previous Research

In this subsection, a comparison and critical review between the sources of TCs found within the UK FIT scheme and the ones identified by similar studies is provided. In particular, based on the main phases of the scheme, potential similarities and divergences between my results and similar studies in the field are acknowledged.

### 4.2.1 TCs related to Planning

According to a comprehensive meta-analysis of Mundaca et al. (2013), TCs during the planning phase of renewable energy technologies are identified as information costs. More specifically, in their study Skytte et al. (2003) argue that TCs commence due to search for information and pre-feasibility studies about the choice of technology and the search for interested partners. Simultaneously, Langniss (2003) also identified the search of information as a major source of TCs when he compared the TCs associated with the German Renewable Energy Act (EEG) and the Texas Renewable Portofolio Standard (RPS). In the study of Langniss (2003), parties that mostly borne these TCs were new firms entering the market. As regards the TCs related to the planning phase of the UK FIT scheme, it was found that TCs arose from the search for information about technology solutions and search for certified companies (i.e. MCS-installation companies, EPC certification companies, electricity suppliers). In addition, the assessment of information mainly occurring during the preparation of FIT applications was also identified as source of TCs, particularly for renewable-electricity generators. When the results of similar studies in the field and the results of this study are compared it becomes clear that both sides identify due diligence as the main source of TCs in the planning phase of a project. Nevertheless, it is also obvious that similar studies do not include sources of TCs related to the preparation of a scheme from the authorities in their analysis. In other words, search for information and consultation costs borne by the authorities during the planning phase are addressed only in the case of UK FITs.

### 4.2.2 TCs related to Implementation

When comparing the results of similar studies with the results of this analysis some differences come to the picture. Specifically, contrary to the studies of Finon and Perez (2007), Langniss (2003) and Skytte et al. (2003), the TCA of the UK FIT sheme indicates that negotiation and bargaining costs are not identified as a significant source of TCs since the level of tariff rates are fixed by the law. As a consequence, no remarkable time is spent between generators and FIT suppliers negotiating for the level of FIT generation payments or the contract terms. Particularly, Finon and Perez (2007) argued that critical source of TCs for policy instruments, like RO or tradable green certificate schemes, consists the contract and negotiation procedures among renewable electricity generators and obliged parties. Analogously, Langniss also identified that costs associated with negotiations were borne both by the electricity suppliers and the renewable electricity generators in the case of RPS in Texas. While, bidding and negotiation costs were also considered high in the study of Skytte et al. (2003) about the challenges for investments in renewable electricity projects in EU. Moreover, in the case of the UK FITs the importance of TCs related to the need of legal and technical experts to comply with grid interconnection requirements is low. On the other hand, Ram and Selvaraj (2012) in their study related to the barriers of RE entrepreneurs in India, mention that there is need of hiring legal and technical experts in order to understand and comply with grid interconnection requirements while the TCs associated with this fact are significant. This difference exists because in the case of UK electricity network there are uniform interconnection standards whilst in India there are not. As would be expected, except for the divergences there are also similarities between the results of this thesis and those of similar studies. Particularly, TCs related to approval and certification procedures were also identified in the case of the FIT scheme in the UK and were borne by the FIT Licensees. In this case, TCs were also associated with processes like calculations, billing and making payments. TCs also arose from administrative procedures as in the case study of the EU market for green electricity (Skytte et al., 2003). Furthermore, the TCA of FITs also showed that obliged parties have to create compliance strategies due to regulation changes (e.g. due to tariff levels reductions FIT licensees have to calculate and make payments in accordance with the new information) as in the study of Skytte et al. (2003).

