MSc Program
Renewable Energy in Central and Eastern Europe

Assessment of the long term implications involved by the support scheme based on tradable green certificates from a Romanian power supplier's perspective

A Master's Thesis submitted for the degree of
"Master of Science"

supervised by
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Affidavit

I, **Irina Chim**, hereby declare

1. that I am the sole author of the present Master's Thesis, "Assessment of the long term implications involved by the support scheme based on tradable green certificates from a Romanian power supplier's perspective", 79 pages, bound, and that I have not used any source or tool other than those referenced or any other illicit aid or tool, and
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Abstract

Promoting the use of renewable energy sources is important both to the reduction of the EU's dependence on foreign energy imports, and in meeting the targets set to tackle the green house emissions issue. In its role as a Member State, Romania has to commit to the EU targets set for the renewable energy sector. In this context Romania has opted for a system of tradable green certificates (TGC) awarded for the power produced from renewable sources. Power suppliers are obliged to meet annual green certificates purchase quotas, depending on their total power supply.

Compared to the support schemes based on a feed in tariff which have been implemented in the majority of the EU countries, the support scheme based on green certificates implies greater complexity of investment strategies due to the new thus generated market for such intangibles. Hence, the power suppliers take over a new active role as major players in the support scheme process.

This work completes the picture about the impact of the support scheme based on TGCs by bringing into discussion the role of one of the most important actors: the power supplier.

Beside the assessment of the possible impacts on the development of the renewable energy market in Romania, a benchmark at European level will analyze countries that have already implemented support schemes based on tradable green certificates, examining their related experience and the effectiveness of the support schemes, showed in developing their renewable energy market.

Finally this work presents a procurement strategy for a power supplier in Romania in order to cover the risks on an unstable market which also impacts directly the investments in renewable energy projects and the development of the renewable energy market as a whole.

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List of Abbreviations

ANRE	Romanian Regulator of the Energy Market
BE	Belgium
CHP	Combined heat and power
CWaPE	Walloon Energy Regulatory Authority
DAM	Day Ahead Market
DSO	Distribution Service Operator
eg.	Example
ELIA	Transmission Grid Operator in Flanders
ERO	Energy Regulatory Office in Poland
EU	European Union
FIT	Feed-In-Tariff
FX	Foreign Exchange
GBP	UK currency
GCPA	Green Certificates Purchase Agreement
GSE	Gestore Servizi Elettrici - Italian Market Operator
GWh	gigawatt hours
i.e.	id est ("that is")
IT	Italy
LTC	Long term contract
mio.	Million
MW	megawatt
MWh	megawatt hours
Ofgem	Electricity Market Authority in UK
Opcom	Romanian Market Operator
PCCV	Centralized Market for Green Certificates in Romania
PL	Poland
PLN	Polish currency
POLPX	Polish Power Exchange
PPA	Power Purchase Agreement
PRM	Property Rights Market
PV	Photovoltaic systems
RES-E	Renewable energy sources for electricity
RO	Romania

RON	Romanian currency
ROO	Renewables Obligation Order
SE	Sweden
SEA	Swedish Energy Agency
TGC	Tradable Green Certificate
TWh	terawatt hours
UK	United Kingdom
VAT	Value added tax
VREG	Flemish Energy Regulatory Authority

1 Introduction

The European Union member countries are currently one of the main players in the development and application of renewable energy. Promoting the use of renewable energy sources is important both to the reduction of the EU's dependence on foreign energy imports, and in meeting the targets set to tackle the green house emissions issue. The main target is that by 2020, the EU would seek to obtain 20% of its total energy consumption requirements from renewable energy sources.

In its role as a Member State since 2007, Romania has to commit to the EU targets set for the renewable energy sector. Therefore during the past three years Romania was active in setting the prerequisites for the future development of the renewable energy production sector by implementing support scheme legislation in order to meet the targets set by the EU until 2020.

In 2011 the European Commission approved the amendments brought by the Romanian Government to the support mechanism for renewable energy. As a result of the above mentioned amendments, Romania has opted for a system of tradable green certificates (TGC) awarded for the power produced from renewable sources and delivered into the distribution network. Power suppliers are obliged to meet annual green certificates purchase quotas, depending on their total power supply. Also, the grid operator issues green certificates for the whole renewable energy produced, so that the producers could benefit from both the sale of the power itself and the value of the certificates received from it.

Compared to the support schemes, based on a feed in tariff, which have been implemented in the majority of the EU countries, the support scheme based on green certificates implies greater complexity of investment strategies due to the new thus generated market for such intangibles. In this context the power suppliers take over a new active role as major players in the support scheme process. They have the role of actively forecasting the quotas of green certificates they will have to purchase during one year and try to pass on their costs with green certificates to the final consumers, according to the relevant legislation in this respect.

1.1 Problem statement

By analyzing the development of the renewable energy market in other European countries and examining the specific literature on the impact different of support schemes on the evolution of this sector, it becomes clear that support schemes based on tradable certificates

erode constantly in Europe (i.e. Italy and Belgium) and evolve into feed in tariff based schemes. It seems that, from all the countries that have adopted the tradable certificates support schemes, Sweden is the only one which is successful with this approach. This means that only the right combination of instruments within the support scheme based on tradable certificates can bring a balance between risks and profits.
In this context benchmarks are needed for supporting the strategic procurement of tradable certificates, due to the fact that all the challenges that are assessed at a certain moment in time might change their value once amendments to the supporting scheme legislation will come into force.

The motivation to write about this aspect was the wish to complete the picture about the impact of the support scheme based on TGCs by bringing into discussion the role of one of the most important actors: the power supplier. Its role was rather neglected in all the discussions about the implementation of these schemes, which were mainly taking into consideration only investors' perspective. The role of the supplier should be addressed in this context, as its strategies could eventually have a major impact on the future development of the renewable energy market in Romania.

1.2 Main objective

Hence, the main target of this master thesis is to assess the possible impacts on the development of the renewable energy market in Romania taking into consideration the strategies adopted by the power suppliers in order to profit from the opportunities and minimize the possible long term risks arising from the support scheme setup. This assessment will be also made at European level based on benchmarks which will analyze countries that have already implemented support schemes based on tradable green certificates, examining their related experience and the effectiveness of the support schemes, showed in developing their renewable energy market. The question to be answered refers to the best procurement strategy a power supplier can chose in Romania to cover the risks on an unstable market which also impacts directly the investors in renewable energy projects and the development of the renewable energy market as a whole.

1.3 Course of investigation

The method of approach is based on the analysis of the general impact of the support scheme in Romania compared to other countries where a support scheme based on tradable green certificates has already been implemented. An analysis of the effectiveness of the

Romanian support scheme will be carried out, looking especially the capacities deployed, and putting it against the lessons learned from other European countries.
The thesis will begin with a presentation on the current RES-E status in Europe and the presentation of different support schemes for RES-E deployed in the European countries. Afterwards a more detailed analysis of the TGC support schemes in different EU countries is concluded. The Romanian newly amended TGC system will be described into detail, starting from the legal background up to the quota calculation and the TGC market functioning. The lessons learned and the experience with TGC systems in Europe will be summarized subsequently based on the multiple research conducted in this field. A comparison with other support schemes, especially feed in tariffs will be presented and the conclusions for the effectiveness and efficiency of TGC system as opposed to FIT systems are highlighted.
In the last part of the thesis a case study concerning the procurement strategy of a Romanian power supplier is presented. As long term contracts are an important tool in TGC markets in order to safeguard the financing of RES-E projects for smaller investors, the strategy is directed to finding out what is the best mix for the TGC portfolio in order to profit of the possible market opportunities and at the same time minimize potential risks in the future. The proposed strategies will be developed based on RES-E market evolution scenarios, which will be developed. Based on the future expectations from the TGC market, the procurement strategy will be developed and alternatives of volumes and prices will be discussed and the best method will be selected, consistent with the argumentations presented. Within the conclusions the possible impacts on the evolution of the renewable market in Romania will be highlighted, taking into account the position of the power suppliers on this market.

2 Overview on evolution of RES-E generation and support schemes in Europe

Increasing the share of RES-E has a high priority in the energy strategies of all the EU Member States. The EU has set ambitious targets for RES-E since the late 1990s[1]. In order to facilitate the achievement of proposed RES-E targets, several economic, institutional, political, legislative social and environmental barriers have to be overcome.[2]

Despite a significant decrease of 27% in energy intensity in the European Union from the early 90s to the end of 2008, the overall energy consumption has increased by almost 10% until 2006. During the same period the energy dependence of the EU on energy imports has increased to ca. 50% of energy imports in 2008 because the own energy production in the EU is insufficient. The declining fossil energy production in the EU implies that the import dependency will further increase if no countermeasure will be taken[3].

There are several challenges that Europe is facing: sustainability, security of supply, safety of the energy chain growing demand in the developing countries. One of the measures to face these challenges is the development of RES-E in Europe.

In this chapter first an overview of the current RES-E in Europe is presented, and subsequently the review of different support schemes is conducted.

2.1 Development of European RES-E production

The EU renewable energy policy started in 1997, when the European Commission published a white paper stating a target for the EU to double the European Union's renewable energy share of the gross domestic energy consumption to 12% by 2010. The 1997 White Paper included a renewable energy strategy and action plan. Subsequent legislation[4] set indicative national targets for electricity produced from renewable sources. The target for the whole European Union was set to 21% of electricity consumption from renewable energy sources by 2010, and the Member States' targets ranged from Luxembourg's 5,7% to Sweden's 60%[5]. In 2008, the Commission proposed a new, more rigorous framework to drive forward the development of renewable energy and set new legally binding targets for 2020. The 2009

[1] Cp. eg. Directive 2001/77/EC and Directive 2009/28/EC.
[2] Cp. Haas et al. (2011).
[3] Cp. Jaeger-Waldau et al. (2011).
[4] Directive 2001/77/EC.
[5] Cp. VTT (2011).

directive “on the promotion of the use of energy from renewable sources”[6] set mandatory renewable energy targets for each Member State and drafted a trajectory on how to reach the targets. Because each Member State has different renewable energy potential and energy mix, targets vary between Member States. EU’s overall target for renewable energy was set to be 20% for 2020. The Directive also improves the legal framework for promoting renewable electricity, requires national action plans that establish pathways for the development of renewable energy sources, creates cooperation mechanisms to help achieve the targets cost effectively and establishes the sustainability criteria for biofuels. The percentual targets for RES in each Member State versus the already reached quotas in 2010 are shown in Figure 1.

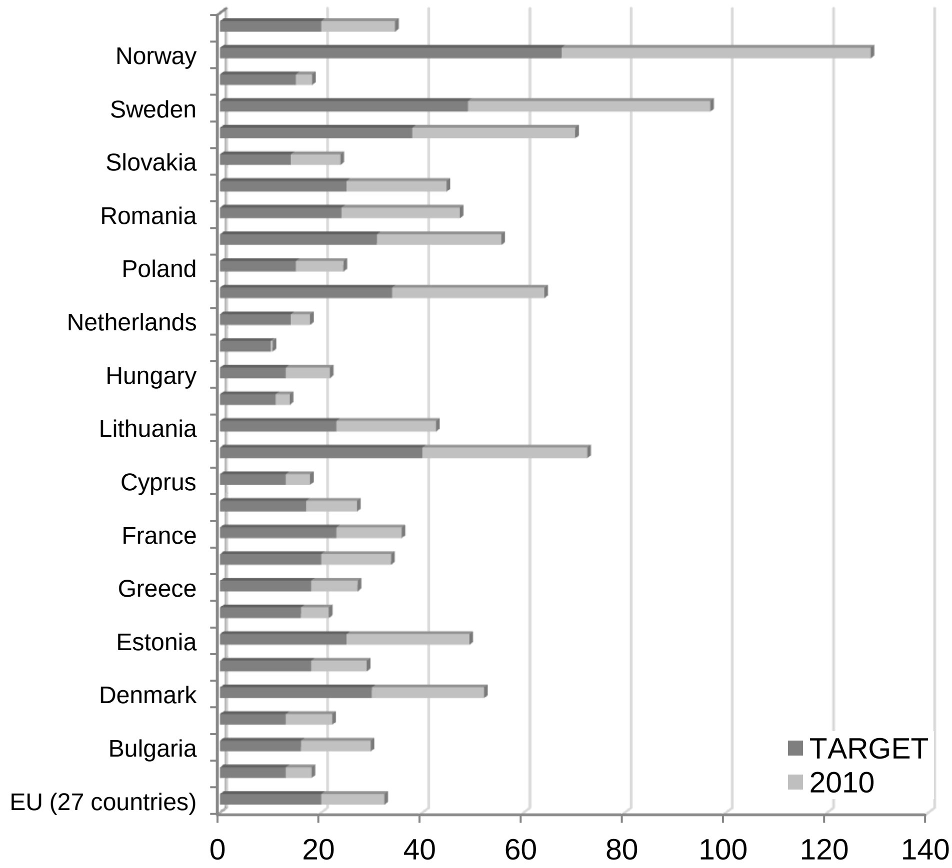

Fig. 1: *Share of renewable energy in the gross final energy consumption*.
Source: Eurostat (2012).

[6] Directive 2009/28/EC.

