The Impact of Renewable Electricity Support Design on Investment Returns

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Abstract

The thesis at hand analyzes how support schemes (Feed-in-tariffs, Quota obligations and Auctions) provided to renewable electricity producers influence returns of renewable projects. The thesis is divided into two parts. First, private financial data is obtained from renewable electricity producer for 9 photovoltaic power plants from three countries. The data is used to compile DCF valuations models. Using the DCF, we compared valuations incorporating initial expectations of investors with valuations accounting for subsequent negative modifications to support schemes pursued by governments in Romania, Cyprus and Slovakia. Our findings show, that Feed-in-tariff support design provides insufficient downside protection, even though governments are likely to promise otherwise. In the second part of the thesis, observations from case studies are analyzed on more systematic level. In particular, the link between support design type and firm profitability is tested on historical accounting data of 169 companies. Our findings show that the influence of support design differs across renewable technologies.

Keywords: Renewable electricity, Support scheme

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1. Introduction

In the last decade, global climate concerns drove enormous political pressure to promote clean energy. To encourage the development of renewable sources, European Union implemented multiple initiatives with the most recent being Renewable Energy Sources Directive in 2009. The major objective of the directive is to achieve 20% of energy consumption from renewable sources and 10% renewable fuel consumption in transport. In competition with conventional energy sources such as coal and nuclear energy, renewable energy sources face higher production costs and are thus uncompetitive without government support schemes. Therefore, when investors decide where to deploy capital and develop renewable sources, they must incorporate the support design properties into their business forecasts as it will determine the success of the projects in future. The development of the support schemes in EU is fast and ever-changing, with yet little understanding of the consequences of the support design on investment returns. Very few studies are conducted with the aim to connect the support design properties with historical returns of renewable electricity producers. Therefore, the study aims to analyze how support design properties impact the profitability of firms producing renewable energy.

In the 2009 Directive, each member state is committed to its own target, based on its current technological development and future potential. Even though fulfillment of targets is obligatory, member states are given complete independence in designing their own support scheme design. Generally recognized support scheme types include Feed-in-tariffs, Feed-in-Premiums, Quota Obligations, Tax exemptions and Investment Grants. Their design mostly differs in the degree of risk sharing between governments, electricity producers and consumers.

Since most of the demand for support policy analyses comes from governments, the literature assesses the success of support designs by analyzing the efficiency of the design in promoting investments at the lowest cost possible. Since, majority of the literature analyzes the support schemes from government's perspective, our paper wants to complement previous findings with investor's perspective and experience.

Therefore, in section 3, 9 cases of photovoltaic power plants in three different countries are assessed using proprietary data gathered from well-established renewable electricity producer active across Europe. The cases analyzed, provide valuable insight into how different support schemes impacted investors. In respect to investor returns, negative modifications to the support schemes were pursued by all three countries analyzed. Therefore, the case studies allow us to formulate theories about risks faced under different support designs. For each of the projects, discounted cash flow model is assembled and used to assess the impact of different policies on project value. Following the case studies, theories on the impact of support design on investor returns are developed.

The theories developed from case studies are further tested in section 4 on publicly available accounting data sets using econometric tools. By analyzing larger sample size, more systematic approach is developed, allowing us to observe the relationships between support design, support size and firm profitability.

1.1. Overview of literature, theory and our results

The only study on support design that analyzes historical accounting figures of European electricity generators on cross-country EU level, is the insightful study written by Jaraite and Kazukauskas (2013). The study provides comprehensive analyzes of the link between profitability, risk premiums and support design types. The findings confirmed the common view in previous literature, that extra risk faced by firms operating under Green Certificate support scheme, increases the risk premiums demanded by investors on the electricity sector level.

However, since Jaraite and Kazukauskas (2013) did not differentiate between conventional and renewable electricity producers, little can be inferred on how support design impacts renewable electricity producers. Hence, our paper decided to implement methodology in section 4, that narrows down the analyses to renewable energy producers. The methodology adopted in our study also differentiates across the most common renewable technologies – Wind, Photovoltaic and Hydro power. After differentiating across technologies, our results suggest, that findings observed by Jaraite and Kazukauskas (2013) on the sector level cannot be blindly extended to renewables subsector. The relationship between support design and profitability is technology dependent.

Even though most of the literature is focusing on evaluating the support schemes from government's perspective, valuable information relating to profitability of renewable producers can be indirectly inferred from the studies. Clearly, connection between the costs of support to consumers and the financial returns of producers must exist. Groba et. al (2013) wrote the first study with rigorous econometric analyses of the link between support design and its impact on promoting investments. The authors designed Return on Investment (RoI) indicator, which was used to explain the aggregate investment level by country. Authors estimate that Feed-in-tariff support design increased investments by 0.5% for every 1% ROI. This study shows, that countries that adopted Feed-in-tariff support scheme achieved higher investments. For purposes of our study, the study revealed the preference of investors towards Feed-in-tariffs support scheme.

Kilinc-Ata (2016) studied the effectiveness of support schemes on promoting renewable investments in 50 US member states and 27 EU countries. He concludes that Feed-in-tariffs, tenders and tax incentives were the most effective in contrast to quota obligation support design. Bolkesjø et. al (2014) observed how cumulative investments in 5 countries are affected by different support policies. The study also concludes that Feed-in-tariffs support scheme have significant impact on the photovoltaic and wind investments.

Findings by Killinc-Ata (2016), Bolkesjø et. al (2014) and Groba et. al (2011) show that investors have favored the Feed-in-tariff design in the past. However, in our view, analyzing the success of promoting investments in the past and neglecting the returns following the investment decisions is insufficient to forecast investor preferences for support designs in the future. Comparing the investment rates between the countries, which are largely driven by government promises, and neglecting the realized returns by producers following the investments can result in biased assessment towards support schemes that promised a lot but delivered little for investors.

For example, Czech Republic benefited from enormous initial investments and fulfilled the EU targets 6 years before the deadline (Eurostat, 2016) due to highest photovoltaic Feed-in-tariffs among all the member states (CEER, 2015). However, after power plants were built, government implemented highly debated controversial measures, offsetting the previous gains. Similar trend could be observed across multiple member states where high investment rates were achieved initially.

The observed trend across the countries mentioned, motivated our research to analyze whether support design explains the profitability following the investment decisions. To conduct such study, in section 3 of this paper, we used a discounted cash flow valuation method to value photovoltaic projects and observed whether investors assessed the riskiness of support designs correctly in the past. If investors were deceived by governments in the past, their perception and support design preference could have changed. Consequently, the higher effectiveness of some policy designs implemented in the past might diminish in future. The 9 projects analyzed in our paper confirm this concern. The company interviewed in the study is much more cautious in the assessment of the support design than in the past. In particular, the company developed high skepticism towards trusting the support design risk characteristics.

Modifications to support designs negatively impacting investments could also be observed in the case studies from Romania and Slovakia. These two countries use completely different support design in terms of risk sharing. Commonly, it is assumed that Green Certificate support system implemented in Romania is riskier for investors than the Feed-in-tariff support scheme used in Slovakia. Since the case studies suggest similar risk levels, just manifesting via different mechanisms, theory is developed suggesting that support design is itself insufficient in reducing the risks that investors face. To later test this theory, the impact of support design on the profitability of European renewable electricity producers is observed.

Therefore, in our paper, analyzes are conducted to assess whether particular support scheme (i.e. Feed-in-tariff) protected the investors from subsequent negative changes implemented by governments more than other scheme type (i.e. Quota Obligations). For example, Slovakian cases analyzed in our study show that Feed-in-tariff scheme, did not protect investors from the negative development of government's attitude towards renewables. This contradicts the notion in most of the literature that Feed-in-tariffs provide lower risk and thus risk premiums demanded by investors are lower. Even though Feed-in-tariffs should mitigate the risk on paper, Slovakian government found methods to transform the design by subtle changes resulting in disappointing outcome for investors.

Couple authors recognized the lacking inclusion of investor views in the policy design and provided great contributions to understanding the interplay between the design and investor preferences. Dinica (2004) was first to analyze how policy design impacts investments by analyzing the risk-profitability characteristics of support scheme types. He shows that usual comparisons between Feed-in-tariffs and Quota obligations neglect that preference for certain support type is driven by concrete design details rather than broad classification. By analyzing Spain's wind energy investments in his next paper, Dinica (2006) showed that Feed-in-tariffs support scheme was mistakenly credited for the success in promoting wind power sector investments. Hence, realizing the need to capture many support details, our study uses the Discounted Cash Flow methodology to assess the support schemes.

Also, Fagiani et al. (2013) show that the success of Feed-in-tariff is dependent on the ability of regulator to set the right price level, otherwise ineffectiveness of support or over investment occurs. They also argue that quota design poses advantages such as limits to overinvestment and optimizing the timing of investments by postponing investments into yet inefficient technologies into the future. Some of the findings are confirmed by our case study analyzes. In particular, when Slovak government set too-high Feed-in-tariff support levels initially, overinvestment occurred.

1.2. Structure

First, in section 3 of the paper, 9 specific projects in 3 countries will be analyzed using proprietary data from solar plant development and operating company. The 9 cases assessed are in Romania, Cyprus and Slovakia. The support schemes adopted in these 3 countries differ, thus will provide the readers with insight into key differences for investors in terms of risks and returns. The analyses of business plans, cost structure, financing options and legislation changes impacting the profitability of these plants will be observed. The results show that each support scheme poses great investment risks, as initial promises and low risk support design are likely to be modified by governments in future.

In the second part of this paper, more systematic approach will be developed using accounting data of European renewable electricity plant operators. By first assessing the exposure of the renewable electricity producers to different support schemes, a link can be observed between the scheme type and project profitability, risk premiums and investor expectations.

By dividing the thesis into the aforementioned two parts, a comparison can be made between public available data and proprietary data, acknowledging the tradeoff between having detailed data on 9 projects and less reliable public data on much larger sample.

2. Brief overview of different support scheme types

Different support scheme types are most often categorized as Feed-in-tariffs, Feed-in-Premiums, Auction schemes, Quota obligations, Investment support, low interest loans and tax exemptions.

2.1. Feed-in-tariffs

Feed-in-tariffs is the most widely used support scheme to motivate investments into renewable electricity production. Under the Feed-in-tariffs regime, the producer of renewable electricity is promised fixed price for unit of electricity produced. Since the cost of renewable electricity production is often above the current electricity market price, the investor is offered sufficient price to fill in the gap between the costs of electricity production and cost of electricity on the market. Since the electricity producers is promised fixed price, they are protected from volatility in electricity market price. Consequently, investors prefer high predictability of this scheme, which may result in lower risk premiums demanded to pursue investments. On the other hand, Held et al (2014) show that Feed-in-price support distorts the electricity market, since renewable electricity producers are not motivated to consider current supply and demand as their revenue is fixed.

2.2. Feed-in-premiums

Lack of market signaling in Feed-in-tariffs is partly solved via feed-in-premiums support scheme. Feed-in-premiums is designed to compensate renewable energy producers by offering higher price for electricity but via a mechanism where producers first sell the electricity directly on the market and receive the premium on top of the price from the government. The exposure of renewable electricity producers to electricity price movements, creates better market incentives. For example, producers that sell electricity in regions where shortage of electricity (and hence high price) occurs, benefit from higher returns. Such support thus promotes decentralized production which in turn decreases the challenges faced by the grid and distributors of the electricity. However, since the plant operators are impacted by electricity price volatility, extra risks are involved. To offer higher stability and transparency, variations such as premium with cap and floor have been developed in some member states.