### 4.2.3 TCs related to Monitoring

If we compare the results of this analysis with ones of analogous studies, it becomes clear that there are several points where they come into an agreement. To begin with, the analysis of the UK FIT scheme identified TCs related to metering procedures as Langniss (2003) did in his study about the German EEG. Langniss (2003) identified monitoring costs as part of TCs which are borne by the regulator in the case of Texas RPS. In specific, monitoring costs arose from the approval and certification processes that the regulator had to monitor. However, in the case of the UK FIT scheme these costs are not only borne by the regulator (Ofgem) but also by the FIT licensees. Another identified similarity relates to the administrative costs and the additional costs that the obligated parties undertake in order to secure their compliance with the policy requirements. In particular, the analysis of the FIT scheme in the UK indicates that FIT licensees have to verify the generation and export meter readings in a regular basis to secure themselves from making FIT payments to ineligible installations. Additionally, sample reviews and random inspections in order to monitor the compliance of the obliged parties are also undertaken by the regulator (Ofgem) in the UK FIT scheme. At the same time, Oikonomou and Mundaca (2008) in their paper about the Tradable Green Certificate scheme in the Netherlands and in Sweden characterized TCs as "additional costs undertaken by obligated parties beyond costs of meeting the obligation itself". Specifically in Sweden, the administrative costs were borne by electricity producers and suppliers who handled the RE quota obligation on behalf of end-users (Bergek & Jacobsson, 2010; Mundaca et al., 2013). Metering procedures and random quality checks are also characterized as sources of TCs under the German EEG (Langniss, 2003). Another point in commong is the fact that in both in the case of the German EEG (Langniss, 2003) and the UK FIT, the publication of reports about the performance of the schemes is defined as source of TCs borne by the authorities.

Overall, in all the cases the search for and assessment of information, approval and certification procedures as well as administrative and metering processes were identified as sources of TCs. However, some divergences were acknowledged regarding the parties which borne these costs. In addition, a major difference between the results of similar studies and the current analysis consist the existence of negotiation costs and the TCs related to them. Consequently, what someone can conclude from the comparison above is that the nature of TCs under the UK FIT scheme is relatively consistent with those of other RE policy instruments. The existence of few divergences can be explained by the fact that each policy instrument has a different design form. According to Dijk et al. (2003), there might be divergences regarding the nature of TCs even between the same policy schemes since TCs are very much connected with the design form of a policy instrument and are not always directly linked to the selection of the instrument.

## 4.3 Expert Views on the FIT Scheme

In order to confront the findings of the first part of the analysis as well as the results from the comparison with similar studies mentioned in the previous sections, views from experts in the field were asked. In particular, three experts were interviewed and asked to express their opinion regarding the identified sources of TCs and if these costs were suitable for the case or not. Moreover, they were asked to comment on the similarities and differences being distinguished among the similar studies and to point out if there are additional TCs that should be included into the findings. A sample of the interview questions can be found in Appendix A.

The first interviewee was Dr. Ole Langniss who is senior consultant at Fichtner GmbH & Co KG in Germany. Besides this, he has examined the TCs related with the German FIT scheme and the Texas RPS at his Phd dissertation in 2003. According to Dr. Langniss there are search for information and consultation costs that the authorities bear during the preparation and planning of the FIT scheme. Moreover, he pointed out that source of TCs can be related to marketing activities for the promotion of the scheme. While setting the tariff levels is certainly a source of TCs according to him especially if different slots of tariffs for the different sizes of the systems need to be created. However, what determines if this preparation will be complicated or not, is the government's experience on similar policy instruments. Specifically Dr. Langniss mentioned that if similar RET policy instruments are already implemented in the UK then the development of FIT baselines will be less complicated. Although, he mentioned that in democratic societies like the UK or Germany is a bit more time consuming to plan the FITs and to fix the tariff levels since more viewings and discussions with stakeholders are taking place compared to central economies like China. Regarding the nature of TCs during from the generator's perspective, Dr. Langniss thinks that information costs can be describes as the main source of TCs. According to him, the potential generator has to search for information about the level of the tariffs, the registered energy suppliers, the application process, the payments etc.

Moving to the implementation phase of the scheme, Dr Langniss agrees that is logical not to have negotiation costs under the UK FITs since the tariffs are fixed and there is a standards agreement between the FIT supplier and the RE generator. He adds that the in Texas the case is different since the contracts are individually adapted and people need to negotiate for the level of the tariff. Moreover, Dr. Langniss argues that during the implementation phase the FIT licensees bear most of the administrative costs and consequently most of the TCs. In particular he mentioned "Administrative costs consist a main source of TCs and it positive that part of them is included in the calculations of levelisation payments. The level of administrative costs that Ofgem recognizes sounds reasonable to me but I can not really judge it, it really depends on the process that the FIT licensees follow."

As regards the monitoring phase, he believes that there are many sources of TCs related to metering activities that both FIT licensees and the authorities have to undertake. "Monitoring activities are one of the main sources of TCs under FIT shemes like the German and the UK one." he mentioned.