The primary RES-E production in EU27 doubled in the last ten years, from ca. 1000 TWh in 1999 to almost 2000 TWh in 2010, whereas the total primary energy production decreased with ca. 12%, from 11000 TWh in 1999 to 9663 TWh in 2010. This implies an increased share of RES-E primary production, from 9% in 1999 to 20% in 2010.

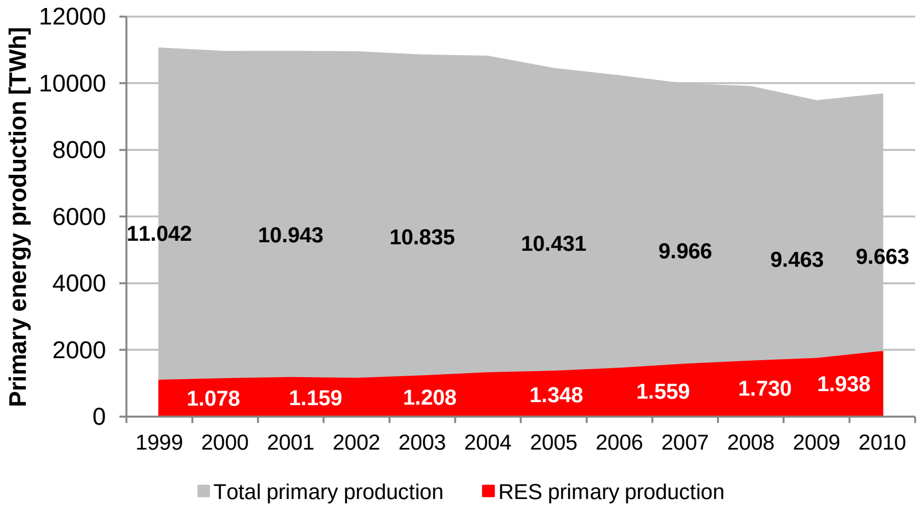

Fig. 2:*Primary RES-E production from total primary energy production in EU27*.
Source: Eurostat (2012).

The share of produced electricity form RES-E increased constantly throughout the last years, whereas the total gross electricity consumption has remained relatively constant, showing a slight decrease towards 2010.

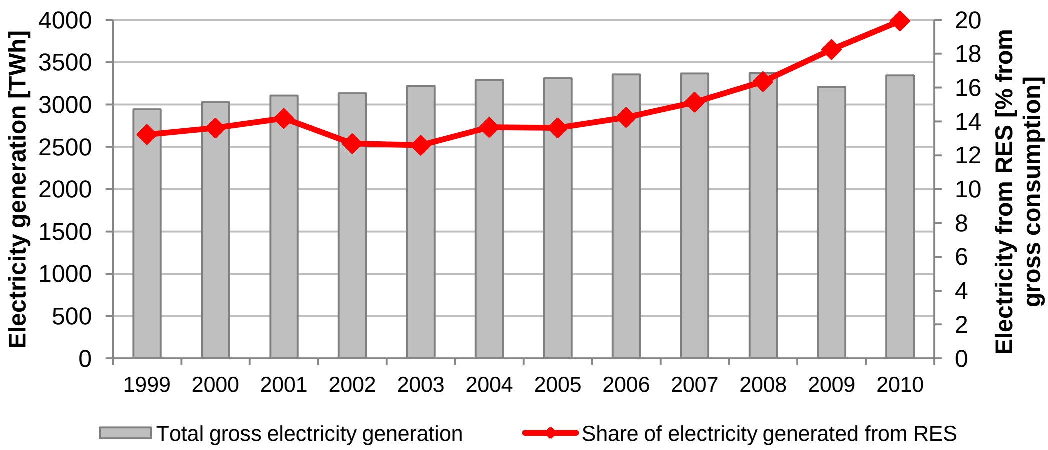

Fig. 3:*Electricity generation from RES by technology for EU27*.
Source: Eurostat (2012).

Concerning the structure of the RES-E produced in the EU, it can be noted that the majority of the production comes from hydro and biomass. These technologies are historically speaking the most deployed renewable sources and due to the fact that the majority of these power plants are old power plants, the investment costs are already depreciated. The hydro production remained somehow constant during the last 10 years, moving yearly between 340 and 360 TWh, depending foremost on the precipitation level. The hydro production is concentrated in the countries Norway (with ca. 32% from the total production), Sweden (with ca. 18% from the total production) and Spain, France, Italy and Austria with respectively around 10-15% share from total production.

The biomass production doubled throughout the analyzed period, from 666 TWh in 1999 to 1311 TWh in 2010. 50% of the biomass electricity is produced in Germany, France and Sweden. The geothermal production increased with 30%, from 52 TWh in 1999 to 68 TWh in 2010. It has to be mentioned that 80-90% from the European geothermal energy is produced in Italy. The other countries have little resources and experience for geothermal production.

Regarding the new technologies wind and solar power, there is a clear evolution throughout the last years. Nevertheless, these technologies seem to still have a lot of potential in most countries. The wind production increased 10 times during the last decade, reaching from only 14 TWh in 1999 to 149 TWh in 2010. This shows a spectacular evolution, yet over 75% of this capacity is concentrated only in 5 countries: Germany and Spain produce more than half of the total wind generation and France, Italy, Portugal and UK ca. 25%. This clearly shows that there is still a big potential to be used in the other countries in this domain.

The solar power production also shows an constant increase also of almost 10 times, from 5 TWh produced in 1999 to 43 TWh in 2010. In this case there is a similar situation like in for the wind power, namely, 67% of the EU27 solar production is generated in Germany and Spain. This implies similar like in the former case, that there is still much potential for the development of solar power. The below chart shows the development of RES-E production in EU27 and the total share of electricity from RES-E from the gross consumption.

Summing up, it can be said that Europe shows a constant positive development in the RES-E sector during the last ten years. Nevertheless, the majority of the RES-E production is concentrated only in a few countries, which proves that there is still much potential in Europe for the further development of RES-E. In order to benefit from this potential, competitive support schemes have to be put in place so that investors are incentivized to invest in this field.

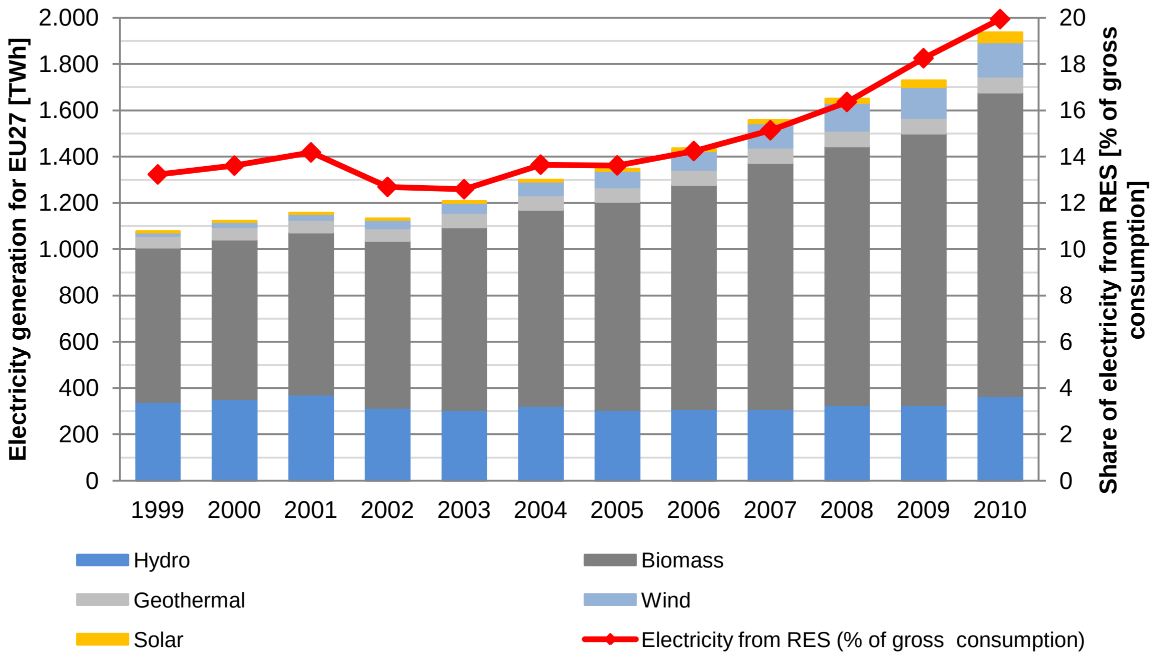

Fig. 4: *Electricity generation from RES by technology for EU27*.
Source: Eurostat (2012).

2.2 Overview on main RES-E promotion policies

As mentioned above, one of the aims of the Climate and Energy Package is to reach a 20% share for renewable energy generation in EU energy consumption by 2020 in a cost-effective and economically efficient manner. To the extent that support for renewable electricity is either passed on to the electricity prices or directly added to the electricity bill, the costs of achieving the agreed objectives will ultimately be borne by electricity end-users. As many renewable energies are still more expensive than conventional fuels, a variety of support schemes have been put in place in the EU Member States in order to accelerate their uptake and meet the EU's goals. Currently a wide range of strategies is applied in different countries across Europe, but it is still under discussion which of them shows the greatest efficiency and effectiveness for the development of RES-E production.[7]

There are different types of support schemes used in Europe, which can be mainly distinguished in direct and indirect policy instruments. Direct measures aim at the immediate stimulation of RES-E whereby the indirect measures aim at establishing a long term framework for RES-E. Another classification can be made whether the support schemes are regulated

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[7] Cp. CEER (2011).

or voluntary and whether they are price or quantity driven[8]. In the below table on overview of possible promotion schemes is presented:

		Direct		*Indirect*
		Price driven	Quantity driven	
Regulatory	Investment focused	Investment incentives Tax credits Low interest loans	Tendering systems for investment grant	Environmental taxes Simplification of authorization procedures Connection charges, balancing costs
	Generation based	Feed-in-tariffs Fixed premium systems	Tendering system for LTC TGC system	
Voluntary	Investment focused Generation based	Shareholder programs Contribution programs Green tariffs		Voluntary agreements

Fig. 5: *Types of promotion strategies*.
Source: Haas et al. (2011).

In the following attention will be drawn especially to the regulatory direct price and quantity driven strategies, i.e. the feed-in tariffs and the TGC systems, as most successful incentive instruments used currently in Europe.

The regulatory price-driven strategies are defined by a subsidy that is given either per electricity produced or per installed capacity. These tools can be either focused on investments, like soft loans or tax credits or on generation, like feed in tariffs or fixed premiums. The premium systems the amount to be added to the electricity price is fixed on for FIT the total feed-in price is fixed. The premium system shows a higher volatility and insecurity due to the volatility of electricity prices. Although this system could establish fair competition, it is very difficult to calculate the add-on so that this mechanism reflects the external costs of conventional power generation. In reality the premium is based on a comparison with the electricity price and does not reflect the environmental benefits of RES-E. Within the FIT systems, the price per unit of electricity that a utility or supplier or grid operator is legally obliged to pay for electricity from RES-E producers is determined by the government. Furthermore, the FIT guarantees certain duration for receiving the tariff. This aspect provides for security for RES-E investors. FITs allow technology specific promotion and can be designed dynamically in order to account for cost reduction by decreasing over time[9].

FIT's are nowadays the most widely used promotion instrument in Europe, due to the fact that this system attracts much capacity as it is a guaranteed amount of money on a larger period of time. The FITs have to be designed in such a way that they meet investors' needs

[8] Cp. Haas et al. (2011a).
[9] Cp. Haas et al. (2011a).

by covering their generation costs and yield supplementary return on investment for the producers. Research shows that FIT systems were the most successful in attracting new investments, especially in Germany and Spain[10].

The regulatory quantity driven instruments refer to the desired level of generation or market penetration of RES-E expressed through a quota that is set by the governments. There are two main instruments used in this context: tendering or bidding systems and tradable certificate systems. The bidding systems are calls for tenders who are launched for defined amounts of capacities and bidders compete for the contracts in order to receive a guaranteed price for the contract for a specified period of time. The TGC system can be both an accounting system for the certification of RES-E production and a regulatory instrument available for public authorities to reach a specified goal for RES-E production[11]. The market of TGCs consists of supply and demand for TGCs. Demand is driven by a politically determined target for RES-E production and the indication of the obliged party to buy the TGCs. Supply of TGCs is ensured by giving the producers of RES-E a TGC for each unit of RES-E produced and delivered into the grid. TGCs are tradable assets sold on a market separate from the physical electricity market. Since RES-E and conventional energy cannot be distinguished from one another, both are sold in the energy market at the same price. The additional cost of producing RES-E is recovered through the sale of TGCs. In this way the income obtained by the RES-E producer will be the sum between the energy price and the TGC price.

The demand for certificates is induced by transferring the national target for RES-E production to an obliged party, who can be either power suppliers, producers of conventional energy, distributors or consumers. These parties will have to prove that they complied with the set targets by presenting the specified number of TGCs corresponding to the TGC quota. Non-compliance is sanctioned in quota based systems. The costs incurred by the TGCs are borne by end-consumers within their electricity bills.

[10] Cp. for eg. Haas et al. (2011b) and Fouquet/Johansson (2008).

[11] Cp. Nielsen/Jeppesen (2003).