2.3. Quota obligations

Quota obligations support scheme is an alternative which poses less market distortion than Feed-in-price and Feed-in-Premium schemes. Based on the national targets on renewable energy, governments force electricity suppliers to buy certain quota of electricity from renewable sources. Depending on renewable technology type, the renewable electricity producer receives certain number of Green Certificates for every unit of electricity produced. The Green Certificates, are later bought by electricity suppliers to fulfill the quota. Failure to fulfill of quota results in penalties for suppliers.

All the revenue received by renewable electricity producers is determined on the market. First source of revenue, comes from selling the electricity at market prices. Second source of revenue, comes from the certificates whose price is also determined on Green Certificate Market.

Since price of green certificates is determined by supply and demand, this scheme introduces certain degree of self-regulation and market mechanisms in promoting investments into renewable energy. When clean energy capacity is lacking, the motivation to invest are higher due to the upward pressure on Green Certificate price. On the other hand, when renewable energy overproduction occurs, the green certificates above the quota are worthless and thus further investments into clean energy become unprofitable.

However, volatility of Green Certificate price and electricity price introduce extra risk for investors and thus can potentially result in higher risk premiums expected by investors. Higher risk premiums can translate into higher costs incurred by consumers or government.

2.4. Investment support, low interest loans and tax exemptions

As will be observed in the case studies presented below, initial capital expenditure account for the majority of costs of renewable electricity production. Therefore, the ability to finance renewable projects at lower cost has significant impact on returns of renewable projects. Thus, governments often provide either initial subsidies on capital expenditures or low interest loans for the projects. Tax exemptions can also be used to promote investments.

3. Analyses of 9 Photovoltaic Plants in Romania, Cyprus and Slovakia

There has been extensive coverage in previous literature analyzing the efficiency of different support schemes on achieving national targets of EU member states. However, less attention was given to analyzing the impacts of these schemes on investor returns. The lacking studies on the impact of subsidies to investor's returns are mostly caused by the private nature of the data that is required to assess individual renewable projects. The large majority of companies active in renewable space are private and hence do not disclose financial data. Moreover, majority of the public companies present in renewable field are as well active in other businesses such as conventional electricity production. Due to accounting consolidation in financial reports, it is hard to assess the impact of subsidies on individual projects and renewable technologies.

The added value of this section, lies in uncovering and processing financial data that is of private nature. The data is received from active plant operator present in multiple countries in Europe. The company provided the author with separate financial data for each individual project, which allows for comparison in between projects and different countries. The primary financial data received from photovoltaic plant developer and operator, mainly active in Central and Eastern Europe, is used to draw conclusions about the impact of different support scheme design on investments. The data includes historical financials, business plans with financial forecasts and capital structure for each project. The data is used to value the projects. The accompanying valuation models allow us to observe how different types of support schemes are accounted for in the business plans and how they impact risks and returns of the projects. In majority of the cases, the public information on the support scheme design, lacks details that have significant impact on returns or risks of the projects. By interviewing the company, our study uncovers risks hidden under surface.

The projects analyzed are based in 3 different countries – Slovakia, Cyprus and Romania in which the support scheme designs vary substantially. When assessing investments impacted by various support scheme designs, investors face different challenges in producing assumptions and business forecasts. By analyzing how the business forecasts were formed, one may capture the impact of the support scheme on the valuation and investment. Qualitative and quantitative comparison between the 3 countries will be presented including the advantages and disadvantages of each support design for the investors. Also, valuable data about different sources of risks can be obtained by interviewing an employee of this company.

The analyses are presented as follows. For each country, brief introduction about the macroeconomic environment and the design of the support scheme will be presented. Later, using the data obtained from the company, quantitative impact of the support scheme on project valuation will be obtained. An analyses on how the support scheme impacted the business forecasts of the company will be qualitatively and quantitatively evaluated. We will also observe the sensitivity of the project value to the support scheme specifics and hence analyze the dependency of the projects on government support.

3.1. Methodology

None of the EU members have same RES-E support design. Even though classification and categorization of the schemes can be made, each scheme has its own modifications. The unique design of each support mechanism makes it difficult to compare financial impact of support schemes using models with only few inputs. In the first part of the thesis, two methodologies will be used. First, due to the unique and fairly complicated nature of each support scheme, the method of choice to analyze the financial impact on project firms value for the 9 projects presented, is discounted cash flow valuation (DCF). The second approach used, will be qualitative comparison of the impact of support design features on investments.

The DCF valuation results will be presented for each country. DCF method provides many advantages for the purpose of this study. The company was interviewed to provide all the assumptions and expectations of current management and investors. This method was chosen, because it allows the author to capture all the details of the support scheme design. Since each support scheme consists of fairly complicated rules and legislative and market conditions, DCF valuation allows for detailed observation on the effect of individual support design features on investor returns and firm's value. It also allows for sensitivity analyses to various assumptions which indicates the reliability of assessing the effectiveness of support schemes on individual parameters. For example, a support scheme can seem high on surface, but accompanying regulatory fees and expenses could potentially offset its effect. This tradeoff could be easily spotted in DCF valuation as every source of revenue and cost is separated and can be stripped out.

Using the DCF method, one may observe the actual cash flows rather than accounting profit. Often, the investments into renewable projects require withholding of substantial cash at the beginning, for example in reservoir funds, which cannot be directly observed on P&L accounting figures such as net income or EBIT.

This approach also reveals how actual investors evaluate the support scheme and how they think about revenue, costs, risk, cost of capital and other assumptions. To form assumptions about the projects, company employee was interviewed. By using the company's assumptions rather than those of the author, the valuations obtained reflect actual investor's expectations.

Usually, the disadvantage of DCF method is the high valuation sensitivity to terminal value which is the sum of discounted cash-flows assumed after forecasted period. Terminal value is usually sensitive to assumptions in far future. However, in solar plant projects, the cash-flows are bounded by the lifetime of the project and then a plant shutdown is assumed. Under such circumstances, DCF method provides for more precise valuation.

However, the dependence of DCF on multiple assumptions and forecasts also pose disadvantages due to their subjective nature. Since the data is collected from one company, there can be significant bias in the evaluation of all these projects based on management's opinions on various topics. It is hard to draw generalizing conclusions using this method, as the market expectations can differ. Therefore, in section 4, our study analyzes whether generalizing observations can be made on larger data set including public profitability information on other projects.

However, qualitative observations from the projects are easier to generalize across different support design schemes. For example, the ability to forecast returns under different support scheme designs are caused by the support scheme rather than specific projects.

For each country (Romania, Cyprus and Slovakia) following procedure is applied:

Step 1 – Introduce macroeconomic environment for photovoltaic investments
Step 2 – Create discounted cash flow valuation model incorporating the business forecasts prior to the project launch. Presentation of key financial inputs and outputs will be provided.
Step 3 – Present the changes to support scheme proposed by governments and analyze the impact of market developments on the project

Step 4 – Create discounted cash flow valuation incorporating the market developments and changes to support scheme

Step 5 – Compare the financial metrics of the project before and after the changes

Final step (after 1-5 is repeated for every country) – Compare the projects and corresponding support schemes across countries

3.2. Data

The data gathered concerns 9 projects in total with 4 in Romania, 2 in Slovakia and 3 projects in Cyprus. The interviewed company provided comprehensive business plans for the projects involved, sufficient to assemble discounted cash flow model for each project. Specifically, historical and forecasted Profit and Loss statements, Balance Sheet accounts, and financing details are provided. The assumptions that are used for the valuation of these projects via DCF are gathered from the interviews with the company.

The company also provide a lot of details on how policy development impacted their ongoing businesses. The qualitative assessment provided by the employee is used to form assumptions on DCF inputs, that are further used to value the impact of support changes on firm value.

All the projects are either ongoing or yet to be launched, and hence the data must be provided anonymously. For this purpose, the names of the projects used are generic, i.e. Project 1 – 9, with the capacity of the plant rounded to nearest MW of capacity to prevent potential identification of these projects.

3.3. Cases from Romania

3.3.1. Macroeconomic environment

In the 2009 renewable energy directive, Romania has committed to 24% energy commitment by 2020. Below is the summary of the historical share of renewable energy in gross energy consumption between 2004-2014.

Table 1 Share of renewable energy in gross final energy consumption in Romania

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2020 TARGET
EU (28 countries)	8.5	9.0	9.5	10.4	11.0	12.4	12.8	13.1	14.3	15.0	16.0	20.0
Romania	17.0	17.6	17.1	18.3	20.5	22.7	23.4	21.4	22.8	23.9	24.9	24.0

Source: Eurostat

In 2014, Romania has already achieved the 2020 target, while being only 0.1% short of the target in 2013. Observing the fulfillment of the target is especially important in the obligation quota support design used in Romania. In a quota obligation system, investors must closely watch the gap between targets set by governments and the actual electricity production as the fulfillment of the quota creates pressure on the Green Certificate price which punishes overproduction. As we will see in the analyzed Romanian projects, the Green Certificate price collapsed as the result of the oversupply.

According to CEER (2015), 6 EU member states adopted Green Certificates support design to achieve the EU renewable targets. These members are Belgium, Italy, Poland, Romania, UK, Austria and Romania. However, Romania is the only EU member state that has adopted quota obligation support scheme without any other scheme in place for renewable energy plants connected to the grid. For example, Belgium, Italy and United Kingdom allow producers to choose between Feed-in-tariffs and Green Certificates for some technologies. Therefore, by analyzing Romanian projects, the impact of the quota obligation on the project valuation is more transparent than in countries with combined support designs.

3.3.2. Valuation prior to the launch of projects

The projects studied in this section are 4 photovoltaic power plants with capacities ranging from 3MW to 5MW. The revenue forecasts are created by the company as follows. The revenue consists of two sources. First revenue source comes from selling the electricity on open market at assumed market price. The current electricity price is assumed to grow by inflation of 2%. The weather conditions are assumed similar to previous years, with slight decay in the effectivity of the solar panels (0.5% per year). The total electricity production is determined by plant capacity and climate potential. The second and major revenue source comes from the Green Certificates received from the Transmission System Operator, at the rates and conditions present at the time the project was launched (6 Green Certificates per MWh). The revenue from Green Certificates is computed by multiplying the number of Green Certificates received in the given year and their expected price. In **Table 2**, valuation summary is provided.