Dr. Langniss thinks that for several reasons is justified that I have found different sources of TCs between similar studies or even for the same type of scheme. The different design of the schemes is one reason that can explain this, according to him. If different activities take place under a scheme then different cost will occur. In specific he mentioned "If you have a monthly monitoring cycle then obviously the costs will be higher compared with the case of an annual monitoring cycle. This is a detail on the design of the scheme but it really makes a difference." Another reason he pointed out is the time period for which the scheme is being implemented. "If the scheme is new implemented (like in UK) then the different stakeholders are not so much experienced on administrating the programme. While when the scheme is already established the TCs become lower because of the economies of scale (like in Germany)." For Dr. Langniss is not right to make generalizations about TCs related to RET policies while is better to examine each case separately.

Overall, he argues that the phases were the most significant and highest TCs occur are the implementation and monitoring while the actors who bear most of them are the FIT licensees and in a second place the authorities. The TCs borne by the generators are minor – otherwise people would not take part in the scheme anyway, according to him. Potential ways to front and decrease TCs is the standardization of implementation and monitoring activities. As an example Dr. Langniss mentioned the case of the German FIT where the government has standardized the data collection process (e.g use of the same software) between the generatots and the FIT licensees as well as between the FIT licensees so it is clearer what everyone has to do and TCs are lower.

In addition, Dr. Poul Erik Morthorst who is professor at the Department of Management Engineering in the Technical University of Copenhangen was interviewed. Dr. Morthorst mentioned that due diligence costs can be identified during the planning phase of the FITs both for the autority's and generator's perspective but the level of these costs is actually low. Concerning the nature of TCs during the implementation of the scheme, he agreed that there are no negotiation costs since payment levels are fixed by the law. However, he argued that administrative costs borne by the FIT suppliers are a significanr source of TCs. Besides this, metering costs and monitoring costs can be considered as an additional source of TCs under the FIT scheme. "Implementation and monitoring costs would be the highest cost under the UK FITs" he mentioned. Moreover, he described the monitoring phase as the "heaviest" part of the scheme from a TC perspective. As regards the fact that differences between the identified sources of TCs under similar studies, Dr. Morthorst comment that the nature of TCs depends on the design of a particular scheme and this can be different even between the same type of policy instrument. As an example he mentioned the FITs in Denmark where there is only one type of payment compared to UK and hence the monitoring activities are more simple.

The third interviewee is Dr. Axel Michaelowa, head of research on International Climate Policy at the University of Zurich. His research focus is on market mechanisms in climate policy and the development of the future international climate policy regime. According to Dr. Michaelowa there are two perspectives from which the TCs of a RET policy can be examined: the political process and the single participant's perspective. The first one includes TCs borne by the regulator during the preparation of the scheme. For the case of the UK FIT scheme, Dr. Michaelowa mentioned that "The UK Government has to design the instrument and this creates TCs. After that, there are other costs that the Government faces related to the set up of the rules, the regulations and the specification of the energy companies that have to take part." Dr. Michaelowa argues that TCs that are generated during the design and set up of a policy instrument like the FITs in UK should be included into the analysis if a comprehensive assessment of TCs is requested. In order to identify the sources of these costs as well as estimate their magnitude questions like "How many officers did work on the drafting of the blueprint? How much time did Ofgem spend on stakeholder conferences or on the marketing of the scheme?" have to be posed. As regards the single participant's perspective, TCs related to the search for information during the planning phase could be identified. Nevertheless, he believes that the TCs that borne by generators during the planning phase are not so significant.

Concerning the implementation phase of the scheme, Dr. Michaelowa agrees that most of the administrative costs are borne by the FIT licensees. However, he thinks that TCs are borne by Ofgem since they also have to collect data regarding the payments been made. In addition, he agrees that since the tariff levels are set by the Government, negotiation costs can not be identified as sources of TCs in the UK FIT case. Furthermore, he mentioned that considering that FIT licensees are also required to participate in the complaint process in relation to generators' compliance under the scheme there might be a source of TCs. Even so, it really depends on the amount of complaints that the FIT licensees have to deal with. So there might be cases where TCs are high if the FIT supplier has to hire an expert and cases where the dispute handling will be almost costless.

His conclusion was that TCs associated with the preparation and designing of the FIT scheme are significant and should not be underestimated as well as the monitoring costs that the authorities bear during the operation of the scheme. In addition, he mentioned that TCs sources may differ among FITs schemes and that it is not suitable to make generalizations about TCs since each policy instrument has a different design. In addition, he argued that trust is also an important factor since its absence can increase the level of due diligence and administrative costs or to create additional TCs.