3 Development of European TGC support schemes

Based on the presentation of support policies in Europe in the previous section, in this chapter a detailed overview on TGC systems in other European countries is presented. After the description of the current legal framework and the TGC market in the countries Sweden, Poland, UK, Italy and Belgium, a thorough analysis of the legal and commercial background of the Romanian support system is conducted. Based on the information acquired on every TGC system, a comparative depiction of prices, quotas and market development in these countries is summed up. In a last step lessons learnt from all the TGC systems are analyzed and conclusions from the European experience so far in the RES-E incentive schemes are drawn and potentials for the future development of the TGC systems are discussed.

3.1 Overview on different TGC systems

Several countries use green certificates as a mean to make the support of green electricity generation closer to a market. Such national trading schemes are in use in Poland, Sweden, the UK, Italy, Belgium and Romania. In this chapter the main characteristics of the support schemes based on TGCs in Europe are being presented.

Quota based system in Sweden

Sweden’s energy vision is that in 2050, the country will have a sustainable and resource efficient energy supply with no net emission of greenhouse gases into the atmosphere.[12] The Swedish Parliament has decided that in 2020 the proportion of renewable energy will be at least 50% of the total energy usage. This target is one percentage point higher than the official binding target. The target for renewable electricity generation is an increase of 25 TWh compared with 2002.

In 2010 Sweden had a total RES-E production of ca. 18 TWh, mainly based on hydro power and biomass power plants, being the most cost efficient technologies. Compared to 2003 the RES-E production increased over three times, from 5,6 TWh to 17,3 TWh. The wind power also shows a constant increase of ca. 7 times in the last period reaching from only 0,5 TWh in 2003 to 3,5 TWh in 2010. This is mainly due to the different additional incentives offered to wind producers in Sweden.

[12] Cp. VTT (2011).

Sweden has a support scheme based on a quota system, combined with tax mechanism and three types of subsidies, especially for wind power production.

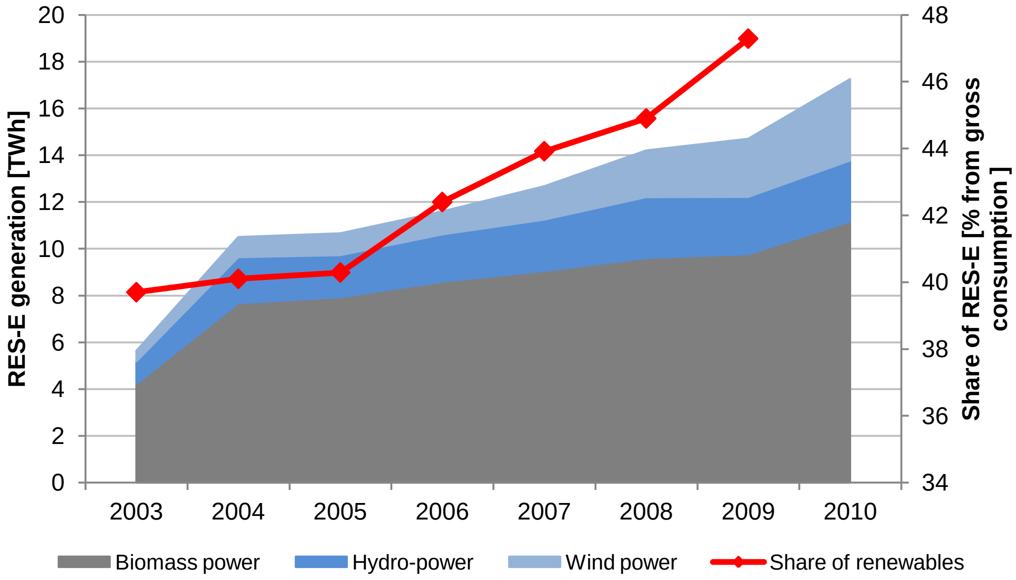

Fig. 6:*RES-E generation in the TGC system and share of RES-E in Sweden*.
Source: SEA (2012).

The main incentive for the use of renewable energy sources is a quota system in terms of quota obligations and a certificate trading system. The Electricity Certificates Act obliges energy suppliers to prove that a certain quota of the electricity supplied by them was generated from renewable energy sources. Energy suppliers provide this evidence by presenting TGCs allocated to the producers of electricity from renewable sources. The electricity certificate trading system for RES was launched in 2003.[13] In general all technologies are eligible in Sweden for the quota system, especially wind energy, solar energy, geothermal energy, biogas, wave energy, certain types of biomass and hydro power plants with an installed capacity under 1500 kW and commissioned after 1st of April 2003, large existing hydro plants may be eligible only if changes in the legal framework have made their profitable operation impossible, or if they have a capacity of 15 MW or less and have become unprofitable after renewal. The eligibility of power plants commissioned after 2003 will cease after 15 years, latest at the end of 2035.[14] The obliged parties in the Swedish TGC system are electricity suppliers, certain electricity consumers and energy-intensive companies.[15] The mandatory quota will in-

[13] Cp. Energy Market Inspectorate (2011).
[14] Cp. RES (2012), Sweden.
[15] Cp. RES (2012), Sweden.

crease constantly from 17,9% in 2011 to 19,5% in 2020 and will afterwards decrease stepwise until reaching 8% in 2035.

One TGC is issued for every MWh of electricity produced, regardless of the generation technology employed.[16] Obligated parties that fail to satisfy their quota obligation shall pay per missing TGC a fine of 150% of the weighted, average certificate value during the applicable obligation period.[17] The authorities in charge of the quota system are the Swedish Energy Agency, which monitors the procedure, and the Swedish transmission grid operator, which manages the certificate accounts. Concerning the TGC market, trade has to be reported to the Swedish National Grid Company. The majority of the trades are fulfilled bilaterally. The producers mainly have agreements for their whole yearly production so when the certificates are issued they are directly moved to a buyer's account.

TGC system in Poland

In Poland 94% of the total RES-E production is generated from biomass. Since 1999 an increase of ca. 80% of the biomass production can be noticed, from 41 TWh to 75 TWh in 2010. Poland has a very low hydro power and wind production. Hydro power production increased slightly in last decade, from 2 TWh in 1999 to 3 TWh in 2010, whereas wind power production had a very modest evolution, reaching to only 1,6 TWh in 2010 and representing not more than 2% of Poland's RES-E production. The current status of RES-E in Poland shows great potential for the new technologies and a well designed support scheme could incentivize investments in this field.

In Poland, electricity from renewable sources is promoted mainly through a quota system combined with a TGC trading system. Furthermore, electricity from renewable sources is supported through loans[18] and tax relief, producers of electricity from renewable sources being exempt from the tax on the sale and consumption of electricity.

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[16] Cp. RES (2012), Sweden.
[17] Cp. RES (2012), Sweden.
[18] The total budget for the support programme for renewable energy and combined heat and power for 2009-2012 is 1.5 bn PLN (370 m €) according to 4.1 Priority Programme RES. The amount of loan may be 4 m to 50 m PLN (1-12.5 m €) but must not exceed 75% of the project costs. The investment must exceed 10 m PLN (2.5 m €). Up to 50% of the loan may not need to be repaid (7.2.- 7.4.Priority Programme RES).

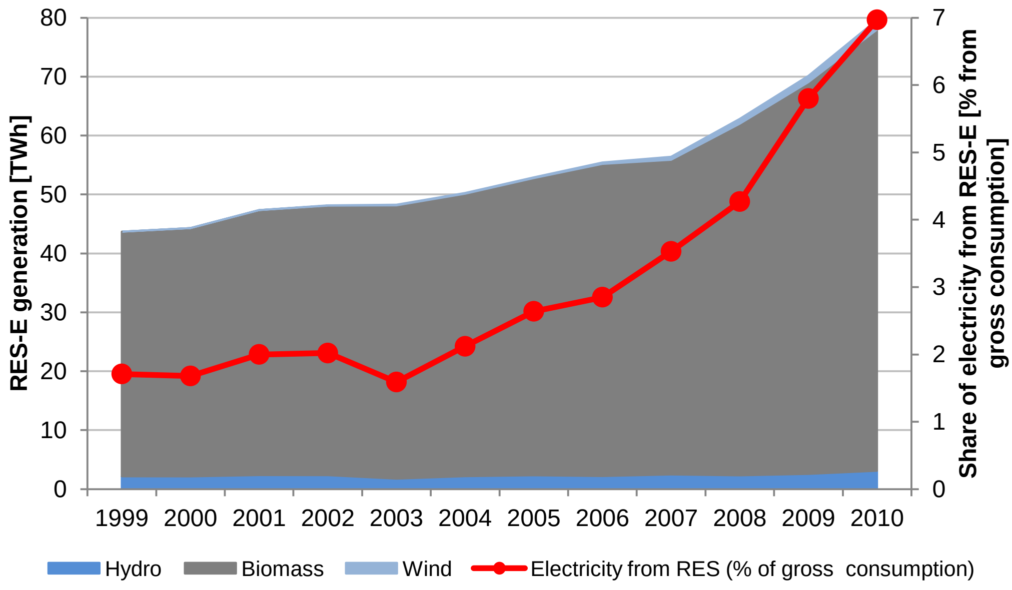

Fig. 7:*Renewable generation and share of renewable energy in Poland 1999–2010*.
Source: Eurostat (2012).

Electricity suppliers are obliged to acquire a certain number of TGCs[19] which are issued to the producers of electricity from renewable sources. As an alternative, the companies may pay a fee. Satisfying neither of these obligations carries a penalty. The established quota is a percentage of RES-E produced from the total annual amount of electricity consumed. The quota is yearly constantly increasing and has been fixed until 2017 when it will have to reach 12,9%.

The quota may change due to amendments in legislation. The quota does not depend on the technology used, and each technology is eligible for the same amount of certificates for the same amount of energy. Energy generated from renewable sources includes electricity generated, in particular by hydro-plants and wind farms, biomass and biogas-based sources, solar photovoltaic cells and thermal collectors, geothermal sources, and also a part of energy recovered from incineration of municipal waste.[20]

Electricity suppliers licensed to supply electricity to households that have not chosen a supplier are obliged to purchase electricity from renewable sources from producers within their area of service at a fixed price. The fixed price is the mean electricity price of the previous year and it is calculated by the regulatory authority. The Polish support system contains various types of certificate of origins, which have different purposes: certificates of origin for

[19] Cp. RES (2012), Poland.
[20] Cp. ERO (2012a), p. 2.

electricity generated in Renewable Energy Sources („green certificates“), certificates of origin for electricity generated in high-efficient CHP units fired with gaseous fuels or with the total installed power lower than 1 MW („yellow certificates“), certificates of origin for electricity generated in high-efficient CHP units fired with methane or with gas obtained during processing of biomass („purple certificates“), certificates of origin for electricity generated in other high-efficient CHP units („red certificates“) and certificates of origin from biogas that testify the production and introduction to the gas distribution network of agricultural biogas (“brown certificates”).[21]

The certificates of origin can be traded on the Property Rights Market (PRM) which is managed by the Polish Power Exchange (POLPX). The POLPX keeps the Certificate of Origin Register and is responsible for the organization of trading in property rights resulting from those certificates.[22] There is no minimum price for the certificates of origin. All of the certificates are traded either bilaterally on the PRM with or without the clearing by POLPX or during the exchange session on PRM[23]. The weighted average price for TGCs between June 2011 and May 2012 was 280,79 PLN/MWh on PRM. Nevertheless, from a total of 14.270.217 TGCs issued in Jun 2011 – May 2012, only 3.610.231 TGCs were traded on PRM, i.e. only 25% of the available TGCs are traded transparently on the POLPX platform.[24]

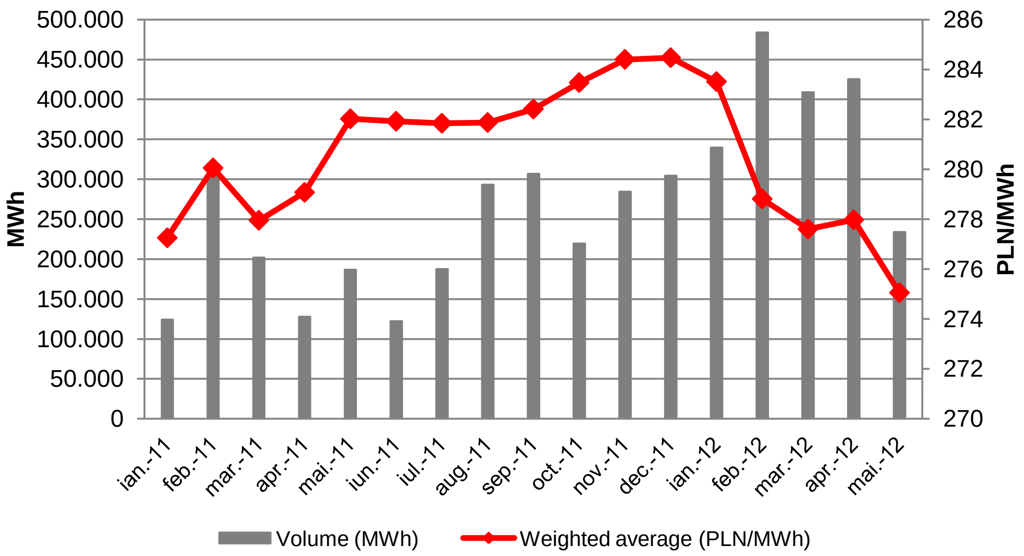

Fig. 8: *Monthly TGC price and volume evolution in Poland, 2011-2012*.
Source: TGE (2012a).