Table 2 Valuation of Romanian Projects Prior to Support Changes

Valuation of Romanian Projects Prior to Support Changes

Inputs	Project 1	Project 2	Project 3	Project 4
Investment costs per MW installed (EUR)	1,227,197	1,278,342	1,349,673	1,387,260
Capacity (MW)	5	4	3	3
Quantity of energy supplied 1. year (MWh/MWp)	1,176	1,168	1,222	1,185
GC Price	29.4	29.4	29.4	29.4
Avg GC Price	42.6	42.6	42.6	42.6
GC Price Discount	*0.0%*	*0.0%*	*0.0%*	*0.0%*
Energy Market Price (EUR/MWh)	24.1	24.1	24.1	24.1
Indexation of the min GC price	*1.0%*	*1.0%*	*1.0%*	*1.0%*
Growth of electricity price (2018 onwards)	*3.0%*	*3.0%*	*3.0%*	*3.0%*
WACC	*8.5%*	*8.5%*	*8.5%*	*8.5%*
Outputs				
Enterprise Value	10,147,223	7,831,191	6,943,032	6,251,562
Enterprise Value per MW	2,122,850	2,093,901	2,268,965	2,107,031
PV of Electricity Revenue	304,315	302,292	316,179	306,636
PV GCs Revenue	2,212,181	2,198,697	2,338,583	2,263,694
PV of Corporate Costs	(393,646)	(407,088)	(385,798)	(463,299)
NPV	4,281,223	3,050,191	2,813,032	2,135,562
NPV (per MW)	895,653	815,559	919,292	719,771
Unlevered IRR	18.15%	16.98%	17.75%	15.55%
Unlevered FCF in 2015 and 2016	1,845,838	1,365,007	1,240,472	1,028,167
Levered FCF in 2015 and 2016	775,626	555,907	430,675	417,816
Profitability	*323.8%*	*307.6%*	*312.6%*	*285.7%*

Notes:

Enterprise Value is computed as present value of unlevered FCFs discounted by WACC

PV of Electricity Revenue equals discounted future revenue from electricity by WACC

PV of Corporate Costs equals discounted future cash-impacting costs by WACC

NPV is computed as Enterprice Value net of Investment Costs

Metrics expressed as per MW are computed by dividing the appropriate figure by the capacity in MW

Unlevered FCF is cash flow prior to debt service

Levered FCF is cash flow after servicing interest and debt repayments

Levered and Unlevered FCF is computed by adding the FCF in 2015 and 2016 to capture the impact of GC deferral post 2017

Profitability is computed as net absolute money generated by the project

Indexation of min GC price is the level by which government increases the GC price floor every year

As observed in **Table 2**, the investment costs per MW of capacity are decreasing with the size of the plant. This is due to economies of scale. However, the interviewed employee explained that economies of scale are diminished after certain capacity is achieved (estimated between 5MW-10MW).

First, the valuation of future free cash flows to firm from selling electricity alone less the corporate costs are negative. In other words, operating costs excluding the depreciation are higher than revenue from selling electricity on the market. These costs include land rental costs, security fees, project management costs, electricity consumption, grid point maintenance fees, insurance fees, annual fees to regulators (OPCOM, ANRE), income taxes, taxes for land and special construction, reactive power costs and other costs. Since cash-impacting operating costs (excluding D&A) are higher than revenue from selling electricity, the company would be better off closing the plants immediately if cost restructuring would not be possible. These results clearly show that financial feasibility of solar plants operating in Romania depends almost entirely on the support scheme. Therefore, also the majority of the project risk comes from the support scheme changes.

However, for all the projects concerned, the company expected high IRR between 15.6% – 18.2% on unlevered bases. Since the IRR is significantly above the cost of capital (8.5%), the company considered the investment very profitable. Positive profitability, NPV and other metrics summarized in Table 2, explain why Romania witnessed such large investment levels observed at the time.

3.3.3. Overview of implemented support changes

Analyzes of 4 Romanian projects show that despite high government promises of high future returns, high uncertainty and investment risk is present. A common support policy development among member states with higher political uncertainty (i.e. Bulgaria and Czech Republic) could be observed, as governments motivated high investments by introducing higher than usual support schemes with subsequent negative changes after the investments have realized. On one hand, increased support encouraged investments but on the other hand the higher cost to consumers or tax payers became politically unpopular which triggered sudden modifications to the support schemes. Since the legal principles of retroactivity were violated in multiple cases, investors legally challenge the support modifications by governments.

Romania was not exception to this practice, as high promises encouraged investments with subsequent modifications offsetting the expected returns. The initial support provided fixed amount of Green Certificates per MWh produced, depending on the renewable technology. The costlier RES technology was awarded higher number of Green Certificates than technology with lower efficiency.

Changes in support schemes impacting renewable electricity plants were applied to both investments realized before and after the legislative changes. Investments realized after the changes faced steeper support decreases by reducing the number of Green Certificates per MWh by up to 50% for all technologies. Although, decreasing the support for new investors over time as technology becomes cheaper is standard and expected. However, by modifying support scheme to investments realized before the proposed changes, investors were caught off-guard as governments have previously promised the given support for 15 years.

For investments realized prior to support changes, the major measure pursued by government effecting the support has been realized through restrictions on the ability to trade Green Certificates that investors have received. In particular, renewable electricity producers were forced to postpone the selling of 33% of received Green Certificates. Initially, the solar plant technology was promised 6 GC/MWh, but the modifications implemented in 2014 allowed the producers only to sell 4 Green Certificates/MWh and defer the selling of the remaining 2GC/MWh after April 2017.

By design, Quota Obligation support scheme provides highest revenue uncertainty to investors as both electricity price and GC price is determined in the market and thus unknown in advance. Initially, to partially mitigate downside from Green Certificate price volatility, Romanian government implemented floor and cap on the allowed Green Certificate trading prices. In principle, by adding cap and floor to Green Certificate trading price, the resulting support system should resemble the Feed-in-Premium support scheme. In previous literature (Ecofys, 2014), it has been assumed that by creating a cap and floor on the Green Certificate price, renewable electricity producers are protected from the downside of Green Certificate price collapse. However, the interviewed company showed that electricity producers receiving Green Certificates were unable to sell at the defined minimum prices. As consequence, market price was far below the floor (up to 40%). This discount is not captured by official data, because most of the transactions are recorded at minimum prices even though economic value received is lower. The valuation impact of the drop in Green Certificate price is captured in the valuation summary presented in Table 3 in the next section. Key takeaway from Romanian projects is that regulation setting the Green Certificate floor price provides insufficient protection for renewable investments.

3.3.4. Valuation incorporating the changes to support scheme

The legislative changes described above can be quantified by observing their valuation impact on 4 projects analyzed. Table 3 summarizes valuation before and after the changes to support scheme. The "Before" column shows financial metrics prior to the changes to support scheme. The "GC Deferral" column shows the valuation impact of the trading restrictions imposed by the government. The "40% Discount" shows the impact of Green Certificate price collapse below the Green Certificate price floor set by the government.

Table 3 Valuation of Photovoltaic Projects 1 and 2 in Romania After the Support changes

Valuation of Photovoltaic Projects in Romania After the Support Changes

	Project 1			Project 2		
Inputs	Before	GC Deferral	40% Discount	Before	GC Deferral	40% Discount
Investment costs per MW installed (EUR)		1,227,197			1,278,342	
Capacity (MW)		5			4	
Quantity of energy supplied 1. year (MWh/MWp)		1,176			1,168	
GC Price	29.4	29.4	17.64	29.4	29.4	17.64
Avg GC Price	42.6	42.6	30.0	42.6	42.6	30.0
GC Price Discount	*0.0%*	*0.0%*	*40.0%*	*0.0%*	*0.0%*	*40.0%*
Energy Market Price (EUR/MWh)	24.1	24.1	24.1	24.1	24.1	24.1
Indexation of the min GC price		*10%*			*10%*	
Growth of electricity price (2018 onwards)		*3.0%*			*3.0%*	
WACC		*8.5%*			*8.5%*	
Outputs						
Enterprise Value	10,147,223	10,068,923	6,759,265	7,831,191	7,770,333	5,196,151
Enterprise Value per MW	2,122,850	2,106,469	1,414,072	2,093,901	2,077,629	1,389,345
PV of Electricity Revenue	304,315	304,315	304,315	302,292	302,292	302,292
PV GCs Revenue	2,212,181	2,195,800	1,503,403	2,198,697	2,182,425	1,494,141
PV of Corporate Costs	(393,646)	(393,646)	(393,646)	(407,088)	(407,088)	(407,088)
NPV	4,281,223	4,202,923	893,265	3,050,191	2,989,333	415,151
NPV (per MW)	895,653	879,273	186,876	815,559	799,287	111,003
Unlevered IRR	18.15%	17.68%	10.58%	16.98%	16.57%	9.70%
Unlevered FCF in 2015 and 2016	1,845,838	1,183,314	653,271	1,365,007	850,069	438,118
Levered FCF in 2015 and 2016	775,626	113,102	(416,941)	555,907	40,969	(370,982)
Profitability	*323.8%*	*324.0%*	*224.1%*	*307.6%*	*307.8%*	*212.4%*

Notes:

Enterprise Value is computed as present value of unlevered FCFs discounted by WACC

PV of Electricity Revenue equals discounted future revenue from electricity by WACC

PV of Corporate Costs equals discounted future cash-impacting costs by WACC

NPV is computed as Enterprice Value net of Investment Costs

Metrics expressed as per MW are computed by dividing the appropriate figure by the capacity in MW

Unlevered FCF is cash flow prior to debt service

Levered FCF is cash flow after servicing interest and debt repayments

Levered and Unlevered FCF is computed by adding the FCF in 2015 and 2016 to capture the impact of GC deferral post 2017

Profitability is computed as net absolute money generated by the project

Indexation of min GC price is the level by which government increases the GC price floor every year

Table 4 Valuation of Photovoltaic Projects 3 and 4 in Romania After the Support Changes

Valuation of Photovoltaic Projects in Romania After the Support Changes

	Project 3			Project 4		
Inputs	Before	GC Deferral	40% Discount	Before	GC Deferral	40% Discount
Investment costs per MW installed (EUR)		1,349,673			1,387,260	
Capacity (MW)		3			3	
Quantity of energy supplied 1. year (MWh/MWp)		1,222			1,185	
GC Price	29.4	29.4	17.64	29.4	29.4	17.64
Avg GC Price	42.6	42.6	30.0	42.6	42.6	30.0
GC Price Discount	*0.0%*	*0.0%*	*40.0%*	*0.0%*	*0.0%*	*40.0%*
Energy Market Price (EUR/MWh)	24.1	24.1	24.1	24.1	24.1	24.1
Indexation of the min GC price		*10%*			*10%*	
Growth of electricity price (2018 onwards)		*3.0%*			*3.0%*	
WACC		*8.5%*			*8.5%*	
Outputs						
Enterprise Value	6,943,032	6,867,581	4,626,433	6,251,562	6,180,614	4,078,273
Enterprise Value per MW	2,268,965	2,244,308	1,511,906	2,107,031	2,083,119	1,374,544
PV of Electricity Revenue	316,179	316,179	316,179	306,636	306,636	306,636
PV GCs Revenue	2,338,583	2,313,926	1,581,525	2,263,694	2,239,782	1,531,208
PV of Corporate Costs	(385,798)	(385,798)	(385,798)	(463,299)	(463,299)	(463,299)
NPV	2,813,032	2,737,581	496,433	2,135,562	2,064,614	(37,727)
NPV (per MW)	919,292	894,634	162,233	719,771	695,859	(12,715)
Unlevered IRR	17.75%	17.15%	10.17%	15.55%	15.07%	8.37%
Unlevered FCF in 2015 and 2016	1,240,472	799,814	447,275	1,028,167	613,805	282,292
Levered FCF in 2015 and 2016	430,675	(9,983)	(362,522)	417,816	3,454	(328,059)
Profitability	*312.6%*	*313.0%*	*217.3%*	*285.7%*	*286.0%*	*195.9%*

Notes:

Enterprise Value is computed as present value of unlevered FCFs discounted by WACC

PV of Electricity Revenue equals discounted future revenue from electricity by WACC

PV of Corporate Costs equals discounted future cash-impacting costs by WACC

NPV is computed as Enterprice Value net of Investment Costs

Metrics expressed as per MW are computed by dividing the appropriate figure by the capacity in MW