# 5 Conclusions

The opportunities related to the introduction of policy instruments such as FITs that aim at the diffusion of RET seem to be great however there are also barriers and issues that slow the RE deployment into modern economies. To overcome barriers to small-scale RET and to make the FIT scheme more cost-effective, transaction costs related to the application of FITs need to be analysed, better understood and eventually reduced.

This study has identified three natures of TCs occurring during the life cycle phases of the UK FIT scheme: due diligence, approval and certification and monitoring. The life cycle phases of the scheme in which the costs were identified are i) planning, ii) implementation and iii) monitoring and verification. It was found that during the planning phase of the scheme most of the costs occurred were due diligence costs. TCs of due diligence arise in relation to search for and assessment of acquired information regarding the design and preparation of the scheme, consultations with other stakeholders, search for certified installation companies and preparation of the application for RE developers. In the implementation phase it was found that approval and certification costs were the main sources of TCs. Approval and certification costs arose in relation to application assessments, collection of data, administration of the scheme, calculation of FIT payments and paying activities. In the monitoring and verification phase, TCs occur in relation to monitoring. In specific, monitoring costs are associated with monitoring of the FIT licensees' and the FIT generators' compliance including random quality checks and hiring third parties for auditing, publishing annual reports and reviews and with managing of the levelisation process in a quarter and annual basis. As regards the actors which bear these costs the analysis found that the TCs arising in the planning phase are borne by the authorities (DECC) and the RE developers, while TCs arising in the implementation phase are typically born by the FIT licensees. Concerning the TCs occurring in the monitoring phase, these are borne by Ofgem and in a second place by the FIT licensees. In all, due diligence, administrative and metering costs identified as the main sources of TCs, while most of them occurred during the implementation and monitoring phases. When the findings of the UK FIT scheme compared with those of similar studies in the field it becomes clear that there are many similarities regarding the nature of the identified TCs. Nevertheless, in the case of the UK FIT scheme contract negotiations were not identified as a major source of TCs as in the other studies. In addition, the findings were confronted with the views of experts in the field. Experts confirmed the sources of TCs under the UK FITs and pointed out which are the most significant costs. According to them, the most significant TCs occur in the implementation and monitoring phases, while approval and certification costs as well as monitoring costs characterize the nature of the TCs borne mainly by the FIT licensees and Ofgem.  An important point that experts pointed out was that the required monitoring of the UK FIT scheme may be complicated and associated with higher costs since its baseline seem to be more complex compared to the German or the Danish. Furthermore, some of them suggested that the preparation and design of the scheme can be important sources of TCs that the authorities bear and should be considered under the TCA of the scheme. Nevertheless, the experts argued that the nature and the significance of TCs are very likely to differ even under FIT schemes because of a number of endogenous and/or exogenous factors. Main reasons are the different design forms of the schemes, the experience regarding the development of FITs, the maturity of the RET markets as well as the level of trust to authorities or to the involved actors. Since the sources of TCs are affected by several factors and are case specific it is not suitable to make generalizations about FIT schemes. Finally, examples of strategies that could front and potentially reduce TCs were identified such as the standardization of the data collection process done by the FIT licensees and of monitoring/auditing activities performed by both Ofgem and the FIT licensees.

Overall, according to the statistics the UK FIT scheme can deliver the expected 1.6% of electricity from renewable sources by 2020. Nevertheless, if tariff degressions continue to be announced at regular intervals, the TCs will probably be more evident as well as their impacts on the performance of the scheme. Therefore, the analysis of TCs and the search of ways that can confront them are necessary. The identification of the TCs' nature under the UK FIT scheme it is the first step to understand which phases during the life cycle of the scheme TCs arise and who the actors that bear them the most are. Nevertheless, the estimation of their level will help to better understand the impacts of TCs on the scheme's performance and to find the most suitable measures and strategies for reducing them.