[21] Cp. ERO (2012a).
[22] Cp. TGE (2012a), p. 9.
[23] Cp. TGE (2012a), p.14.
[24] Cp. POLPX (2012).

Quota system in Italy

From Italy's total RES-E production of 190 TWh in 2010, representing a share of ca. 22% in the gross electricity consumption in Italy, 37% is represented by biomass. The production from biomass increased over 4 times over the last ten years, reaching from 17 TWh in 1999 to 70 TWh in 2010. The rest of the RES-E production is mainly covered in equal parts by hydro power, having a share of 27% and geothermal energy with 29% from the total RES-E production. Both technologies show a relatively constant trend over the whole period. Italy is the biggest geothermal energy producer in Europe, accounting for ca. 90% of the total geothermal production. Concerning the newer technologies, Italy shows modest development in this field. Wind power accounts with 9 TWh in 2010 only for ca. 5% of the total RES-E production and solar power has a share of 2% with a production of 3,5 TWh.

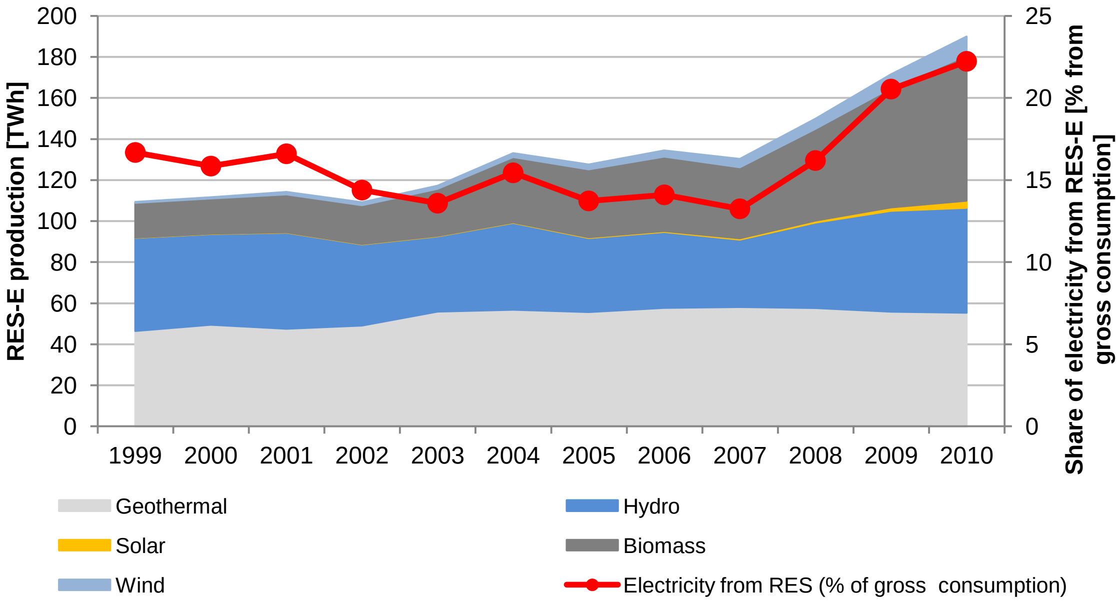

Fig. 9:*Renewable generation and share of renewable energy in Italy 1999–2010*.
Source: Eurostat (2012).

In Italy, electricity generated from renewable energy sources is mainly promoted through a quota system. Renewable energy sources in general and photovoltaic energy in particular are promoted through several kinds of feed-in and premium tariffs, which especially benefit small systems. Photovoltaic systems are promoted through a guaranteed payment. Small systems, except for photovoltaic systems, can also choose the guaranteed feed-in tariff as an alternative to green certificates. Photovoltaic and wind energy systems are also eligible for a reduced VAT, from 20% to 10%.

Under the quota system, electricity producers of more than 100 GWh per year and importers of electricity are obliged to prove that a certain quota of the electricity produced or imported by them was generated from renewable energy sources. On the one hand, electricity producers may satisfy this obligation by generating "green electricity", which is rewarded with TGCs. On the other hand, they may satisfy the quota by purchasing green certificates. The certificate system may be combined with other support instruments, except for the premium tariff for photovoltaic systems and the feed-in tariff for electricity from renewable energy.[25] Except for solar energy generation, all renewable energy generation technologies are eligible for the green certificate system. Wind power is eligible only if the annual output exceeds 200 kW. Photovoltaic systems commissioned after 31 December 2007 are eligible only for the feed in premiums. The percentage of renewable energy in electricity production for 2011 is 6,8% per 100 GWh. In 2012, the target quota will be 7,55%.

The eligibility period for the TGC system depends on the date of commissioning. Systems commissioned between 1 April 1999 and 31 December 2007 receive certificates for a period of 12 years, the ones commissioned after 31st December 2007 whose annual production exceeds 1 MW (0,2 MW for wind energy) receive certificates for a period of 15 years. Systems commissioned after 30 June 2009 will be eligible for the same eligibility period, unless they receive other national, regional, local or European public subsidies[26]. Systems commissioned after 1 January 2013 will not be eligible for this support scheme. Issued TGCs are valid for three years. Due to a large number of exemptions to the country's renewable energy quota, there was a constant oversupply of TGCs on the market. In order to help support green certificate prices, in 2008 the government authorized GSE (Gestore Servizi Elettrici) to temporarily buy back the green certificates in March each year. The final annual buy-back was to be held in March 2011 for TGCs issued for the years 2008-2010. Without the buy back, prices of TGCs would drop significantly. In 2011 it was established that the buy back value should be paid by GSE only until 2015 and its value would be 78% from the difference between 180 EUR and the electricity price as established by the Italian regulatory authority.

Between the years 2007 to 2012 the quota increased by 0,75% and depended on the electricity produced and imported in the previous year. Every three years, the quota system was

[25] Cp. RES (2012), Italy.
[26] Idem.

planned to be amended by the GSE[27]. From 2012 onwards, the quota (7,55% in 2012) will be subject to a linear decrease until becoming equal to 0 in 2015[28].
Since 2008, the value of one certificate has been 1 MWh. However, the value of a certificate may be altered by a decree of the Ministry of Economic Development. For systems put into operation in 2008, the number of certificates is based on the net production in the previous year, which is multiplied with a certain coefficient[29].

Source	*Multiplication coefficient*
Wind onshore (capacity > 200 kW)	1,00
Wind off-shore	1,50
Geothermal	0,90
Waves and tides	1,80
Hydro	1,00
Biodegradable waste and biomass	1,30
Biomass and biogases obtained from agriculture, animal husbandry and forestry	1,80
Landfill gas, sewage treatment plant gas and biogases	0,80

Fig. 10: *Multiplication coefficients for the allocation of TGCs in Italy*
Source: RES (2012).

When the obligated party fails to submit the required amount of certificates and to buy them ex post, GSE will inform the energy authority, which issues a warning and may even impose sanctions[30]. There is no established penalty for non-fulfillment of the quota.

TGC system in Belgium

The current RES-E production status in Belgium shows that 90% from the produced RES-E comes from biomass. The biomass production increased between 1999 and 2010 almost four times from 5 TWh to 21 TWh. Wind power has with 1,3 TWh production in 2010 a share of only 6% from the total RES-E production and solar has 3% with a total production of 0,7 TWh in 2010. Especially due to the development of the biomass sector, the share from electricity from RES-E in the total consumption increased constantly from 1% in 1999 to almost 7% in 2010.

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[27] Cp. RES (2012), Italy.
[28] Idem.
[29] Cp. GME (2012a).
[30] Cp. RES (2012), Italy.

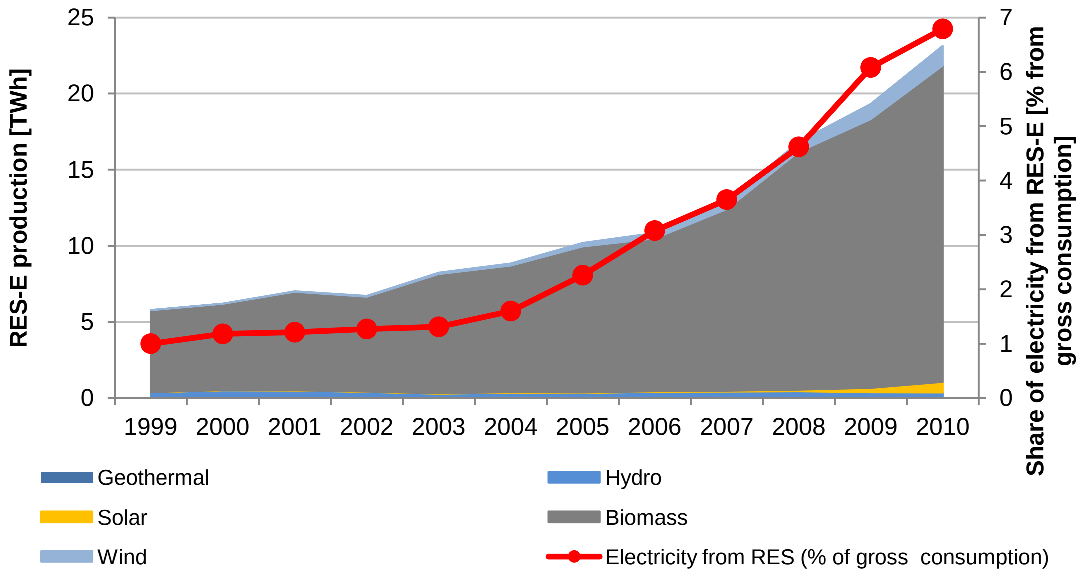

Fig. 11: *Renewable generation and share of renewable energy in Belgium 1999–2010*. Source: Eurostat (2012).

In Belgium, electricity from renewable sources is promoted mainly through a quota system based on the trade of certificates. In general, renewable energy is a regional matter; only offshore wind power is governed by national regulations. Every region Wallonia, Flanders and Brussels Capital has its own standards of support for renewable energy, based on a national framework. The minimum price per certificate is guaranteed by statutory law. Entitled persons may offset part of their investments in photovoltaic and geothermal systems against income and thus reduce their tax burden.

In general, all renewable electricity generation technologies are eligible to participate in the quota scheme. The minimum price per certificate in the national quota system differs for every technology, and is shown in the table below[31]:

Technology	*EUR/MWh*
Off-shore wind power stations with a capacity of up to 216 MW	€ 107 (for every further MWh € 90)
On-shore wind power stations	€50
Solar energy systems	€150
Hydro-electric power stations	€50
Other facilities including biomass systems	€20

Fig. 12: *Minimum TGC prices in the Belgian federal support scheme.* Source: RES (2012).

[31] Cp. RES (2012), Belgium.

The federal grid operator is obliged to purchase TGCs from all the generators that have applied for the sale of electricity at a minimum price so that the sale of a certain minimum amount of electricity can be guaranteed[32].

In the quota system applicable for the **Walloon** region, one certificate is issued for every MWh divided by the amount of CO2 saved. There are several levels of CO2 savings, which are set by the regulatory authority CWaPE and depend on the renewable energy generation technology employed[33]. In general, all RES-E technologies except for geothermal power plants are eligible. Green certificates have a validity of 5 years. Eligibility for green certificates ceases after 15 years. When the installation has received certificates for 10 years, the amount of certificates issued is reduced according to the so-called "k-factor". The "k-factor" is calculated according to several criteria and is adjusted every three years Moreover, the number of green certificates issued for renewable energy systems put into operation prior to 1 May 2001 decreases by the "q-factor", which is similar to the k-factor, only that it is applied for old systems.

	No. of certificates allocated	*k-factor*	*q-factor*
Wind energy	The amount of TGCs is calculated on a case-by-case basis and depends on the size and type of plant.	100%	75%
Solar energy	7 TGCs/MWh for the first 5 kWp 5 TGCs/MWh for the next 5 kWp 4 TGCs/MWh for a further 240 kWp 1 TGCs/MWh for an installed capacity of more than 250 kWp	0%	100%
Biogas	Amount of green certificate is calculated on a case-by-case basis and depends on the size and type of plant	25-100%	50%
Hydro-electricity	Amount of green certificate is calculated on a case-by-case basis and depends on the size and type of plant	25-100%	50-80%
Biomass	Amount of green certificate is calculated on a case-by-case basis and depends on the size and type of plant	25-100%	50%

Fig. 13: *K-factor and Q-factor in the Walloon support scheme.*
Source: RES (2012).

The mandatory quotas set in the Walloon region show and increasing trend starting in 2003 with 3% and reaching 15,75% in 2012. The Walloon government analyses the green certifi-

[32] Cp. RES (2012), Belgium.
[33] Idem.

cate market on a regular basis. CWaPE advises the Ministry of Energy on whether or not the quotas should be adjusted yearly.

The grid operators are obliged to purchase green certificates from the generators of electricity and submit them to the regulatory authority CWaPE, otherwise they shall pay a fine of EUR 100 per missing certificate. The minimum price per green certificate is EUR 65.