Unlevered FCF is cash flow prior to debt service

Levered FCF is cash flow after servicing interest and debt repayments

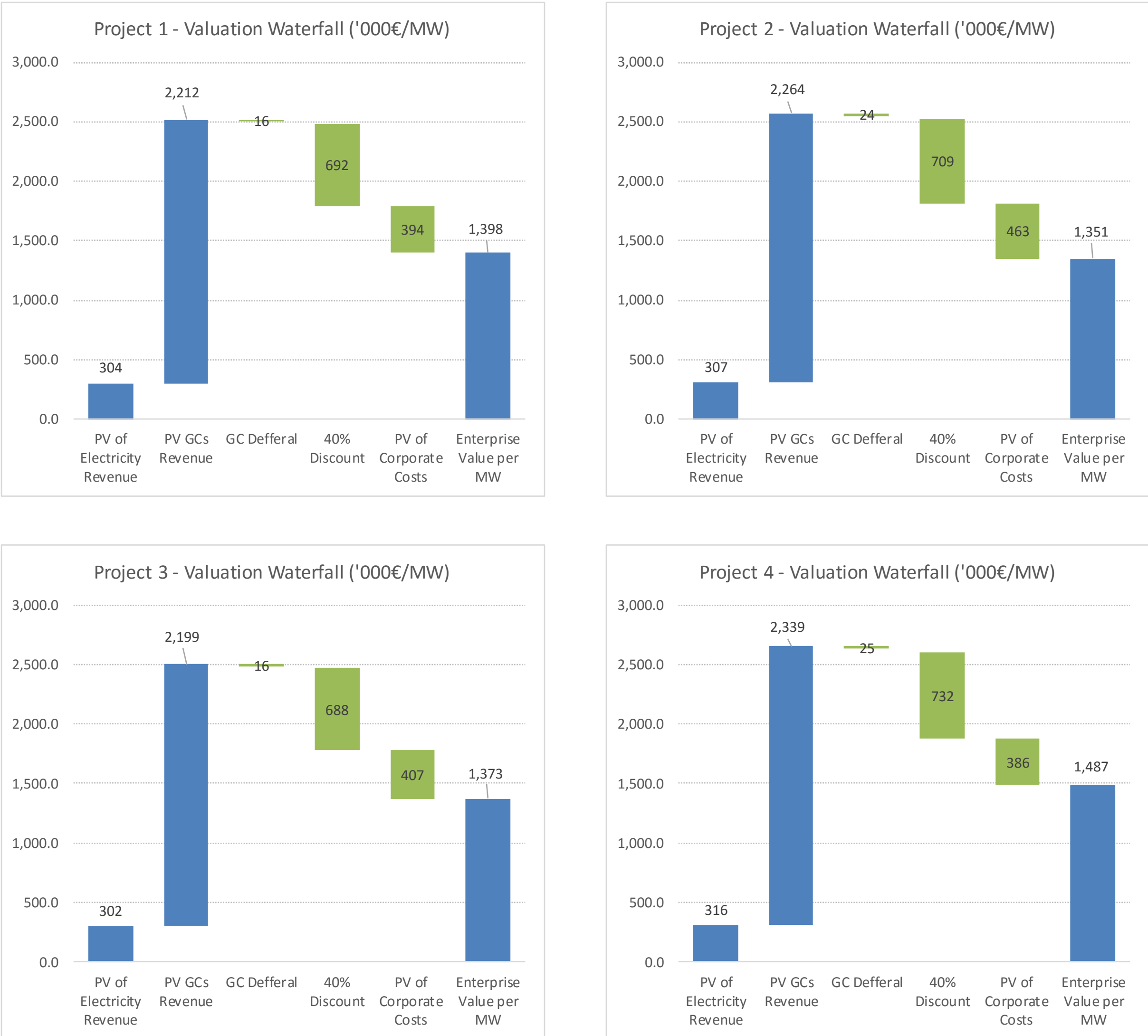
Levered and Unlevered FCF is computed by adding the FCF in 2015 and 2016 to capture the impact of GC deferral post 2017

Profitability is computed as net absolute money generated by the project

Indexation of min GC price is the level by which government increases the GC price floor every year

To analyze the value that investors receive from the Green Certificates, following procedure is applied. The total company value is assumed to be the present value received from selling electricity on the open market, adding present value received from selling the Green Certificates and subtracting the present value of costs associated with running the project, prior to changes to the support scheme. To account for support changes, negative valuation impact is divided between the “GC deferral” and “40% discount”. Resulting valuation waterfalls are presented in Figure 1 showing the valuation impact of the support and its subsequent modifications:

Figure 1 Valuation waterfalls of 4 Romanian photovoltaic projects



As observed in Figure 1, the Green Certificate trading restrictions have negligible impact on NPV and IRR metrics. But since the government implemented changes that impacted investments retroactively, legal action followed the changes. Investors argue that implemented changes violate the EU law.

The interviewed company explained how the legislative changes drastically impacted the financing for renewable energy projects. Prior to support changes in 2014, banks were willing to finance photovoltaic projects. Despite low impact of Green Certificate trading restrictions on valuation of Romanian projects, the short-term negative impact on immediate cash flows (Levered FCF in Table 3), triggered wide spread restructurings. As a consequence, banks became concerned that Romanian government is unpredictable and may adopt even more drastic cuts in the future.

3.4. Cases from Cyprus

3.4.1. Macroeconomic environment

Since Cyprus is a small island, its electricity production was historically dependent on fossil oil imports. Dependence on oil imports poses challenges such as its negative impact on the balance of payments, lack of control over cost of electricity and environmental issues. On the other hand, Cyprus benefits from very encouraging irradiation for photovoltaic electricity production and fairly positive wind conditions for wind energy. High costs of current electricity production combined with positive climate conditions for renewable sources, create high incentive to adopt and promote renewable energy production. During the implementation of EU 2009 Renewable Directive, Cyprus's level of development was below of average of other member states. In particular, 5.6% of electricity was produced from renewable sources in 2009, while the EU average was more than double at 12.4%. Therefore, as can be seen in

Table 5, the 2020 overall national target for Cyprus set in the directive was 13.0%, far below the 20% average.

Table 5 Share of renewable energy in gross final energy consumption in Cyprus

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2020 TARGET
EU (28 countries)	8.5	9.0	9.5	10.4	11.0	12.4	12.8	13.1	14.3	15.0	16.0	20.0
Cyprus	3.1	3.1	3.3	4.0	5.1	5.6	6.0	6.0	6.8	8.1	9.0	13.0

Source: Eurostat

By observing high electricity prices in Cyprus, government realized that renewable energy sources provide cheaper alternative to conventional electricity production from imported fossil oils. In addition, current electricity prices in Cyprus are above the marginal cost of production of conventional renewable technologies such as solar and wind.

In 2012, the interviewed company became interested in the Cyprus renewable electricity production. The company created business plans for potential projects and engaged with banks and investors to secure project financing to launch the projects in 2014. However, as will be analyzed in next section, market conditions changed dramatically in 2013 and the company postponed most of the projects into future depending on situation improvements.

In 2012, only 16MW of photovoltaic capacity was installed in Cyprus. The installed capacity was distributed between small electricity producers and households with installed solar panels on roofs. Small electricity producers benefited from investment grants and a net metering scheme. The Energy Authority of Cyprus (EAC) allowed the small consumers to spread the solar panel investment costs into monthly electricity bills. In many cases, the cost savings to households from using solar panels were so high, that even in the initial period when the solar panels costs were spread into 36 months, the electricity bills decreased. After paying down the investment costs, the savings to households became substantial.

On one hand favorable legislative conditions for small electricity producers and lack of large photovoltaic projects attracted the company to invest in Cyprus. For reference, the company considered investing larger capacity than the aggregate national photovoltaic production at the time. This displays the enormous gap that investors perceived as the plans of governments planned for 192MW photovoltaic capacity by 2020 (PV magazine, 2016). In the end, due to the favorable conditions for small producers and negative changes to large production, the company decided to pursue only investments into 100 kWh plants and postponed the large projects.

3.4.2. Valuation prior to the launch of projects

Using the data provided by the company, valuations are created to assess the impact of market condition changes on the valuations of the projects. To compute return metrics of the projects that are unaffected by financing, the internal rate of return (IRR) is computed on unlevered bases.

In contrast to Romania's quota obligation system, Cyprus adopted Feed-in-tariffs for large producers and investment grants with Feed-in-tariffs for small producers to support renewable electricity. Feed-in-tariffs support system allows for much simpler and more precise revenue forecasts in contrast to Green Certificates system in Romania. In Cyprus, Feed-in-tariffs provide fixed support levels (per MWh) for the next 15 years of the project with only inflation adjustments. Therefore, the predictability of revenue is much higher (compared to Romanian cases), since there are no forecasting challenges caused by Green Certificate and electricity price volatility present.

The company provided business plans for projects ranging from small photovoltaic plants at 100kW to large projects at 5MW, 10MW. Table 6 provides the summary of project valuations that are based on assumptions prior the expected launch of the project.

Table 6 Valuation of Photovoltaic Projects in Cyprus prior to and after support changes

Valuation of Photovoltaic Projects in Cyprus prior to and after Support Changes

	0.1MW		**5MW**		**10MW**	
Inputs	Before	After	Before	After	Before	After
Investment costs per MW installed	1,500,000	1,500,000	1,350,000	1,350,000	1,300,000	1,300,000
Capacity (MW)	0.1	0.1	5	5	10	10
Energy supplied - 1. year (MWh/MWp)	1,900	1,900	1,650	1,650	1,650	1,650
Feed-in-Tariff	138	250	138	83	130	74
WACC	8.5 %	8.5 %	8.5 %	8.5 %	8.5 %	8.5 %
Outputs						
Enterprise Value	205,305	394,009	9,047,700	5,045,931	17,443,808	9,264,689
Enterprise Value per MW	2,053,048	3,940,093	1,809,540	1,009,186	1,744,381	926,469
PV of Electricity Revenue	2,442,256	4,329,301	2,120,906	1,320,553	2,003,853	118,594
PV of Corporate Costs	(389,208)	(389,208)	(311,366)	(311,366)	(259,472)	(259,472)
NPV	55,305	244,009	2,297,700	(1,704,069)	4,443,808	(3,735,311)
NPV (per MW)	553,048	2,440,093	459,540	(340,814)	444,381	(373,531)
Unlevered IRR	*13.3%*	*28.3%*	*12.9%*	*5.0%*	*12.9%*	*4.7%*
Unlevered FCF 2015	23,220	44,500	1,018,500	567,225	1,945,000	1,022,650
Levered FCF 2015	(4,780)	16,500	(444,000)	(895,275)	575,667	(346,683)
Profitability	171 %	431 %	165 %	43 %	164 %	35 %

Notes:

Enterprise Value is computed as present value of unlevered FCFs discounted by WACC
PV of Electricity Revenue equals discounted future revenue from electricity by WACC
PV of Corporate Costs equals discounted future cash-impacting costs by WACC
NPV is computed as Enterprice Value net of Investment Costs
Metrics expressed as per MW are computed by dividing the appropriate figure by the capacity in MW
Unlevered FCF is cash flow prior to debt service
Levered FCF is cash flow after servicing interest and debt repayments
Profitability is computed as net absolute money generated by the project

The main inputs into the DCF valuation are investment costs, capacity, solar irradiation, Feed-in-tariff and cost of capital. Fairly high solar irradiation in Cyprus creates positive incentive for solar investments. In Cyprus, each kW of capacity produces 1650 – 1900 kW of electricity. The investment costs are slightly higher than in Romania, mostly caused by transportation costs of the panels and higher labor costs.