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## Interviews

Duncan, Keith, 15th July 2013, Senior Manager of the Governance & Renewables Compliance Environmental Programs at Ofgem

Dr. Langniss, Ole, 29th August 2013, Senior Consultant at Fichtner GmbH & Co KG, Germany

Dr. Michaelowa, Axel, 9th September 2013, Head of research on International Climate Policy at the chair "Political Economy and Development", University of Zurich

Dr. Morthorst, Poul Erik, 5th September 2013, Professor at DTU Management Engineering, Technical University of Copenhagen

Dr. Owen, Gillian, 8th July 2013, Senior Research Associate at the Energy Institute at UCL, Australia. Non-executive board member of the energy regulator, Ofgem (previous position)

Dr. Toke, David, 8th July 2013, Reader in Energy Politics in the Department of Politics and International Relations in the University of Aberdeen - Key player in the campaign to establish feed-in tariffs for small renewable projects in the UK.

## Email Communication

Bird, Jon, 1st August 2013, Head of Sustainability, Northern Powergrid Holdings Company

Le Gros, Richard, 15th August 2013, Technical Development Adviser, Energy Networks Association

# Appendix A: Sample Interview Questions for Experts

After exposing the findings of my analysis and mentioning the identified similarities/differences with similar studies to the interviewees, the following questions were asked:

- What is your opinion regarding the identified sources of TCs during the planning phase? Do you think that these costs are suitable for this case? Do you think is not suitable and why?
- What is your opinion regarding the identified sources of TCs during the implementation phase? Do you think that these costs are suitable for this case? Do you think is not suitable and why?
- Do you think that the administration – qualifying costs are sufficient for addressing the TCs that the energy suppliers face during the implementation phase?
- What is your opinion regarding the identified sources of TCs during the monitoring phase? Do you think that these costs are suitable for this case? Do you think is not suitable and why?
- What is your comment on the fact that TCs related to negotiations were not identified under the UK FIT scheme?
- Do you think that it is reasonable similar studies in the field to identify different sources of TCs? How this can be explained?
- From your point of you, which is the phase under which most of the TCs occur and which is the most significant source of TCs under the FITs?

# Appendix B: Tables and Figures

| | |
|---|---|
| British Gas | Reuben Power |
| Ecotricity | Scottish Power |
| E.ON | Smartest Energy |
| EDF Energy | SSE (encompassing Scottish Hydro, SWALEC, Southern Electric & Atlantic) |
| EnDCo | |
| F & S Energy Limited | Spark Energy |
| First:utility | Symbio Energy LLP |
| Flow Energy Limited | Texas Retail Energy, LLC |
| Gilmond Consulting | The Midcounties Cooperative Limited |
| GDF SUEZ Energy UK | Total Gas & Power |
| Good EnergyGreen Energy | Tradelink |
| iSupply Energy | UK Healthcare Corporation Limited |
| Neas Energy Limited | Utility Warehouse |
| Npower | Utilita |
| Opus Energy | UPL |

*Figure B-1 List of Confirmed FIT Licensees - 1 April 2013 to 31 March 2014*
*Source: Retrieved From Ofgem website [http://www.ofgem.gov.uk/SUSTAINABILITY/ENVIRONMENT/FITS/RFITLS/Pages/rFiTls.aspx](http://www.ofgem.gov.uk/SUSTAINABILITY/ENVIRONMENT/FITS/RFITLS/Pages/rFiTls.aspx)*

*Table B-1 Summary of solar PV tariffs for 2013*

| Total installed capacity (kW) | Generation tariff with eligibility date* or after 1 May 2013 and before 1 July 2013 | Generation tariff with eligibility date on or after 1 July 2013 and before 1 October 2013 | Lower tariff** with eligibility date 1 May 2013 – 1 October 2013 | Export tariff for 2013 |
|---|---|---|---|---|
| **<4kW (new build and retroFiT)** | 15.44p/kWh | 14.90p/kWh | 6.85p/kWh | 4.64p/kWh |
| **>4-10kW** | 13.99p/kWh | 13.50p/kWh | 6.85p/kWh | 4.64p/kWh |
| **>10-50kW** | 13.03p/kWh | 12.57p/kWh | 6.85p/kWh | 4.64p/kWh |
| **stand-alone** | 6.85p/kWh | 6.85p/kWh | 6.85p/kWh | 4.64p/kWh |

*Source: Table based on information in EnergySavingTrust.org website*
*http://www.energysavingtrust.org.uk/Generating-energy/Getting-money-back/Feed-In-Tariffs-scheme-FITs*

*The eligibility date is the date from which a generator is eligible to receive FITs payments. In most of the cases, this is the date when a FIT supplier receives a valid application for FITs.