The region of **Flanders** uses a different quota system and a certificate market to support renewable energy, compared to the national and the Walloon systems. TGCs are issued by the Flemish regulatory authority VREG. The mandatory quotas are set until 2012 and have to reach a target of 7%. This quota is applied to the total energy distributed by a DSO in the reference timeframe. Starting with 2013 a new formula is used in order to establish the mandatory number of TGCs to be submitted by the grid operators, taking into consideration the quota, the energy distributed and a total banding coefficient that is calculated as a ratio between the number of TGCs delivered two years before the reference year and the gross green electricity production two years before the reference year[34]. The quota will reach 13% in 2020[35]. According to current legislation, the quota obligation will be in force until 2021. TGCs have a validity of 48 months in Flanders The right to receive TGCs usually ceases after 10 years from the date on which the system is put into operation. The operators of PV systems have a different eligibility period. PV systems put into operation on or prior to 31 December 2012 receive certificates for a period of 20 years and PV systems put into operation from 1 January 2013 will receive certificates only for 15 years.

In general, Flanders supports all renewable energy generation technologies. The number of certificates issued does not depend on the renewable technology employed. One TGC is issued for 1 MWh of electricity from renewable sources. However, a minimum price per certificate is guaranteed by law and depends on the technology used. Furthermore, the minimum price varies according to the date on which a system is put into operation:

[34] Cp. RES (2012), Belgium.
[35] Cp. VREG (2010).

Technology	*Min. price [EUR/TGC]*
Wind Onshore	€ 80 - € 90
Wind Offshore	€ 107
PV (capacity <>250 kWp)	€ 90 - € 330
Geothermal	€ 90 - € 95
Biogas	€ 60 - € 110
Hydro	€ 90 - € 95
Biomass	€ 80 - € 90

Fig. 14: *Minimum TGC prices by technology in Flanders.*
Source: RES (2012).

The obliged parties that fail to meet their quota shall pay a fine for every missing certificate. The fines vary depending to the obligation period and are set by the regulatory authority. Until March 2012 the fine is € 125, in 2013 the penalty is € 118 and after March 2014 the obliged parties have to pay a fine of € 100 per missing TGC.

The entities obliged to purchase TGCs are the distribution grid operators or ELIA, the transmission grid operator, depending on whose grid a given system is connected to. The grid operators shall meet their quota obligation as defined by law by presenting green certificates to VREG by 31 March[36]. ELIA has been obliged to satisfy a quota since 1 July 2003; however, its obligation only applies to systems installed less than 10 years ago. In the case of offshore wind power plants, only ELIA, the transmission grid operator, is obliged to purchase certificates.

TGC system in the United Kingdom

Similar to the other European countries presented in this chapter, the biggest share from the total RES-E production in the UK is held by the biomass production, accounting with 47 TWh in 2010 for 76% from the total RES-E production, and increasing with 2,5 times from 18 TWh in 1999. Unlike Italy, Belgium and Poland, wind power showed also an important increase during the last years, developing from 0,8 TWh in 1999 to 10 TWh in 2010. Nevertheless, wind power still holds for only 16% of the RES-E production. Hydro power production showed a constant trend, main influencing factor being the precipitation level from one year to the other[37].

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[36] Cp. RES (2012), Belgium.
[37] Eurostat (2012).

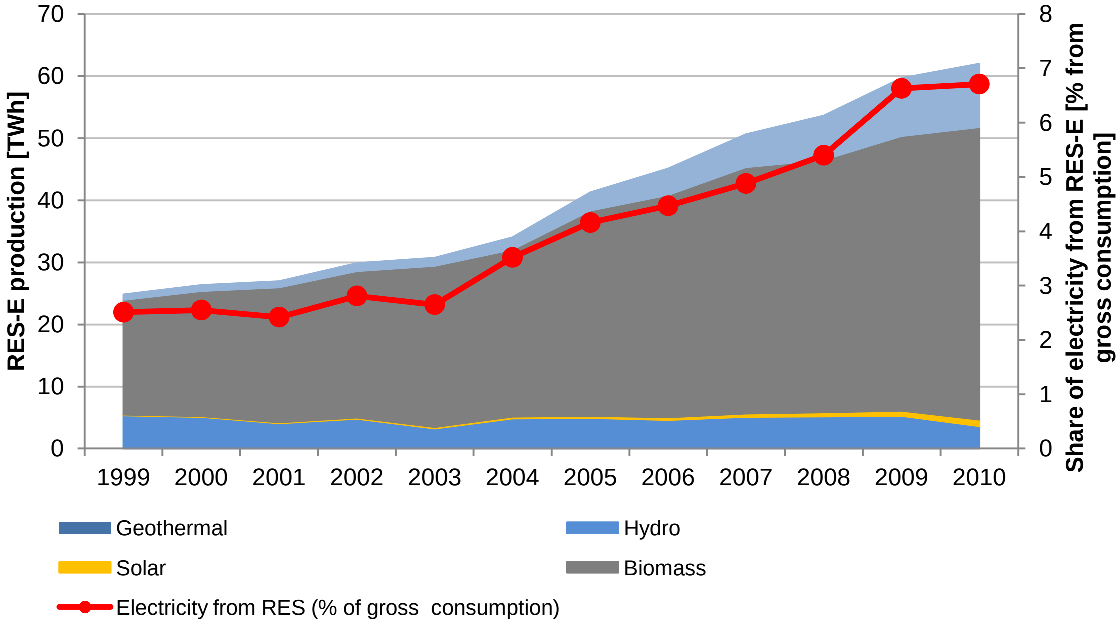

Fig. 15: *Renewable generation and share of renewable energy in the UK 1999–2010*. Source: Eurostat (2012).

In the United Kingdom, the generation of electricity from renewable sources is regulated by a combination of a feed-in tariff scheme and a quota system in terms of quota obligations and a certificate scheme. Under the feed-in tariff, accredited producers whose plants have a capacity of less than 5 MW can sell their electricity at fixed tariff rates established by the Gas and Electricity Market Authority (Ofgem). Under the quota system, electricity suppliers of more than 5 MW are obliged under the Renewables Obligation Orders (ROO) to supply a certain share of electricity from renewable sources to their customers. Plants between 50 kW and 5 MW are entitled to choose between the fixed-rate system and the Renewables Obligation.

In general all types of renewable technology are eligible for the Renewables Obligation support scheme. Plants that were commissioned prior to 1990 and have not been substantially renewed are ineligible. The mandatory quota will increase constantly until 2016, from 11,4% in 2011 to 15,4% in 2016. The 2016 quota will be maintained constant until 2037.

The UK has a banded TGC system and issues a different number of certificates according to technology. The corresponding TGCs for every MWh of electricity produced is presented in the table below.

Generation type	*Issued TGCs/MWh*
Electricity generated from landfill gas	1/4
Electricity generated from sewage gas	1/2
Co-firing of biomass	
Onshore wind	1
Hydro-electric	
Energy from waste with CHP	
Co-firing of biomass with CHP	
Standard gasification and pyrolysis	
Offshore wind	1,5
Co-firing of energy crops with CHP	
Wave	2
Tidal-stream	
Advanced gasification and pyrolysis	
Dedicated biomass with CHP	
Solar photovoltaic	
Geothermal	
Enhanced tidal stream	3
Enhanced wave	5

Fig. 16: Number of TGC allocated by technology in the UK.
Source: RES (2012).

If a supplier fails to satisfy his quota obligation, he shall make a "late payment". The late payment is the sum of the buy-out price plus interest of 5 percentage points above the base rate of the Bank of England[38].

The entities obligated to satisfy a quota according to the ROO are those electricity suppliers that supply electricity to final consumers within the UK. Suppliers may satisfy their quota by presenting TGCs. These certificates are issued to the plant operators for every MWh of electricity from renewable sources they produce. Suppliers may satisfy their quota obligation also by paying a certain amount of money to the regulatory authority. On 1 April 2009, the buy-out price was set at GBP 37.19 per MWh. Each year, this buy-out price changes with the retail price index[39]. For the period from 2011 to 2012, the buy-out price was set at GBP 38.69 per MWh. The regulatory authority collects the buy-out payments received within one

[38] Cp. RES (2012), UK.
[39] Idem.

obligation period in a fund and then distribute it amongst all British electricity suppliers that have satisfied their quota obligation.

3.2 TGC support scheme framework in Romania

Romania has a historical rich source of hydro energy production. The state-owned producer Hidroelectrica is the biggest Romanian power producer. In 2010 ca. 19 TWh is produced from hydro power, including large power plants. Apart from this important renewable source in Romania, in the last years, the wind power sector has developed steadily. In 2011 the wind production more than doubled, reaching to a total production of ca. 1,5 TWh from 0,7 TWh in 2010[40].

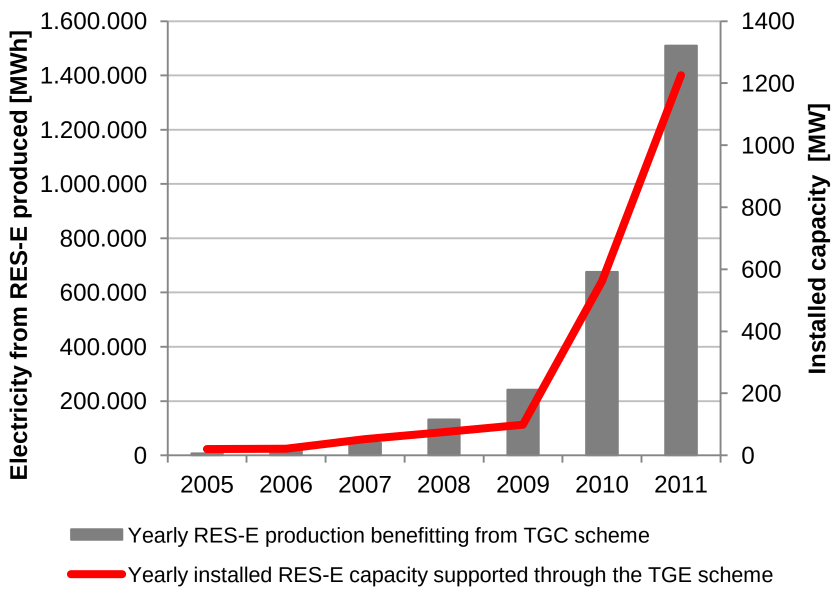

Fig. 17: *Renewable generation and installed capacity of RES-E benefitting from support scheme in Romania, 2005–2011*.
Source: ANRE (2012a).

In order to incentivize the production of newer RES-E technologies like wind and solar, Romania introduced a support scheme based on TGCs in 2005 which was amended in 2008. The most recent modifications of the law in the year 2011 introduced a technology banding TGC system which is expected to drive a sudden positive development in the following years.

[40] Eurostat (2012).

The Romanian support scheme comprises two main components: a quota system based on TGCs and subsidies provided by the Romanian Environmental Fund for projects for environmental protection. As the subsidies account for a rather small part[41] of the support scheme, the focus of the analysis in the present thesis falls on the quota system based on TGCs.

Based on the EU Directive 2009/28/CE, Romania elaborated the National action plan for RES-E. The total produced RES-E in 2011 in Romania was of 16,14 TWh, representing 31,72% from Romania's gross consumption, and takes into consideration all types of RES-E production, including large hydro power plants. From the total RES-E produced in 2011 only 1,5 TWh was supported through the Romanian incentive scheme.

The cumulated installed capacity that benefits from the support scheme in Romania in 2011 was of 1134 MW and includes wind power plant, hydro power plants with installed capacity of under 10 MW, power plants based on biomass and solar plants. The produced RES-E from these sources represented only 2,5% from the final gross consumption. The target quota established in the law for 2011 was of 10%, meaning that only a quarter of the targeted quota was reached in 2011. The graphic below shows the structure of the RES-E market that benefit from the support scheme at the end of 2011. Over 60% of the produced energy came from wind power plants, 38% were accounted for by small hydro power plants, 2% from biomass and 0% from solar energy.

[41] The maximum subsidy is 50% of the eligible project costs. The subsidy is subject to a maximum of Lei 30 m (approx. € 7.13 m) per project (art. 21 par. 2 Order No. 714/2010). The total budget for the 2010 application round was Lei 900 m (approx. € 214 m) (cp. RES (2012), Romania).

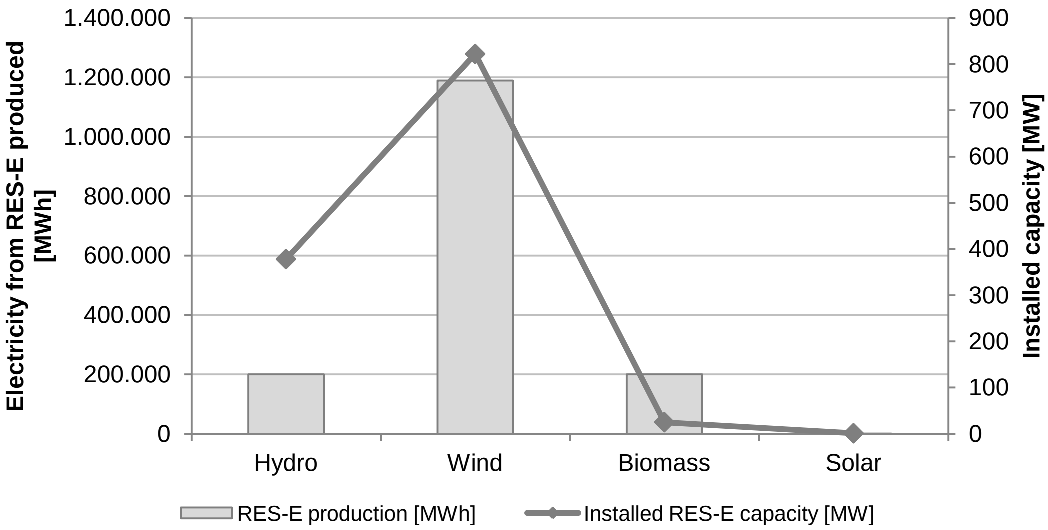

Fig. 18: *Renewable generation and installed capacity by category of RES-E benefitting from support scheme in Romania, 2011*.
Source: ANRE (2012a).