As seen in Table 6, unlevered IRR is above cost of capital. The NPV per MW of capacity ranges from 444 to 553 thousand EUR. The high NPV, unlevered IRR and profitability measures created high incentive for the company to engage in Cyprus' market. Since small plants could be built slightly more efficiently than larger ones, the higher initial investment costs were offset by higher electricity production per unit of capacity. The unlevered IRR for 100kW plant (13.3%) was slightly higher than for the large 5MW plant (12.9%). This shows that economies of scale were not present as even the 10MW project was expected to yield only 12.9% unlevered IRR.

3.4.3. Overview of implemented support changes

Shortly following the formation of company's business plans, the outlook on the returns of renewable electricity production changed dramatically. Realizing that marginal cost of production of renewable electricity is lower than burning oils in already built fire-plants, government decided to increase pressure on investors. To do so, auctioning process was used to determine the Feed-in-tariffs level. Auctioning is a competitive process, where plant developers bid for the access to the grid with business plan proposals with price being one of the key criteria for winning the tender.

3.4.4. Valuation incorporating the changes to support scheme

The valuation incorporating the developments is summarized in Table 6 in the "after" columns. Interestingly, the small plants received support substantially higher than the company expected at average tender price of 250 Euro/MWh in December 2012. This suggests that Cyprus' government preferred small producers. The returns for small photovoltaic plants were very attractive supported by 28.8% unlevered IRR. The profitability defined as net absolute returns during the 15 years of small projects exceeded 440%.

On the other hand, large photovoltaic projects witnessed opposite development. In February 2013, the average auctioned support for larger producers was 84 EUR per MWh, (PV Magazine, 2012 and 2013) substantially lower than support for small producers and the price level expected by the company. High impact of the changes can be observed in significant decrease of unlevered IRR falling from 12.9% to 5.5% and 14.3% to 7.3% for 5MW and 10MW plants respectively. These levels are below the weighted average cost of capital of the company at 8.5%. The NPV of the investments are thus negative. This example shows that high predictability in the revenue caused by the combination of Feed-in-tariffs with auctioning resulted in larger decline in IRR than the Green Certificate scheme in Romania.

3.5. Cases from Slovakia

3.5.1. Macroeconomic environment

The major growth driver of renewable energy investments in Slovakia are the renewable initiatives adopted by the EU, including the latest 2009 Directive. Since Slovakia belongs to member countries with less developed clean energy, it has committed to less ambitious plans than the EU average. For the 2020 target, Slovakia committed to 16% of renewable energy in final consumption, which is lower than in Cyprus (16%) and significantly lower than in Romania (24%) and the EU average (20%). The summary is presented in Table 7.

Table 7 Share of renewable energy in gross final energy consumption in Slovakia

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2020 TARGET
EU (28 countries)	8.5	9.0	9.5	10.4	11.0	12.4	12.8	13.1	14.3	15.0	16.0	20.0
Slovakia	6.4	6.4	6.6	7.8	7.7	9.4	9.1	10.3	10.4	10.1	11.6	14.0

Source: Eurostat

However, despite the 9.4% share of renewables in 2009 energy consumption, the use of solar technology prior to the 2009 EU directive was almost non-existent. In 2009, the estimated installed solar capacity was 0.192MW, while in 2011 it surpassed 480 MW (Chovanec, 2012). The growth surpassed government expectations by big margin, as the targets set out in Slovak National Action Plan where 300MW of solar capacity in 2020. Very high investment rate following the implementation of the directive suggests that the initial support was very lucrative. The company interviewed has built multiple projects in this period and provided detailed data for 2 of the projects. The projects where created in 2009 and the plants where launched in 2010.

3.5.2. Valuation prior to the launch of projects

Slovakia has adopted a Feed-in-tariff support design. However, in contrast to Cyprus, Slovakia does not use auctioning to determine the tariff. The tariff levels are decided by the regulator, with lacking clear and transparent process. For projects launched in 2009, the support levels where determined at 425 EUR/MWh which is very high compared to Romania and Cyprus. However, the support needed to be higher to motivate investments at the time as solar technology was significantly more expensive. Investment costs where approximately 1.9 million EUR/MW compared to 1.2-1.5 million EUR/MW in Romania and Cyprus. As can be observed from valuation summary in Table 8, the generous support still allowed for very high returns (18.9% unlevered IRR), despite higher capital expenditures.

Table 8 Valuation of Photovoltaic Projects in Slovakia Prior to Support Changes

	8.5% WACC	12.0% WACC
Inputs	Before	Before
Investment costs per MW installed	1,930,500	1,930,500
Capacity (MW)	1.000	1.000
Quantity of energy supplied 1. year (MWh/MWp)	1,155	1,155
Feed-in-Tariff	425	425
Outputs		
Enterprise Value	3,284,116	2,675,230
Enterprise Value per MW	3,317,289	2,702,253
PV of Electricity Revenue	4,087,977	3,319,040
PV of Corporate Costs	(208,554)	(160,364)
NPV	1,372,921	764,035
NPV (per MW)	1,386,789	771,753
Unlevered IRR	18.9%	
Unlevered FCF 2015	385,972	
Levered FCF 2015	210,040	
Profitability	221 %	

Notes:

Enterprise Value is computed as present value of unlevered FCFs discounted by WACC
PV of Electricity Revenue equals discounted future revenue from electricity by WACC
PV of Corporate Costs equals discounted future cash-impacting costs by WACC
NPV is computed as Enterprice Value net of Investment Costs
Metrics expressed as per MW are computed by dividing the appropriate figure by the capacity ir
Unlevered FCF is cash flow prior to debt service
Levered FCF is cash flow after servicing interest and debt repayments
Profitability is computed as net absolute money generated by the project

Compared to the projects developed in Romania, the 2 plants operated in Slovakia are smaller at approximately 1MW. This is due to special permits required for larger plants from the TSO, which are limited by government. Therefore, it was a general market trend to build multiple plants with smaller capacity because the regulatory burden was higher than economies of scale.

Due to identical size of the projects, financial metrics used to create the DCF are obtained by averaging the inputs.

The unlevered IRR corresponding to the investor expectations and government promises in 2009 is 18.9%. Since investment into solar energy was in infant stages in Slovakia in 2009-2010, the weighted cost of capital was significantly above the projects analyzed for Cyprus and Romania. The company explained that it was difficult to raise capital below 12% average cost. For comparison purposes, the 8.5% WACC is showed in Table 8, which is derived from the cost of capital in later years in Romania and Cyprus. Similar to Cyprus and Romania, the IRR corresponding to initial expectations significantly exceeds the weighted cost of capital of 12%. The NPV per MW of 0.8m EUR created high incentive to pursue the investment.

3.5.3. Overview of implemented support changes

Despite attractive and predictable features of Feed-in-tariff scheme for investors on surface, Slovakian government took steps to divert the returns away from investors to the government, distributors and consumers. This is in line with other countries in the region with lower political certainty. The employee interviewed emphasized how certain investors closely knit with the government operated with advantageous information regarding the legislative changes, and could make profitable decisions in advance while other market participants were left with disappointments. Well informed market participants knowing in advance the negative legislative changes could sell the plants to foreign investors which were negatively surprised.

In Czech Republic, a neighboring country to Slovakia, government introduced controversial taxes on solar plant profits, which according to photovoltaic investors violated EU principles and resulted in class legal action. Initially, Slovak government was also considering taxing windfall profits, but it is likely that the controversy and development in Czech Republic prevented the government from pursuing such measures.

Consequently, Slovak government took measures that are harder to challenge legally, but resulted in outrage from investors. According to the company interviewed, three measures that harmed investors the most were: sudden retroactive drop in the tariff, so called "G-Component", and a bureaucratic measures preventing subsidy in 2015.

The Feed-in-tariff was initially set at 425-431 EUR/MWh for the investments launched in 2010. Despite the promises, in June 2010, regulator decreased the tariff to 298-345. Firstly, investors argued that law allowed the government to decrease the tariff at most by 10% per year. More importantly, any change in tariff should be applicable following year, as changing the 2010 tariff is retroactive. After investors committed capital into plants that were supposed to launch in months, they suddenly faced dramatic decrease from the promised revenue. The Feed-in-tariff changes are summarized in Table 9.

Table 9 Change of Feed-in-tariffs in Slovakia

Feed-in-tariff	Prices from 15-June-2010	2010 Initial Prices
<100 kW plants on roof	344.58	430.72
<100 kW solar plants	335.96	430.72
100kW to 1MW	318.84	425.12
1MW to 4MW	306.09	425.12
>4MW	297.58	425.12

Source: URSO

Effective from 2014, Slovak government introduced so called G-Component which was a new cost faced by renewable energy producers. Formally, plants connected to the grid were supposed to pay extra charges for the connection to transmission and distribution systems. Effectively, it was a measure that reduced net support given to the photovoltaic plant operators. This measure is currently challenged in supreme court. The company estimates the impact of 20 000 EUR per year for every MW of capacity.

The third controversial cut in the support was realized by bureaucratic measure that punished significant portion of the renewable sector. Every year, plant operators were supposed to file various documents by 15th of August, to apply for next year of renewable support. By law, government bodies accept the fulfillment of this criteria, when the documentation is sent by the official post at the same day. However, the regulator suddenly applied different legal interpretation, and after 15th of August, disqualified every plant that did not deliver the post at the same date. This measure resulted in exclusion of more than 1200 plant operators (out of approx. 3000) from the support in 2015. This measure is also challenged in court.

3.5.4. Valuation incorporating the changes to support scheme

The impact of negative developments on valuation is computed in three steps. First, the base valuation is used from previous section. Second, the effect of G Component is calculated. Third, the effect of lost revenue in 2015 as the result of the bureaucratic barrier is added to the G-Component effect. Finally, in addition to the previous factors, the effect of tariff drop on some 2010 investors is included. The valuation results are summarized in Table 10:

Table 10 Valuation of PV Projects in Slovakia prior to and after Support Changes

	8.5% WACC				12.0% WACC			
Inputs	Before	G Component	2015 lost CF	Tariff Price Drop	Before	G Component	2015 lost CF	Tariff Price Drop
Investment costs per MW installed	1,930,500				1,930,500			
Capacity (MW)	1.000				1.000			
Quantity of energy supplied 1. year (MWh/MWp)	1,155				1,155			
Feed-in-Tariff	425	425	425	306	425	425	425	306
Outputs								
Enterprise Value	3,284,116	3,170,683	2,920,306	2,125,123	2,675,230	2,592,667	2,379,042	1,726,153
Enterprise Value per MW	3,317,289	3,202,710	2,949,804	2,146,589	2,702,253	2,618,856	2,403,073	1,743,588
PV of Electricity Revenue	4,087,977	4,087,977	3,771,845	2,767,826	3,319,040	3,319,040	3,049,311	2,224,956
PV of Corporate Costs	(208,554)	(351,779)	(351,779)	(351,779)	(160,364)	(264,610)	(264,610)	(264,610)
NPV	1,372,921	1,259,488	1,009,111	213,928	764,035	681,472	467,847	(185,042)
NPV (per MW)	1,386,789	1,272,210	1,019,304	216,089	771,753	688,356	472,573	(186,912)
Unlevered IRR	*18.9%*	*18.3%*	*16.3%*	*10.2%*	*18.9%*	*18.3%*	*16.3%*	*10.2%*
Unlevered FCF 2015	385,972	369,972	(6,509)	(6,509)	385,972	369,972	(6,509)	(6,509)
Levered FCF 2015	210,040	194,040	(182,440)	(182,440)	210,040	194,040	(182,440)	(182,440)
Profitability	221 %	207 %	187 %	112 %	221 %	207 %	187 %	112 %