**The Lower tariff is applied in cases where the Energy Performance Certificate requirement is not met (i.e. EPC has a band D or higher).

*Table B-2 Qualifying FIT Costs for FIT year 4 determined by the Secretary of the State*

| Type of Licensee | Qualifying FITs cost s per generator | |
|---|---|---|
| Large FIT Licensee | *New* generator | **£10** |
| | *Ongoing* generator | **£15** |
| Small FIT Licensee | *New* generator | **£25** |
| | *Ongoing* generator | **£30** |

*Source: The Secretary of State (2013)*

According to the "Determination by the Secretary of State for Energy and Climate Change" report (2013), the following determinations/clarifications were given in order to better understand the table above:

1. "Large FIT Licensee" means a FIT Licensee which either:

    a. Supplies electricity to at least 125.000 domestic costumers; or

    b. together with its Affiliates (as defined in Schedule A to Standard Licence Condition 33) jointly supplies electricity to at least 125.000 domestic costumers as at 31 December 2012.

2. "Small FIT Licensee" means a FIT Licensee which either:

    a. Supplies electricity to fewer than 125.000 domestic costumers; or

    b. together with its Affiliates (as defined in Schedule A to Standard Licence Condition 33) jointly supplies electricity to fewer than 125.000 domestic costumers as at 31 December 2012.

3. "new generator costs" are determined to be the one-off costs incurred by a FIT licensee on the occasion when an accredited FIT installation is identified on the central FIT register as being an accredited FIT installation for the first time.

4. "ongoing generator costs" are determined to be the costs which continue to be incurred by a FIT licensee in respect of an accredited FIT installation which remains identified on the central FIT register during the particular FIT year.

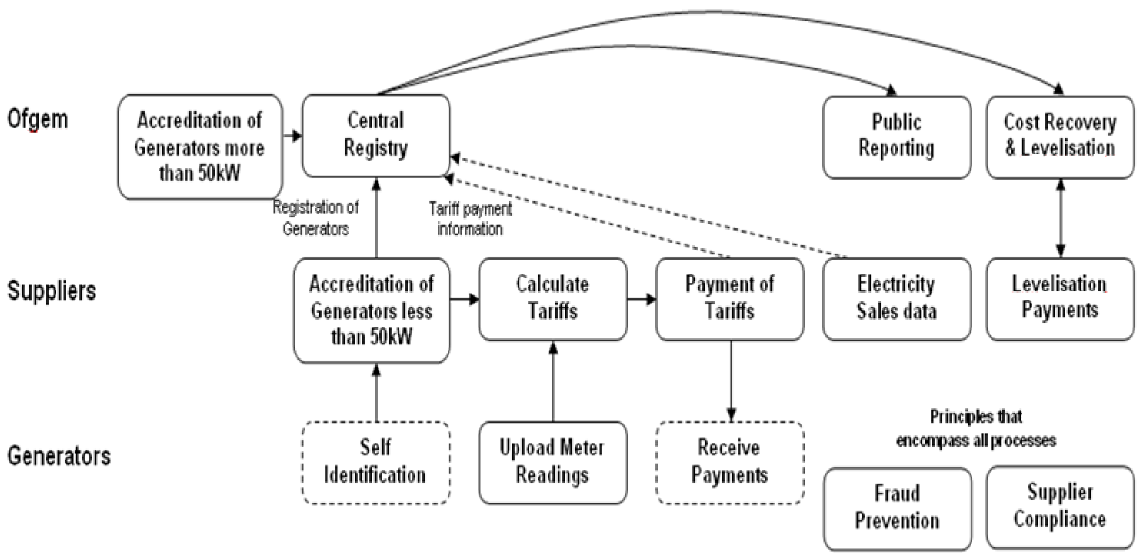


*Figure B-2 Who does what under the FIT scheme*
*Source: Ofgem E-Serve, 2012: "Feed-in Tariffs" Presentation by Keith Duncan, 19 November 2012 (Permission for use in this thesis)*

*Table B-3 Generation tariffs of 2011 and proposed ones for solar PV*

| Band (kW) | 2011 generation tariff (p/kWh) | Proposed generation tariff (p/kWh) |
|---|---|---|
| **4 kW or less (new build)** | 37.8 | 21.0 |
| **4 kW or less (retroFiT)** | 43.3 | 21.0 |
| **>4-10kW** | 37.8 | 16.8 |
| **>10-50kW** | 32.9 | 15.2 |
| **>50-100kW** | 19 | 12.9 |
| **>100-150kW** | 19 | 12.9 |
| **>150-250kW** | 15 | 12.9 |
| **>250kW-5MW** | 8.5 | 8.5 |
| **Stand alone** | 8.5 | 8.5 |