The share of of electricity produced from RES-E in 2011 from the total gross electricity consumption was 31,7%. The target for 2020 is of 38% share of electricity from RES-E. The total electricity production from RES-E in 2011 was of 16 TWh, out of which 1,5 TWh were supported by the TGC incentive scheme[42].

[42] ANRE (2012a).

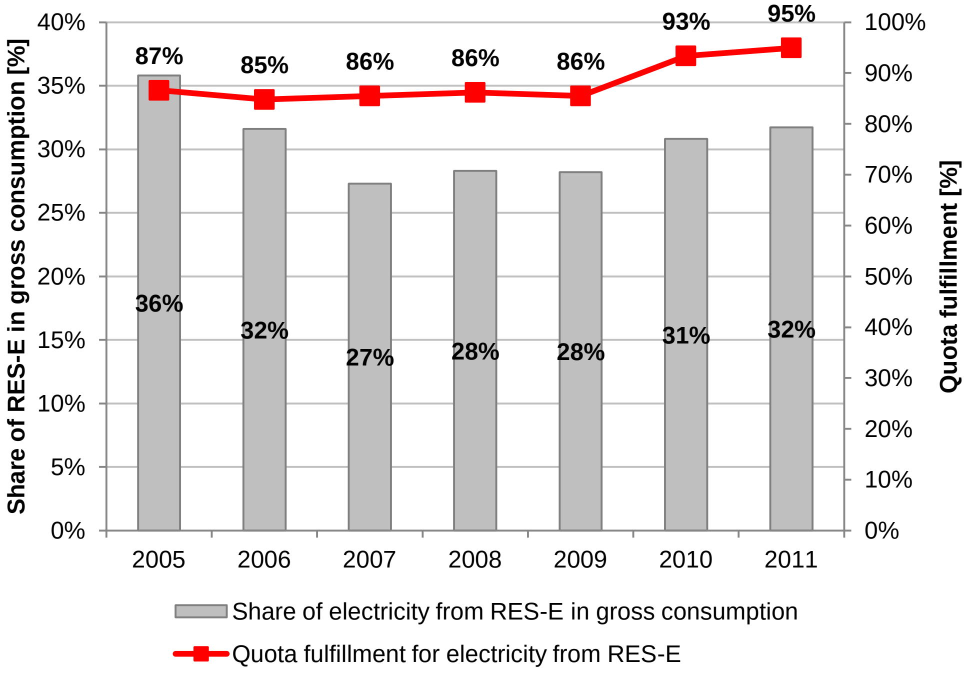

Fig. 19: Realized share of electricity from RES-E and quota fulfillment in Romania[43].
Source: ANRE (2012a).

In order to support the RES projects, producers receive[44] TGCs that they sell on the market to energy suppliers. Power suppliers are obliged by the law to buy a certain quota of TGCs from the renewable energy producers[45]. The mandatory TGC quota established yearly by ANRE is based on the RES-E produced during one year, the TGCs available on the market and the internal gross consumption. In addition to the TGCs received, the electricity generators may sell electricity on the wholesale market in order to get a supplementary income[46].

ANRE qualifies yearly the producers of electricity from renewable energy sources that will receive TGCs. All technologies are eligible for the support scheme based on TGCs[47] but there are considerable differences concerning the incentive amount, the number of green

[43] The quota fulfillment for electricity produced from RES-E from gross electricity consumption in Romania was calculated based on the Romanian targets of 33% for 2010 and 35% for 2015, which result in a target quota of 33,4% for 2011. The realized share of electricity from RES-E was estimated based on levelized values for 2010 and 2011.

[44] Law 220/2008, Art. 6 par. 1.

[45] The Electricity Law establishes the legal framework for the introduction of a quota system to promote electricity from renewable sources and stipulates the rights and obligations of the persons involved. Law 220/2008 complements this framework.

[46] Law 220/2008, Art. 14 par. 1.

[47] Law 220/2008, Art. 3 par. 1.

certificates issued depending on the technology used. The lifetime of the support system is 15 years for the new power plants applicable for units commissioned no later than 2016[48].
Investors in wind energy will receive 2 TGCs up until 2017 and from 2018 they will receive 1 TGC per MWh of electricity generated. The producers of solar energy on the other hand will obtain 6 TGCs per MWh of electricity generated.
For geothermal energy producers will receive 2 TGCs per MWh of electricity generated. Highly efficient CHP plants and systems that use biomass from energy crops based on geothermal energy receive one additional certificate.
Concerning hydro-power production, only systems whose installed capacity is below 10 MW are eligible for the support scheme. Modernized hydro-power stations cease to be eligible after 10 years, and all other systems become ineligible after three years. New hydro-electric plants receive 3 TGCs/MW, modernized hydro-electric plants receive 2 TGCs/MWh, and other hydro-electric plants receive 1 TGC/2 MWh of electricity generated.
The operators of biomass and biogas systems are eligible for green certificates only if they present certificates of origin for the biogas used. There are several types of biogas taken into consideration within the incentive scheme: biogas, gas produced from anaerobic digestion of waste and gas produced from anaerobic digestion of sewage sludge. Biomass production can also be subdivided in three types of production: biomass, liquid biofuels for energy generation that were produced from biomass and are not used in the transport sector. For the production of biogas and biomass producers receive 2 TGCs/MWh, highly efficient CHP plants and systems that use biomass from energy crops based on the above-mentioned energy sources are also eligible for one additional certificate per MWh of electricity generated. For gas produced from anaerobic digestion of waste and sewage sludge producers receive 1 TGC/MWh, highly efficient CHP plants and systems that use biomass from energy crops based on the above-mentioned energy sources are also eligible for one additional certificate per MWh of electricity generated[49].
During the trial period, irrespective of the technology employed, a plant will be eligible for one TGC/MWh of electricity. If a plant is supported under another government-funded programme, the number of certificates to be issued is set by the regulatory authority (ANRE) on

[48] Systems that have already been used for electricity generation within the territory of another state or were in operation on Romanian territory before the Law came into effect become ineligible after 7 years, as stipulated in Law 220/2008 art. 3 par. 2.
[49] Law 220/2008, Art. 6 par. 2, 4, 5.

a case-to-case basis. The number of certificates will be lower than the number usually awarded to a plant of the same technology[50].

TGCs are issued by the transmission grid operator (TSO) for all electricity generated from renewable sources minus the electricity used to power the plant[51]. For this reason, every month the system operators shall report to the TSO on the amount of renewable electricity fed into the grid. The electricity to be reported includes electricity transmitted to the distribution system operators (DSO) and electricity directly supplied to end users[52].

The amount of subsidy corresponds to the price per certificate achieved in the market. During the years 2008-2025 the transaction value of one green certificate will be at least 27 Euros and at maximum 55 Euros. The certificate price will not differ according to the technology employed[53]. If a supplier or a producer fails to meet the annual quota, he will be obliged to purchase the missing certificates at a higher price of 110 Euros each. Every year, this price is adjusted by ANRE on the based on the Euro-zone consumer price index as published by Eurostat[54]. Currently the Regulatory Authority in Romania has proposed a modification to the former legislation, introducing the concept of a “Guarantee Fund”. This fund will be obliged to buy all the supplementary TGCs on the market at minimum price, when there will be an excess of TGCs on the market[55].

The Energy Regulatory Authority ANRE accredits the systems to take part in the quota system and is also responsible for monitoring compliance with the quota obligations[56].

TGCs can be traded both bilaterally and on a centralized TGC markets. The Romanian electricity market operator OPCOM maintains and monitors trade flows on the green certificate market[57]. OPCOM publishes the demand and the offer of TGC at the national level, administrates the TGC Register, provides the trading framework and receives the sell/buy offers for TGC from the suppliers. The price level is set through a market mechanism of offer and demand within the limits established by ANRE.

[50] Law 220/2008, Art. 6 par. 7 letter a, b.
[51] Law 220/2008, Art. 6 par. 1.
[52] Law 220/2008, Art. 7 par. 1.
[53] Law 220/2008, Art. 11 par. 1 letter 1.
[54] Law 220/2008, Art. 12 par. 3.
[55] Draft legislation concerning the modification of the Emergency Regulation 88/2011.
[56] Law 220/2008, Art. 12 par. 1.
[57] Law 220/2008 Art. 10 par. 2.

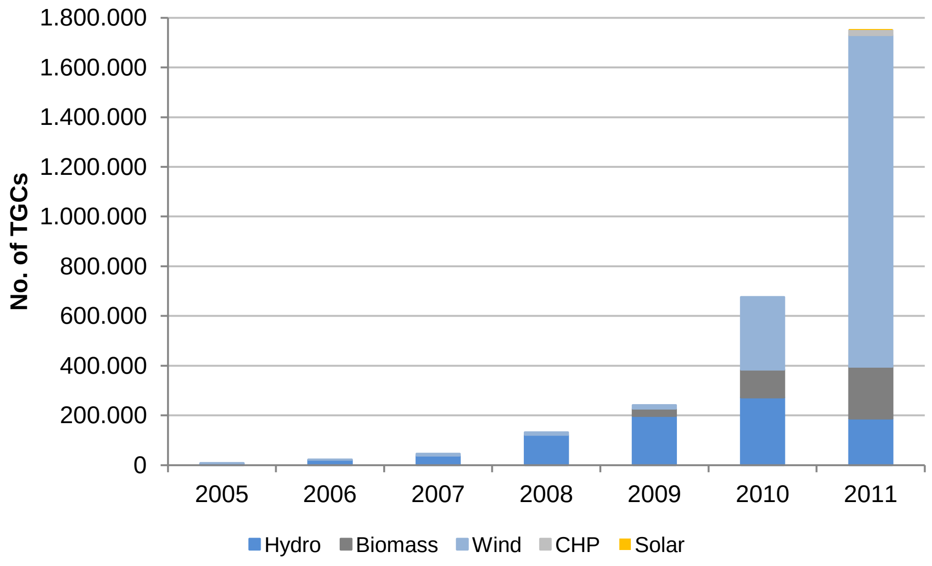

Fig. 20: Issued TGCs in Romania, 2005-2011.
Source: ANRE (2012a).

The TGCs issued increased significantly after the publication of the RES-E law amendments, which offers 2 TGCs for wind power. The above chart shows that the issued TGCs increased aver two times from 2010 to 2011, from ca. 700 000 to 1,5 mio. and in 2012 a total number of over 5 mio. TGCs are expected.

The TGC market is a competitive market, distinct from the electricity market, were TGCs can be traded and has two main components: the bilateral TGC market and the centralized TGC market. The TGC price is established through a competitive market mechanism, where the supply meets the demand, but within the price range legally established. There is at least one auction per month, when the buyers and sellers can send their binding offers and OPCOM centralizes them on the announced auction date, publishing the results on their homepage. Currently there are usually two auctions per month. Before the auction date, OPCOM publishes on their homepage information concerning the total number of TGC issued for RES-E produced during the current year, number of TGCs traded on PCCV, number of TGCs traded bilaterally and number of TGCs available on the market. Concerning the information published there are a few aspects that make trading difficult on PCCV. The most important is that a participant never knows how many TGCs are actually available for trading, because OPCOM publishes only the number of TGCs available on the market, but not for trading. For example, if a producer has a bilateral contract for a whole year, he is obliged to inform OPCOM about the contract only on the due date when ANRE is checking the TGC accounts of the obligated parties. In other words currently a producer can inform OPCOM about the contract at the end of the year, and this information cannot be reflected in the numbers that OPCOM published monthly about the available TGCs on the market. This aspect implies that the parties that want to buy TGCs on PCCV never know the exact number of TGCs available and have to send their bid offer in lack of transparency. The auction results published on the TGC market refer to the number of participants at one auction, the number of supply and demand offers, the actually traded number of TGCs and the closing price for 1 TGC. Furthermore OPCOM publishes the aggregated curves of supply and demand. A historical development of the TGCs prices and volumes on the Romanian TGC market is presented below. It can be noticed that the prices are constant throughout the years, as the TGCs were always traded at maximum price. Concerning the volumes there is a peak of transactions in March every year, when the TGC quota had to be accomplished until now. The forecast is that this market will be more balanced in future concerning the trades, as the TGC quota will have to be fulfilled every quarter.