Notes:

Enterprise Value is computed as present value of unlevered FCFs discounted by WACC
PV of Electricity Revenue equals discounted future revenue from electricity by WACC
PV of Corporate Costs equals discounted future cash-impacting costs by WACC
NPV is computed as Enterprice Value net of Investment Costs
Metrics expressed as per MW are computed by dividing the appropriate figure by the capacity in MW
Unlevered FCF is cash flow prior to debt service
Levered FCF is cash flow after servicing interest and debt repayments
Profitability is computed as net absolute money generated by the project

In terms of unlevered IRR impact, the G-Component was not as significant, corresponding to mere 0.6% drop. However, from speaking to the company, photovoltaic projects were usually heavily levered, in some cases to over 90% of loan to value. High leverage levels were based on the assumption that governments are reliable and would not alter the conditions for investments made in previous periods. When governments implement even slight changes, markets may suddenly lose confidence. Similar to Romanian cases, loss of market confidence quickly transformed to reluctant financing from banks and strict enforcement of covenants. Ex post, the worrying behavior from banks could be justifiable as governments continued in further cuts and bureaucratic measures implemented in 2015 resulted in additional 2.0% drop in IRR. More importantly, the impact of G-Component and loss of 2015 support on free cash flow to equity in 2015 corresponded to a drop from unaffected 210’040 to -182’440 EUR/MW. The employee also explained that this cash flow loss resulted in massive restructurings in the solar sector due to the inability of many market participants to service their debt.

The cumulative impact of all three measures on unlevered IRR corresponds to drop from 18.9% to 10.2%. Since the IRR of 10.2% is below the 12% cost of capital, it is clear that the company interviewed would not invest into solar plants in case the negative changes would be applied from the start. However, in contrast to most of investors, the company interviewed did not face the tariff drop as they launched the project ahead of the tariff changes.

3.6. Comparison of the cases in Romania, Cyprus and Slovakia

Table 11 Qualitative summary of analyzed case studies

Qualitative summary of solar investments analyzed in Part 1:

	Romania	**Cyprus**	**Slovakia**
Scheme design	Green Certiciate	Feed-in-Tariff with auctioning	Feed-in-Tariff
Initial promises	High compensation levels with guaranteed floor	High expectations but no promises as auction determines the tariff levels	High compensation levels at fixed and guaranteed rate
Market development following investments	Negative	Negative	Negative
Transparancy, communication and government reliability	Low	High	Low
Protectionism of local producers	No	Yes	No
Mechanism of worsening	Collapse of GC Price (Below previously guaranteed "minimum"), Deferred ability to sell certificates by > 2 yesars, Government did not set up the buyer of last resort	Auctioning erased most of the advantages for investors from positive climate conditions, technological learning and economies of scale.	Bureaucratic Introducing costs to lower net support Lowering the feed-in-tarriff retroactively
Presence of economies of scale	Yes, compensation is proportional to the capacity and produced electricity	No, auctioning resulted in lower tarriffs for bigger plants offsetting cost saving	No, investors chose to build plants under 1MW due to barriers to entry for bigger projects
Climate Conditions	Above average	Ideal	Above average
Impact on bank financing	Highly negative	Available only to domestic firms	Highly negative
Future uncertainty	High	Medium	High
Plan to invest again	No	Yes	No
Lawsuit of investors with government	Yes	No	Yes

In most renewable projects, large proportion of renewable electricity producer's revenue comes from government support. As consequence, the risks of renewable investments is closely knit with potential changes to the support in future. In building renewable power plants, the capital expenditures are mostly incurred at the beginning of the plant life-cycle, and variable costs during the life of the project are relatively small. This observation held true across all 9 photovoltaic projects analyzed in this paper across three countries. After the support ends, the company interviewed is likely to cease the operation of the photovoltaic power plants, as they will become loss making. The inability to scale down the costs in case of negative changes to the support in future by governments, forces investors to have convincing reason to trust the promises into far future, before the launch of the project. Thus analyzing how investments encouraged by support designs in the past performed is of upmost importance since the returns have direct impact on future preferences.

The example in Slovakia shows, that Feed-in-tariffs are not guaranteed to be predictable as promised at the beginning of the projects. After government realized that returns provided to investors were successful in promoting investments, it decided to find ways how to directly or indirectly decrease the promised support. But, all the three countries - Romania, Cyprus and Slovakia, show that despite government promises, there is significant investment risk coming from potential change in attitude of governments towards renewables.

First, despite very positive climate conditions in Cyprus for photovoltaic electricity, the auctioning process quickly erased the impact of higher climate efficiency on returns. Even though in Romania, the yearly production is 1100 MWh/MWp, significantly less than 1650-1900 MWh/MWp in Cyprus, the IRR is higher in Romania than in Cyprus. Therefore, one of hypothesis tested in the second part of the thesis is that climate conditions are likely to be offset by lower support levels.

Secondly, the comparison between projects in Romania and Cyprus also suggests, that despite Green Certificate scheme being more unpredictable in nature, the valuation of Romanian plants was not as sensitive to the negative development. Theoretically, governments would have to provide higher returns to investors incurring higher risk. The relationship between the profitability on Green Certificate design will be tested further in next section.

Key takeaway from all the cases, is that governments can use very subtle ways to suddenly alter the profitability of the projects. Even though officially certain support is in place, in reality a completely different support can be received. Example of Romania, where solar producers are unable to sell their certificates at a guaranteed floor, shows that studies based on public figures will miss such negative effects. In Slovakia, the government officially provides certain tariff to producers, but more than third of the producers lost the support due to discretionary decision by regulator.

4. Systematic analyzes of support scheme's impact on profitability

In this section of the thesis, a systematic approach is introduced to analyze whether observations from the case studies can be generalized across the whole EU. To analyze the interplay between the support design and investment returns, following questions are asked:

1. Does the support design impact the support level?
2. Is there a link between ideal support design and technology?
3. Does the support design explain the profitability of EU renewable electricity producers?
4. Is there any connection between equity Market to Book value and the support design?

To answer the above questions, 3 step approach is applied. First, the relationship between the support size and support design is analyzed. Second, the impact of support scheme design and support scheme size on the profitability of renewable electricity firms is observed. Finally, analysis of market to book equity values of public renewable electricity producers is introduced.

4.1. Relationship between support size and design

The first study analyzing the link between different factors explaining the support levels adopted in EU is the study written by Rio et al (2012). Interestingly, the study found that Feed-in-tariff support design allowed governments to provide lower support levels than the rest. However, this study analyzes only the wind power market. Since the study was written, CERE (2015) compiled dataset containing the support costs for EU member states by every major renewable technology. Therefore, our study extends the analyses to three major renewable technologies - Photovoltaic, Wind and Hydro power generation.

4.1.1. Hypothesis formulation and selection of Methodology

In this section, the study develops on findings from the case studies and extends the analyses using econometric tools. By working with larger data sets, the observations from case studies can be tested on cross-country EU data. Multiple cross-sectional OLS regression is used to analyze the relationship between the support level and various explanatory variables.

The dependent variable used is average support per MWh produced. The selection of the dependent variable is linked to the assumption, that support per MWh is closely related to the support revenue received by producers. In any generation based support scheme (Feed-in-price, Feed-in-Premium or Quota), the support to producers is based on the electricity supplied. The support is determined as fixed price per MWh, or the value of fixed number of Green Certificates per MWh.

To account for different support designs in the econometric analyses, independent variables include the dummy variables for each support scheme type (Feed-in-tariff, Feed-in-price, Quota and Call for Tender) for every technology. The technologies analyzed are Wind, Solar and Hydropower.

Multiple factors can play an important role in the discretionary process of determining the support levels by governments. First, the commitment of the government to fulfill the share of renewables in gross energy consumption targets set in the EU 2009 Directive. For this purpose, proxy variable was used equaling the difference between the target and the actual share in the given year.

Moreover, governments determine the support based on the production potential of any given technology in the given climate region. One could expect, that in countries with better climate conditions, lower support levels would be required to promote investments. From cases observed in Cyprus, the impact of positive climate conditions on future returns was inexistent, as producers bid away the support advantage in the auction organized by government. As the result of the auction, photovoltaic electricity producers were selling electricity at lower prices than conventional electricity sources used in the country. To analyze the impact of climate zone on the support, countries are divided into climate zones and for each region a proxy variable is used.

Third important driver of the support is the electricity price. The electricity price captures locally specific features of the energy market such as marginal cost of production of conventional technologies on the market. Therefore, electricity price is used as control variable.

In Romania and Slovakia, support levels provided to initial investors were similar despite different support designs. In Romania, investors received green certificates under Quota obligations support scheme while Slovak producers received Feed-in-tariffs support. In contrast to Slovakia, Feed-in-tariff scheme in Cyprus provided much lower support as auctioning was used to determine support levels. Therefore, in this section the aim is identify whether similar patterns can be observed across EU. Following hypotheses are tested:

H1: Feed-in-tariffs and feed-in-premiums support designs provide lower support levels than Quota Obligations
H2: Auctioning does not impact support levels
H3: Climate conditions do not impact support levels

4.1.2. Data

The support to producers is provided in different forms. Feed-in-price and Feed-in-Premium offer the compensation by guaranteeing electricity price or premium to market price. The Green certificates compensation is dependent on the green certificate market price. Tax exemptions and investment grants directly affect government budgets.

Since in many cases, the support is paid by consumers rather than governments, the average support level cannot be estimated from government expenditures. Different approaches were developed in the past to estimate the costs of support schemes. The most extensive and granular estimations are provided by CEER (2015). The methodology used by CEER analyzes the support costs by estimating the support that producers were likely to receive. In particular, CEERs methodology captures the market price of Green Certificates for quotas, and the difference between market electricity price and tariffs for Feed-in-tariff and Feed-in-Premium.

Moreover, 2013 support costs estimated by CEER are the most recent estimates on EU cross-country level that the author of this study is aware of. The electricity price and the fulfillment of EU Directive targets is provided by Eurostat. The climate zones differentiation is provided in the annex of Ecofys (2014) study.