*Source: DECC, 2011*

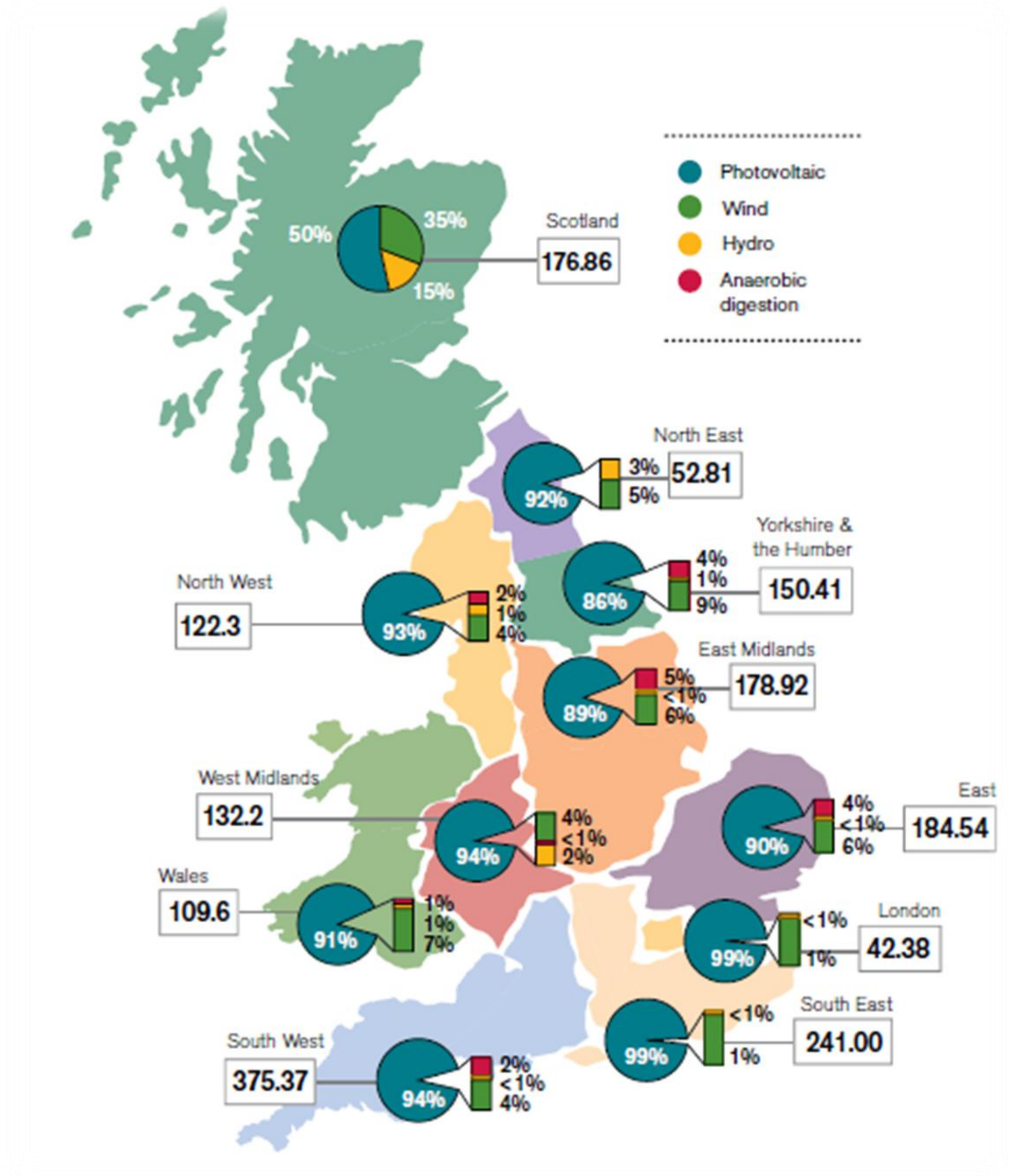


*Figure B-3 Regional illustration of installed capacity by technology (MW)*
*Source: Ofgem (2013c)*