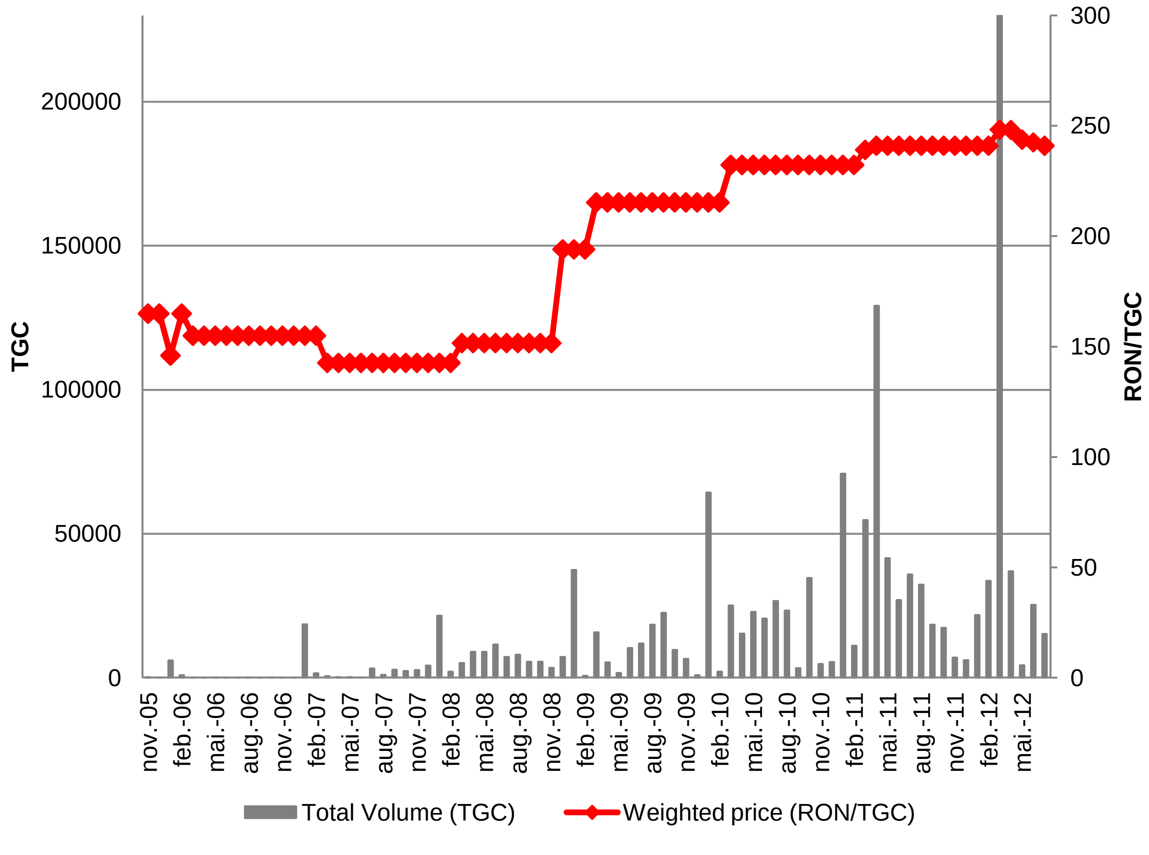

Fig. 21: *Evolution of TGC prices and volumes traded on the centralized market.*
Source: Own illustration.[58]

[58] Based on data from OPCOM (2012); FX rates are depicted in Appendix 1.

Calculation procedure of the yearly mandatory TGC quota

The yearly TGC quota calculation procedure by ANRE is based on different variables. Taking into consideration the European targets to increase the amount of produced RES-E until 2020, Romania has set mandatory quotas of RES-E to be produced until 2020, in order to achieve the European guidelines. The mandatory quota of produced RES-E that will benefit from the support scheme is expressed as a percentage of the yearly internal gross consumption[59] and will have to reach 20% in 2020, from a target of 10% in 2011 which was not met yet. The quota fulfillment in 2011 reached only to one third from the mandatory target.

The methodology for establishing the annual procurement quotas of TGC sets out the framework for calculating the mandatory TGC quota[60].

In the first decade of December each year, ANRE publishes the yearly forecasted quota of TGC to be procured during the following year, based on the following input: RES-E that is going to be produced during the following year, number of TGCs estimated to be issued and gross final consumption estimated for the following year.

The forecasted RES-E to be produced is established by analyzing the installed power for the existing power plants that produce RES-E, the installed capacity for power plants due to be commissioned during the following year, and the average capacity factor representing the ratio between the power delivered from the power plant during the analysis period and the power that would be produced if the power plant functioned at full installed capacity. Electricity produced in hydro power plant with an installed capacity bigger than 10 MW will not be taken into consideration within this calculation.

The total number of estimated TGCs on the market during the following year will be calculated as sum product of the forecasted produced electricity, as established above and the number of TGCs that are issued for every technology, as stipulated in the law. The gross final consumption estimated for the year ahead is calculated as a sum of the forecasted electricity produced in Romania and the energy imports from other countries, subtracting the grid losses and energy exports[61].

In the first decade of February each year, ANRE will adjust the yearly TGC purchase quota for the precedent year based on the actual figures for the previous year[62]. The yearly maximum amount of RES-E supported by the incentive scheme will be calculated as a product of

[59] Law 220/2008 Art. 4 par. 4 and 5.
[60] Order 45/2011.
[61] Order 45/2011, art. 5-10,
[62] Law 220/2008, art. 4 par. 9 and Order 45/2011, art. 15.

the maximum mandatory quota[63] and the gross final consumption. The number of issued TGCs will be established as a sum of the actual TGCs issued and the virtual TGCs issued for the RES-E produced by plants smaller than 1 MW which sell the electricity at prices regulated by ANRE and do not receive TGCs. This sum will be adapted taking into consideration the cumulated subsidies for certain projects. If the amount of RES-E produced during one year exceeds the maximum amount supported yearly, as calculated above, then the TGC quota will be adjusted by the ratio between the maximum amount supported and the actual amount of RES-E produced, otherwise the calculated TGC quota will remain valid[64]. Every year by 10th of April ANRE checks whether the electricity suppliers and producers met their renewable certificate quotas in the last obligation period.

The latest amendment to the RES-E legislation is given by the law 134/2012. There are two main provisions in the new law that influences the TGC market and the TGC prices. First, the mandatory fulfillment of quota will be checked quarterly by the regulator. This means that power supplier have to meet quarterly with the yearly forecasted TGC quota. If the quarterly quota is not met, then the suppliers have to pay the maximum price for the missing TGCs in a “guarantee fund” administered by OPCOM. By having to fulfill quarterly the yearly quota, it is implied that some suppliers will be obliged to pay into the guarantee fund, as for example in the first quarter of a year there will be not enough TGCs on the market to cover the yearly forecasted quota, because the yearly quota is estimated based on the total number of TGCs issued throughout the year. As TGCs are issued for every MWh produced, they also underlie to a specific seasonality depending on the technology which produces the most TGCs, in Romanian’s case the wind power.[65] Another important topic from the new amendments is the fact that TGCs will be issues separately within the energy bill to all electricity customers. The invoicing will be based on the average PCCV TGC price for the quarter before, multiplied with the yearly target quota set by ANRE. Reconciliation will take place after the final quota for the previous year is established.

3.3 Assessment of the efficiency and effectiveness of TGC systems

In the previous chapters different TGC systems in Europe were detailed and the current RES-E situation and historical development of RES-E production has been discussed. It can be remarked that every TGC system has a very different functioning and there is no common

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[63] Set out in Law 220/2008 Art. 4, par. 4.
[64] Order 45/2011, art. 15-20.
[65] Law 134/2012.

ground for the harmonization of the systems as the interest of the countries differ from each other and the local possibilities can offer different opportunities based on the geographical factors. In the below table an overview of the various TGC support scheme is presented. It can be noticed that differences in the policies start from the target quotas and reach to obliged parties, prices, duration and validity of certificates. The main difference can be noticed looking at the TGC prices. The range reaches out between 20 EUR/TGC in Sweden up to over 100 EUR/TGC in Flanders, as can be noticed in the following chart.

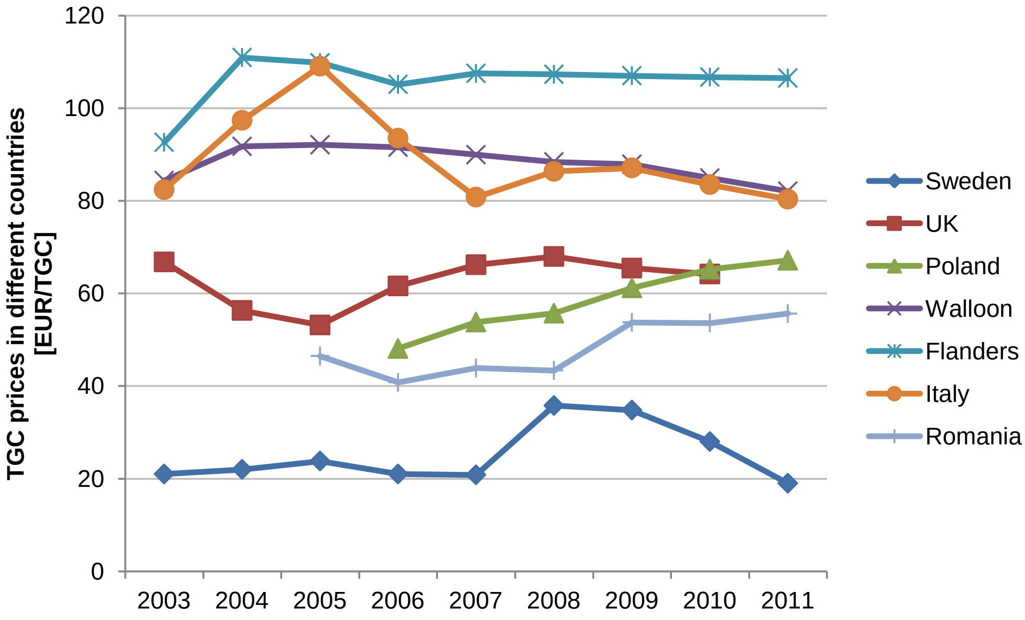

Fig. 22: *Development of European average TGC prices*.
Source: Own investigation. Illustration based on Haas et al. (2011b)[66].

In spite of very high prices for example in the UK, one of the main issues is that the target quota of RES-E has never been reached. The opposite situation is the case in Sweden, who has the lowest TGC price and is the only country with a TGC system that has reached the yearly target RES-E quotas established. One conclusion can be that high TGC prices do not necessarily imply a higher effectiveness of the system as they do not attract more investors. In order to have a positive evolution on the RES-E market, more premises have to be accomplished than a good TGC pricing. Another example for this is Poland. In spite of increasing TGC prices throughout the years, the quota fulfillment is decreasing. This means that there is no enhanced interest in investing in RES-E in Poland although the incentive scheme is improving. In Romania the prices are also increasing together with the quota fulfillment. A

[66] Cp. SEA (2012), GME (2012b), TGE (2012b), CWaPE (2011), VREG (2010), OPCOM (2012), Ofgem (2012); FX rates are depicted in Appendix 1.

sudden increase can be noticed in the last year, due to the introduction of the technology banding. Although the Romanian TGC system was introduced in 2005 it only became attractive to investors in 2011 when the TGC allocation was defined by technology. Romania is the only country which has a minimum, a maximum and a penalty price.

In the below chart the evolution of the quota fulfillment in the TGC systems in Europe is depicted. The only country who could reach its RES-E targets based on a TGC system was Sweden.

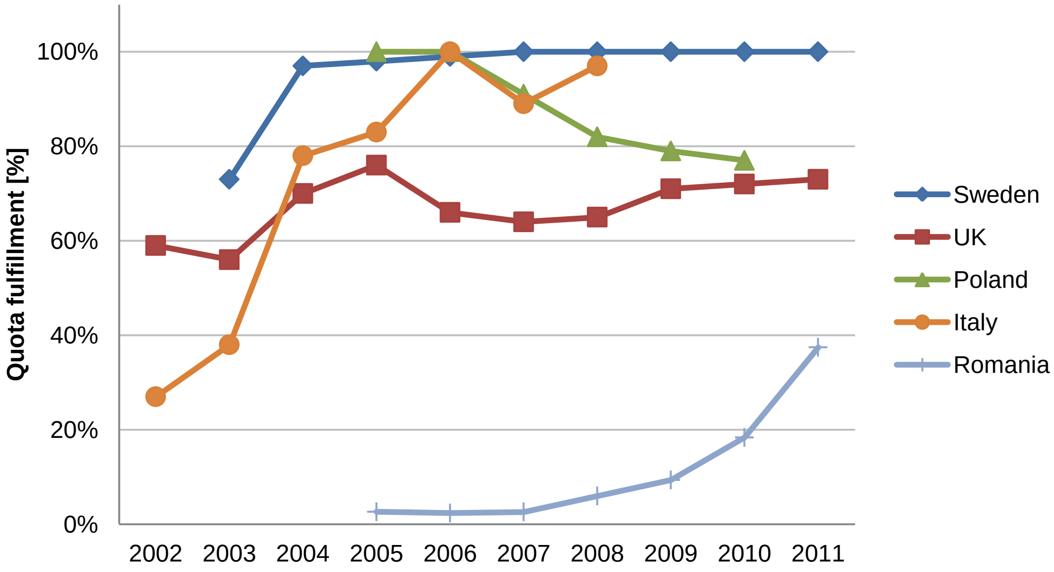

Fig. 23: *Quota fulfillment in different European TGC systems*.
Source: Based on Haas et al (2011).[67]

[67] Cp. SEA (2012), GME (2012b), TGE (2012b), CWaPE (2011), VREG (2010), OPCOM (2012), Ofgem (2012); FX rates are depicted in Appendix 1.