4.1.3. Results and discussion

Table 12 Summary of OLS regression explaining support levels adopted by EU members

Summary of OLS regression explaining support levels adopted by EU members across different renewable technologies

Dependent Variable: Support level (EUR/MWh Produced)

Regression Statistics: (17 variables, n=169)

R-Squared	Adj.R-Sqr.	Std.Err.Reg.	Std. Dev.	# Cases	# Missing	t(2.50%,151)	Conf. level
0.660	0.622	74.025	120.330	169	0	1.976	95.0%

Independent Variables	Coefficient	Std.Err.	t-Stat.	P-value	Lower95%	Upper95%	Std. Dev.	Std. Coeff.	Data source
Constant	*66.022	36.601	1.804	0.073	-6.294	138.338			
Solar	**56.692	27.166	2.087	0.039	3.018	110.366	0.458	0.216	CEER
Solar FIP	***174.186	33.445	5.208	0.000	108.105	240.267	0.213	0.308	CEER
Solar FIT	***183.906	25.536	7.202	0.000	133.452	234.359	0.362	0.553	CEER
Solar Auction	-1.092	57.932	-0.019	0.985	-115.554	113.370	0.108	-0.001	CEER
Wind	9.263	25.611	0.362	0.718	-41.340	59.866	0.493	0.038	CEER
Wind Auction	-47.018	56.754	-0.828	0.409	-159.153	65.116	0.108	-0.042	CEER
Wind FIP	-15.922	27.177	-0.586	0.559	-69.618	37.774	0.276	-0.037	CEER
Wind FIT	12.181	22.159	0.550	0.583	-31.601	55.962	0.406	0.041	CEER
Hydro FIP	-15.169	34.428	-0.441	0.660	-83.192	52.853	0.200	-0.025	CEER
Hydro FIT	9.829	23.943	0.411	0.682	-37.476	57.135	0.367	0.030	CEER
Climate Zone 1	***-77.357	22.758	-3.399	0.001	-122.322	-32.391	0.344	-0.221	EcoFys
Climate Zone 2	***-82.772	20.172	-4.103	0.000	-122.628	-42.916	0.337	-0.232	EcoFys
Climate Zone 3	-39.384	27.188	-1.449	0.150	-93.103	14.334	0.331	-0.108	EcoFys
Climate Zone 4	-33.867	22.175	-1.527	0.129	-77.680	9.945	0.337	-0.095	EcoFys
Electricity Price	0.241	0.258	0.935	0.351	-0.269	0.752	33.761	0.068	Eurostat
Gap EU 2013	-0.743	1.895	-0.392	0.696	-4.488	3.002	4.129	-0.025	Eurostat
Year 2013	-10.395	11.451	-0.908	0.365	-33.019	12.230	0.501	-0.043	

Notes:
(*): p-value < 0.10, (**): p-value < 0.05; (***): p-value < 0.01
Solar, Wind and Hydro dummy variables correspond to renew able technologies used to generate electricity
FIT: Feed-in-tariff
FIP: Feed-in-premium
Auction: Auction w as used to determine support levels in combination w ith FIT or FIP
Climate Zone 1: Finland, Latvia, Sw eden, Estonia, Lithuania
Climate Zone 2: Slovakia, Hungary, Slovenia, Austria, Romania, Bulgaria
Climate Zone 3: Greece, Cyprus, Italy, Malta
Climate Zone 4: Portugal, Spain, Croatia
Climate Zone 5: Netherlands, Germany, Belgium, Denmark, Ireland, United Kingdom, France,Czech Republic, Poland, Luxembourg
Gap EU 2013: Computed as differens in EU 2009 target and actual share of renew ables in gross energy consumption in 2013
Year 2013: Year dummy variable

Summary of hypotheses testing

H1: Feed-in-tariff and feed-in-premium support designs provides lower support levels than Quota Obligations	Rejected
H2: Auctioning does not impact support levels	Not rejected
H3: Climate conditions do not impact support levels	Rejected

Some of the results are surprising given that in literature, it is often assumed i.e. Ecofys (2014), that price based subsidies (Feed-in-tariffs and Feed-in-Premium) are cheaper than volume based subsidies (Quota obligations). It is often argued that Quota support levels must be higher to compensate investors for higher risk. After controlling for different variables, our study shows that cost efficiency of each design can be technology specific.

In particular, for photovoltaic technology, the support levels provided by Feed-in-tariffs and Feed-in-Premiums are significantly higher than support levels provided by Quota Obligations. However, for wind technology, the Feed-in-price design has positive effect on support level, while Feed-in-Premium has negative effect on support level compared to Quota Obligations. Same applies to hydropower technology.

The impact of auctioning on support level is highly negative for wind technology but not statistically significant and hence the *H2* cannot be rejected. For solar technology, the negative impact of auctioning is small and also not statistically significant. The climate region has strong impact on support levels provided. Northern Europe and Eastern Europe provide lowest support, with high statistical significance. Thus H3 is rejected. In the next part we use the explanatory variables gathered in the first part to explain profitability of renewable electricity producers. Summary of regression results is presented in Table 12.

4.2. Explaining the profitability of renewable electricity producers

4.2.1. Hypothesis formulation and selection of methodology

Apart from the study written by Jaraite and Kazukauskas (2013), systematic studies on the historical profitability of renewable companies are lacking. Above authors have written very insightful study on how electricity producers coped under different support schemes. They analyzed, whether market imperfections caused by Quota support scheme increase the returns of the electricity sector. Since the authors analyzed all the firms operating in the electricity sector irrespective of the technology, they were able to work with large data set with over 30 thousand observations. However, grouping together the whole electricity sector does not allow us to observe which particular firms benefit from higher returns. Therefore, in the following section, the aim is to narrow down the scope of analyzes to the renewable electricity producers rather than the whole sector.

Our approach allows us to differentiate to what extent particular renewable technologies are affected by support designs. Also, the study by Jaraite and Kazukauskas (2013) was performed on data before the adoption of EU Directive in 2009. For many member countries, the renewable energy was in very infant stages. As showed in case studies from

Slovakia and Cyprus, the solar and wind technologies were almost nonexistent at the time. Therefore, it is useful to expand the study using the most recent data available from 2013.

By analyzing the case studies, observations were made, showing that Feed-in-tariffs can be as risky to investors as Quota obligations. In theory, the revenue provided to renewable investors under Feed-in-tariff should be guaranteed for the duration of the support. However, our cases show that governments can use many creative ways to decrease the support in future. Hence, our theory developed from the cases suggests that support design itself is insufficient in reducing the risks of investments. To test this H4 is formulated below. In addition, our cases from Cyprus showed that auctioning decreased the profitability of projects substantially. Thus H5 is used to test this on larger data set. Also, cases from Cyprus showed that positive climate conditions did not provide higher returns to investors due to higher competition. Thus, H6 is formulated to test this observation.

H4: Support design does not impact the profitability of renewable electricity producers
H5: Auctioning has negative impact on the profitability of renewable electricity producers
H6: Climate conditions don't impact the profitability of renewable electricity producers

After link was observed in previous section, between the design type and the size of the subsidy, a question arises whether the subsidy type also explains the profitability of the firms operating in renewable electricity plants.

Multiple OLS regression is again used for the analysis. The dependent variable of choice is Return on Assets (ROA). ROA provides good approximation on the profitability of firms, as it captures previous capital expenditures and the return of the assets. Following ROA definition is applied:

$$ROA_t = \frac{EBIT_t(1-t)}{\frac{1}{2}(ROA_{t-1} + ROA_t)}$$

In contrast to Jaraite and Kazukauskas (2013), only companies that are predominantly involved in renewable electricity production are involved in the study. Each company from the data set is analyzed to determine the most dominant renewable technology used by the company to produce renewable electricity. Based on the dominant technology (Hydro, Wind or Solar), a dummy proxy variable is assigned.

To account for the influence of climate conditions on profitability, each company is assigned to particular climate region. After dominant geographical presence and renewable technology is assigned for every company, proxy dummy variables are assigned. In some countries, producers have choice between different support schemes. If this is the case, company is assigned dummy proxy variable for every support scheme available.

Unique approach is developed to control for the support level. After every company's business is evaluated, the most dominant renewable technology and geographical presence is used in estimating the support received by the company. To estimate the support that governments received, the proxy variable - average cost per MW developed in previous section is assigned for every company based on its characteristics. Other controls include electricity price and proxy for the size of the firm.

4.2.2. Data

Historical accounting data is assembled for all renewable electricity providers in Europe that are recorded by extensive database of Capital IQ. The dataset is obtained by filtering out all the companies in EU whose core revenue comes from operating renewable technology plants, specifically Solar, Wind and Hydropower. Filtering of all renewable electricity producers provided us with 169 companies for which accounting data is available. Using the accounting data, ROA in 2013 is calculated.

Often, traditional utilities also own significant portfolios of renewable plants but most of their income comes from conventional technologies, and hence the impact of support on their income cannot be separated. Jaraite and Kazukauskas (2013) found significant impact of Green Certificates design on the whole electricity sector including conventional technologies. However, it is possible that support to renewables impacts the conventional electricity producers differently than renewable producers receiving the support. Therefore, we ignore market participants producing non-renewable electricity, or participants using balanced mix of conventional and renewable technologies. Similar to previous section, Climate Zones are provided by Ecofys (2014). The revenue data is obtained from Capital IQ.

4.2.3. Results and discussion

Table 13 Summary of OLS regression explaining profitability of firms

Summary of OLS regression explaining profitability of European renewable electricity producers

		Data source
Dependent Variable:	Return on Assets (2013)	Capital IQ

Regression Statistics: (17 variables, n=169)

R-Squared	Adj.R-Sqr.	Std.Err.Reg.	Std. Dev.	# Cases	# Missing	t(2.50%,151)	Conf. level
0.241	0.166	5.178	5.669	178	124	1.975	95.0%

Independent Variables	Coefficient	Std.Err.	t-Stat.	P-value	Lower95%	Upper95%	Std. Dev.	Std. Coeff.	Data source
Constant	***51.217	18.266	2.804	0.006	15.144	87.289			
Solar	***-7.115	2.453	-2.901	0.004	-11.958	-2.272	0.476	-0.597	CEER
Solar FIP	**4.192	2.107	1.990	0.048	0.031	8.353	0.343	0.253	CEER
Solar FIT	-2.073	2.745	-0.755	0.451	-7.493	3.348	0.403	-0.147	CEER
Solar Auction	-1.470	2.751	-0.534	0.594	-6.903	3.963	0.195	-0.051	CEER
Wind	-2.758	1.841	-1.498	0.136	-6.394	0.879	0.498	-0.242	CEER
Wind Auction	**-8.566	4.098	-2.090	0.038	-16.659	-0.473	0.106	-0.160	CEER
Wind FIP	-1.300	1.821	-0.714	0.476	-4.896	2.297	0.261	-0.060	CEER
Wind FIT	*3.952	2.344	1.686	0.094	-0.677	8.580	0.480	0.334	CEER
Hydro FIP	-2.835	5.481	-0.517	0.606	-13.659	7.989	0.075	-0.037	CEER
Hydro FIT	3.115	3.040	1.024	0.307	-2.889	9.119	0.295	0.162	CEER
ln(Electricity Price)	**-9.291	3.651	-2.545	0.012	-16.501	-2.081	0.324	-0.531	Eurostat
ln(revenue)	0.146	0.238	0.611	0.542	-0.325	0.616	1.877	0.048	Capital IQ
Support received 2013	*0.021	0.012	1.786	0.076	-0.002	0.044	93.435	0.346	CEER, Own analyses
Climate Zone 1	-4.223	3.207	-1.317	0.190	-10.555	2.110	0.407	-0.303	EcoFys
Climate Zone 4	-0.634	1.674	-0.379	0.705	-3.939	2.671	0.419	-0.047	EcoFys
Climate Zone 5	*-3.212	1.824	-1.761	0.080	-6.814	0.390	0.468	-0.265	EcoFys

Notes:
(*): p-value < 0.10, (**): p-value < 0.05; (***): p-value < 0.01
Solar, Wind and Hydro dummy variables correspond to renewable technologies used to generate electricity
FIT: Feed-in-tariff
FIP: Feed-in-premium
ln(revenue): Used to control for firm size
Auction: Auction was used to determine support levels in combination with FIT or FIP
Climate Zone 1: Finland, Latvia, Sweden, Estonia, Lithuania
Climate Zone 2: Slovakia, Hungary, Slovenia, Austria, Romania, Bulgaria (excluded due to missing observations)
Climate Zone 3: Greece, Cyprus, Italy, Malta
Climate Zone 4: Portugal, Spain, Croatia
Climate Zone 5: Netherlands, Germany, Belgium, Denmark, Ireland, United Kingdom, France,Czech Republic, Poland, Luxembourg
Support received 2013: Proxy for estimated support received by the company

Summary of hypotheses testing

H4: Support design does not impact the profitability of renewable electricity producers	Rejected
H5: Auctioning has negative impact on the profitability of renewable electricity producers	Accepted
H6: Climate conditions don't impact the profitability of renewable electricity producers	Rejected

Our results do not confirm that profitability (and risk premiums) of firms operating under Green Certificate (Quota) support scheme is higher. Therefore, H4 is rejected. Interestingly, the data shows that the relationship between profitability and support design type is technology dependent. For example, for Solar technology, Feed-in-Premiums are shown to have positive effect on Return on Assets, while Feed-in-tariffs had negative effect compared to quotas. In Wind technology, Feed-in-tariff had positive affect while Feed-in-price had negative effect on profitability. However, what is consistent across technologies is that auctioning decreases the profitability of the firms. Thus *H5* is accepted.

Climate zones have also significant impact on the profitability of the firms. For example, firms in Southern Europe (Greece, Cyprus, Italy and Malta) have higher profitability than the rest. Surprisingly, electricity price has negative impact on profitability. Hence, *H6* is rejected.

4.3. Market to book value of equity ratios of renewable electricity producers

In this part, the link between support scheme design and market to book equity value of renewable electricity providers is observed. Market to book equity value captures the premium investors assign to the book values. When the cost of capital increases as consequence of higher risk, the market to book ratio falls and vice versa.

In the Feed-in-tariff support scheme, the price is fixed for the plant and variation in electricity does not concern the operator, at least in short term. In Feed-in-premium, the revenue risk is increased as part of the income depends on electricity price. However, in the quota obligations system, the operator faces the market risk of electricity price, and the value of the subsidy received is also determined on the green certificate market. However, our previous findings showed that for some technologies, despite the risk characteristics of quota system, investors receive higher support from Feed-in-tariff or Feed-in-price.

Unfortunately, there were only 20 public companies that fulfilled the filtering criteria we applied in section 4.3. These 20 companies form a subset of firms analyzed in previous section. Due to the small sample, rigorous econometric analysis cannot be obtained. Despite, the low sample size, some observations are provided.

Firstly, the market to book ratio differs by technology widely. The average market to book ratio for, Solar, Wind and Hydropower are 3.8, 1.4, and 1,3 respectively. In line with profitability observations in previous section, Solar multiples are highest for firms receiving Feed-in-premium, in the middle for firms receiving Green Certificates and lowest for firms receiving Feed-in-tariff support. Same is observed in Wind technology, where market to book multiples are highest for firms receiving Feed-in-premium and lowest for firms receiving Feed-in-tariffs. This data is not sufficient to draw any strong conclusions, but again show that investors preference for Feed-in-tariff cannot be observed.

4.4. Limitations

The quality of OLS analyses is dependent on the data quality. Since the accounting data is gathered from Capital IQ, the selection of companies may be biased. For example, in countries with better accounting reporting rules, Capital IQ can access wider set of companies. Moreover, measurement biases could be introduced in the support cost estimates provided by CEER.

In addition, our econometric study was limited by the need to match the cross-sectional accounting data with the country wide support level estimates. There are few support level estimates public, with the most recent being in 2013 by CEER. Out of 301 currently active companies covered by Capital IQ producing renewable electricity, only 169 companies were covered by capital IQ in 2013. Therefore, lack of more recent data on support levels decreased out sample substantially.

Another limitation of our paper, is the narrow scope of research to only year 2013. It is possible, that the impact of support scheme design on profitability differs across years. However, support designs don't vary much across the time, and hence econometric approaches using time demeaning such as Fixed Differences would face multicollinearity challenges. Hence the cross sectional OLS method was selected.

Cerda and Rio (2015) show that there is lacking consensus on the proper definition of support policy costs. Clear differentiation between often interchangeably used cost definitions is of upmost importance, because estimated support costs may differ from the support received by investors. In most studies, including the approach used in this paper, the estimates of support levels are based on assumption that costs incurred by consumers match the support provided to renewable electricity producers or at least provide a good proxy.

5. Conclusion

The first part of the study benefited from detailed data from an established renewable electricity producer. By conducting thorough analyses, common trend could be observed across two countries – Slovakia and Romania. First, the governments are likely to introduce support levels that allow very high profitability. However, looking at the development following these promises, a skeptical approach is required. Either governments (Romania, Slovakia) failed to deliver on their promises, or mechanisms are in place from the start (Cyprus), that will drive down the profits in very short time.

Negative development for investors was observed in both major support designs – Feed-in-tariffs and Quota obligation system. Each negative development followed unique mechanism. In Quota obligation system, government created pressure by limiting the ability of renewable electricity producers to sell the certificates. In the Feed-in-price mechanism, Slovak government introduced various measures causing producers to lose any support in 2015. Therefore, the key issue for investors is to keep expectations in check and mitigate the risks by accounting for negative changes to the support in future.

The second part of the study expanded on our case study observations. Our results show that the influence of support design type on profitability and risk is more complicated than assumed in previous literature. In particular, the impact of support design on firm profitability differs across renewable technologies.

There are many interesting but unanswered questions for further research. Our studies show, that even though Feed-in-tariffs are safer on paper, governments can violate their promises in future. Testing the following theory would increase the understanding of support design greatly. Since, Feed-in-tariffs do not possess the self-regulation mechanism present in the quota system, overinvestment might be more likely. When overinvestment occurs in quota system, the Green Certificate Market corrects itself. However, when overproduction in the Feed-in-tariff system occurs, governments face larger costs. Unexpected costs might create political pressure to modify the support and fail to deliver on promises. Hence, if the Feed-in-tariff causes overproduction and subsequent negative modifications to its design, the risk benefits witnessed at the beginning of the support diminish. Therefore, it would be very interesting to see studies looking at the development of support schemes dynamically. In particular, to analyze whether certain design is more likely to be altered by governments in future.

Secondly, our findings from case studies and systematic approach show that by combining auctioning with Feed-in-tariffs, profitability of firms is reduced. Since lower profitability is sufficient in promoting investments, lower risk premiums are likely demanded by investors. However, studies analyzing why auctioned Feed-in-tariffs are deemed to be less risky by investors are lacking. Based on our observations, following theory is proposed to be tested by further research. Countries with auctioning schemes, suppress the profitability of initial investments to such levels, that the costs to society are not high enough to create political pressure on governments in the future. In cases of less trustworthy governments, the renewable subsidies created high public costs in the initial years of running the support. Consumers often reacted negatively and demanded measures to prevent windfall profits. As a response, governments pursued legally questionable steps against renewable electricity producers and often suppressed the support to suddenly very low levels. But countries with auctioning, like Cyprus, are more trustworthy and look more committed for investors to fulfill promises, because auctioning kept previous renewable costs at low levels and thus political pressure from consumers is unexpected. Again, dynamic approach would be suitable in analyzing how the initial support design explains subsequent modification to the support.

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7. Appendix

Table 14 Share of renewable energy in gross final energy consumption

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2020 TARGET
EU (28 countries)	8.5	9.0	9.5	10.4	11.0	12.4	12.8	13.1	14.3	15.0	16.0	20.0
Belgium	1.9	2.3	2.7	3.4	3.8	5.1	5.5	6.2	7.2	7.5	8.0	13.0
Bulgaria	9.4	9.4	9.6	9.2	10.5	12.1	14.1	14.3	16.0	19.0	18.0	16.0
Czech Republic	5.9	6.0	6.4	7.4	7.6	8.5	9.5	9.5	11.4	12.4	13.4	13.0
Denmark	14.9	16.0	16.4	17.8	18.6	20.0	22.1	23.5	25.6	27.3	29.2	30.0
Germany	5.8	6.7	7.7	9.1	8.6	9.9	10.5	11.4	12.1	12.4	13.8	18.0
Estonia	18.4	17.5	16.1	17.1	18.9	23.0	24.6	25.5	25.8	25.6	26.5	25.0
Ireland	2.4	2.9	3.1	3.6	4.1	5.1	5.6	6.6	7.1	7.7	8.6	16.0
Greece	6.9	7.0	7.2	8.2	8.0	8.5	9.8	10.9	13.4	15.0	15.3	18.0
Spain	8.3	8.4	9.2	9.7	10.8	13.0	13.8	13.2	14.3	15.3	16.2	20.0
France	9.4	9.6	9.3	10.2	11.1	12.1	12.6	11.1	13.4	14.0	14.3	23.0
Croatia	23.5	23.8	22.7	22.2	22.0	23.6	25.1	25.4	26.8	28.1	27.9	20.0
Italy	6.3	7.5	8.4	9.8	11.5	12.8	13.0	12.9	15.4	16.7	17.1	17.0
Cyprus	3.1	3.1	3.3	4.0	5.1	5.6	6.0	6.0	6.8	8.1	9.0	13.0
Latvia	32.8	32.3	31.1	29.6	29.8	34.3	30.4	33.5	35.7	37.1	38.7	40.0
Lithuania	17.2	17.0	17.0	16.7	18.0	20.0	19.8	20.2	21.7	23.0	23.9	23.0
Luxembourg	0.9	1.4	1.5	2.7	2.8	2.9	2.9	2.9	3.1	3.6	4.5	11.0
Hungary	4.4	4.5	5.1	5.9	6.5	8.0	8.6	9.1	9.6	9.5	9.5	14.7
Malta	0.1	0.2	0.2	0.2	0.2	0.2	1.1	1.9	2.9	3.7	4.7	10.0
Netherlands	2.1	2.5	2.8	3.3	3.6	4.3	3.9	4.5	4.7	4.8	5.5	14.0
Austria	23.3	23.8	25.3	27.3	28.2	30.2	30.6	30.8	31.6	32.3	33.1	34.0
Poland	6.9	6.9	6.9	6.9	7.7	8.7	9.2	10.3	10.9	11.3	11.4	15.0
Portugal	19.2	19.5	20.8	21.9	23.0	24.4	24.2	24.7	25.0	25.7	27.0	31.0
Romania	17.0	17.6	17.1	18.3	20.5	22.7	23.4	21.4	22.8	23.9	24.9	24.0
Slovenia	16.1	16.0	15.6	15.6	15.0	20.0	20.5	20.2	20.9	22.5	21.9	25.0
Slovakia	6.4	6.4	6.6	7.8	7.7	9.4	9.1	10.3	10.4	10.1	11.6	14.0
Finland	29.2	28.8	30.0	29.6	31.4	31.4	32.4	32.8	34.4	36.7	38.7	38.0
Sweden	38.7	40.6	42.7	44.2	45.3	48.2	47.2	49.0	51.1	52.0	52.6	49.0
United Kingdom	1.2	1.4	1.6	1.8	2.7	3.3	3.7	4.2	4.6	5.6	7.0	15.0
Iceland	58.9	60.1	60.8	71.5	67.5	69.7	70.4	71.6	73.2	72.2	77.1	64.0
Norway	58.1	59.8	60.3	60.2	61.8	64.9	61.2	64.8	65.9	66.7	69.2	67.5

Notes:

Source of Data:	European environment agency (EEA)
Code:	t2020_31
Hyperlink to the table:	http://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&plugin=1&language=en&pcode=t2020_31