	Quota target	Involved techno-logies	Obliged stakeholder	Penalty [€/MWh]	Minimum limit [€/MWh]	Technology specific quota	Exist-ing power plants	Applicability of support scheme	Validity of TGCs
BE Flanders	7% in 2012 and new calculation formula from 2013; target of 13% in 2021	All RES, no MSW	DSO and TSO	2012: 125 2013: 118 After 2014: 100	65	No	Yes	Quota obligation until 2021; right to receive certificates only for 10 years; for PV 15-20 years	48 months
BE Walloon	15,75% in 2012	All RES and high quality CHP	DSO and TSO	100	80-330 (depending on technology)	Yes, only for PV	Yes	Valability ceases after 15 years; after 10 years reduction factors applied; for PV 10 years	5 years
IT	7,55% in 2012 and 0% in 2015	All RES (incl. Large hydro, MSW, hydrogen and CHP; excl. PV)	Produ-cers and importers	No	Excess supply of TGCs bought back until 2015 at 78% of diff. Between 180 € and el. price	Yes, since 2008	Yes	For power plants put into operation until end of 2012; right to receive certificates for 12-15 years	3 years
PL	12,9% in 2017	Small and large hydro, wind, bio-mass	Supplier	30% on top of the sub-stitution fee of ca. 60 €	No	Yes, correction factors intro-duced in 2012.	No	Power plants receive TGCs for 15 years after commissioning	Unlimited
RO	20% in 2020	All RES - small hydro, wind, solar, biomass, geother-mal	Supplier	110 (indexed yearly until 2025 with inflation rate for Eurozone)	27 (indexed yearly until 2025 with inflation rate for Eurozone)	Yes, since oct. 2011	Yes (except hydro)	For power plants put into operation until end of 2016; right to receive TGC 15 yr.	16 months
SE	19,5% in 2020	Small hydro (<1,5 MW), large hydro, wind, biomass, geothermal, wave	Supplier	150% of the market price	No minimum price since 2008 (transitional floor prices 2003 - 6,6; 2004 - 5,5; 2005 - 4,4; 2006 - 3,3; 2007 - 2,2)	No	Yes (small hydro)	Eligibility of power plants commis-sioned until end of 2016; receive certifi-cates for 15 yr.	Unlimited
UK	15% in 2020	All RES - small hydro, wind, bio-mass, solar, geo-thermal, wave, tidal	Supplier	Buy-out price plus 5% interest (buy-out price changes yearly with retail price index; 51 for 2012/13)	No	Yes, since 2009	No	Eligibility of power plants commis-sioned until end of March 2017; receive certificates for 20 yr.	Unlimited

Fig. 24: *Overview on quota based TGC systems in EU countries*.

Source: Based on Haas et al. (2011) and own investigations.[68]

[68] Cp. SEA (2012), GME (2012b), TGE (2012b), CWaPE (2011), VREG (2010), OPCOM (2012), Ofgem (2012); FX rates are depicted in Appendix 1.

After having summed up the main characteristics of the various TGC systems described in the previous chapter, in the following an appraisal of the TGC systems will be carried out, based on the findings in the specialty literature on this topic. Starting with the year 2001, after the publication of the EU Directive on RES-E development and targets for Europe, very much attention has been offered to the incentive schemes for RES-E. The impact of the design of direct policy instruments on the market growth and on the policy costs of different support measures have been in the focus of discussion.[69] One topic has been of great importance within the research: the discussion about whether feed in tariffs or TGC based quota systems are a more efficient support scheme.

Among the advantages of TGC systems that were hoped for was the long term predictability for investors by moving costs to promote RES-E from public financing to the market; by being a market-based support system it was thought that this system would reduce costs through competition between different RES-E and technical development[70]. Another advantage discussed was the achievement of policy targets for RE-E production by controlling the volume through quotas. Nevertheless experience shows that the advantages hoped for are very difficult to transpose in real TGC markets and the expected outcome from TGC systems was not as favorable as intended.

Over time a series of studies and analyzes had the role of milestones for the development of this research field. In the following a few of these studies will be presented.

Morthorst[71] assessed over 10 years ago the voluntary TGC systems in Holland and Denmark. His conclusion was that the TGC market would eventually turn out to be very volatile in price, due to the combination of inelastic demand and fluctuations in electricity production from RES-E. He explains that the TGC price could jump very quickly from the minimum to the maximum price and would also be highly influenced by the electricity prices. His conclusion is that a TGC scheme should be designed in such a way that substantial price variations can be handled.

Verbruggen[72] published its view on the Flemish TGC system in the early 2000, reaching to the conclusion that TGCs may become an effective and efficient instrument if handled correspondingly. He stresses out that a TGC system has to address the diversity of the different RES-E technologies either by fine-tuning the more direct support measures or by technology banding, through the allocation of a different number of TGCs per technology. Without the

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69 Cp. Haas et al. (2011).
70 Cp. for e.g. Kildegaard (2008).
71 Cp. Morthorst (2000).
72 Cp. Verbruggen (2004).

recognition of the technology diversity and the cost realities, there will be opportunities for investors to gain windfall profits in more mature technologies and they will not have any incentive to invest into new technologies. Several years later the same author considers that the EU Commission's 2008 proposal to extend the green certificate experiments after 2010 as the worst possible suggestion. He also highlights his opinion that the TGC system overall is flawed and considers that an effective and efficient RES-E policy is based on an extensive and balanced qualification of technologies, and that the TGC system is not able to fulfill the conditions as they yield in excess profits that do not incentivize the development of newer technology, profits that have to be borne eventually by the end-consumers.[73]

Menanteau et al.[74] assesses in 2003 the price versus quantity based support schemes and highlight the criteria that have to be borne in mind when choosing a specific incentive scheme. They consider the policy cost as being more controllable in quantity based system as tenders and TGC systems; the installed capacities have proved more successful in price based systems than in quantity based systems. Concerning the stimulation of technical change, they consider that the quantity based systems can be more effective, as there is a higher competition for cost reducing and due to this fact the progress made in RES-E technology can be an advantage.

Fouquet/Johannsson[75] criticize the TGC system, as with TGC the market would tend to first choose the least costly RES-E option leaving others for later, in order to increase their profit to the maximum. They hold the view that with FIT systems all RES-E technologies can develop, provided the price paid is effective, and this would lead to innovations in all technologies. Concerning the need for long term contracts in TGC systems, in order to secure the off-take and facilitate the financing, the two authors consider that this idea would go against the competition philosophy and contradict its own claim of competitiveness of TGC.

Haas et al.[76] conclude in several analyses of the support policies that the FIT systems have yielded in more RES-E production and hence rendered more effectiveness and at the same time more efficiency by lower costs transferred to the end-consumers. In a comparative analysis regarding effectiveness versus costs of promotion for electricity from RES-E they conclude that Sweden is the only country with a TGC system where a positive RES-E evolution by an increasing RES-E production at social bearable costs, comparable to outcome on the RES-E market in Spain. **Butler/Neuhoff** reach to the same conclusion, that the FIT reduces

[73] Cp. Verbruggen/Lauber (2009).
[74] Cp. Menanteau et al. (2003).
[75] Cp. Fouquet/Johansson (2008).
[76] Cp. Haas et al. (2011b).

costs to consumers and results in larger deployment, within their comparative analysis of the German and UK promotion systems.[77]

Agnolucci highlights in his analysis that as long as the existing capacity is smaller than the quota, TGCs do not differ from a FIT with a tariff equal to the maximum price or the penalty. For this reason, it is highly important to set the right quota. A quota which is too low will determine a certificate price which is not attractive to investors, while a very high quota can imply very high costs by non-complying with the targets.[78]

One of the initial arguments in favor of the implementation of TGC systems in Europe was the idea that such a system could be internationalized and could play a defining role in the cost minimization. The argument was that countries with high costs for the production of RES-E would buy the TGCs from countries with lower costs, as the TGC system would favor the concentration of the RES-E generation in the countries where it can be produced at the lowest cost.[79] In fact, if only the economic advantages would be taken into consideration integrated TGC markets could offer a number of potential efficiency gains in terms of reduced costs and increased competition. Nevertheless, they also raise other concerns which relate mainly to policy legitimacy and design issues. International trade of TGCs could lead to the undermining of nationally based support schemes if countries are obliged to subsidize renewable operators in other countries. Linking together different support systems could also result in higher regulatory uncertainty due to different interest of the EU member states.[80] Also, the policies would have to enable the countries to meet the innovation challenge. In a market economy the prospect of rents is a necessary condition for the encouraging entrepreneurship. However, rents should be practically directed to risk taking investors and not be mistaken as windfall profits for companies who choose to invest in cheap technology in order to skim the profits. TGC systems will tend to disadvantage independent renewable operators and give higher returns to the major electricity companies due to the financing difficulties.

Several authors have discussed the important role of long term contracts in TGC support schemes.[81] The literature suggests policies who encourage long term contracts (e.g. TGC system in Texas) and indentify the lack of such contracts as the cause of TGC market failure. In his research, **Kildegaard** argues that the lack of long term contracts as being one option

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[77] Cp. Butler/Neuhoff (2008).
[78] Cp. Agnolucci (2007).
[79] Cp. for e.g. Toke (2008), Jacobson et al. (2009) and Soederholm (2008).
[80] Cp. Toke (2008).
[81] Cp. for e.g. Agnolucci (2007).

in order to overcome the disadvantage of financing RES-E projects in a TGC system could be the consequence of the market failure than the cause thereof.

Based on the above findings, it can be concluded that the majority of the literature show predominant criticism towards TGC systems and there is a high necessity to properly design TGC systems in order to result in a steady evolution of RES-E production. Although the experience shows that FIT systems were more efficient and effective regarding the electricity from RES-E produced and the costs incurred to society, it can be also stated the countries with TGC system have also shown a continuous positive evolution on the RES-E market. The task for the governments who introduced TGC systems is to learn from the experience from the countries who implemented such systems before and adapt the support schemes in such a way that they become as efficient and effective as to sustain a RES-E development which is bearable for the society in terms of costs. When choosing and developing a support scheme it has to be borne in mind which priority is striven for. Bergek/Jacobsson consider that a TGC framework is able to minimize short term social costs of reaching certain goals with a high degree of predictability. However, they stress out that it cannot be expected to also drive technical change, keep consumer costs down, and be equitable.[82]

[82] Cp. Bergek/Jacobsson (2010).

4 TGC procurement strategy from a Romanian power suppliers' perspective

As presented in the previous chapter, the TGC system in Romania has resulted in a poor development between 2005 and October 2011, when the renewable energy law was amended and a banded technology system was introduced. Taking into consideration both the opportunities presented by the new financial incentives for potential investors, and the development of the RES-E markets in other countries with a TGC support scheme, a future positive development of the RES-E deployment is to be foreseen in Romania. In order to reach the proposed targets for the RES-E market, investment decisions have to be taken in Romania and new power plants would have to be commissioned in a fast pace. Based on the reality that the TGC system does not offer security for the financing of RES-E projects, long term procurement agreements have to be concluded by the investors with local suppliers in order to secure the return on investment, based on the off-take security for the produced power and TGCs. As the TGCs offer a much larger extent of the income than the selling of electricity, it is very important for investors to have a green certificate purchase agreement for a time period of at least 10 years. This is important for smaller investors, who do not have the possibility to self finance the planned RES-E projects in Romania, but depend on bank loans for the financing.

In this respect, the supplier has a key role in the TGC market in Romania, being the obliged party for procuring the TGCs and invoicing them further to the customer. As the TGC system is in constant development a thorough analysis has to be made on the potential evolution of this market, in order to skim early the advantages in a developing market. With many issues concerning the TGC support scheme functioning in Romania still unsettled, a Romanian power supplier has to assess the potential of this relatively new market and try to minimize uprising risks and maximize potential opportunities, which are at this point in time only projections, which will support the local strategies of power suppliers to better perform in future on this market.

In this chapter, first two possible RES-E market evolution scenarios are developed. Based on these scenarios a proposal of long term TGC procurement strategy is discussed. Afterwards the threats and weaknesses of the strategy are discussed and in a last step, the potential long term impact of this type of strategy on the evolution of the RES-E market in Romania and the achievement of the proposed targets will be outlined.

4.1 Development of long term market evolution scenarios

The Romanian RES-E market is subject to a lot of changes in the last months. The amendment of the law 220/2008 from October 2011 brought many changes and an increased interest in RES-E investments in Romania, as the new law provided for a banded technology framework, which made investments in economically more costly RES-E options interesting. As presented in the previous chapter concerning the development of the support scheme in Romania, during 2012 even more changes to the RES-E legal background were introduced, which will have a long lasting effect on the functioning of the TGC market and on the evolution of the RES-E market.

Taking into consideration the current status of the Romanian TGC policy framework two RES-E and TGC market evolution scenarios were developed in order to have an exhaustive view upon the future impacts of this market on the current business of the power suppliers in Romania. First, the ANRE official market development scenario is outlined, as it is published on their website and afterwards an adapted market scenario is depicted, based on the current market findings and information and the latest actual developments on the market, that took place after ANRE published its calculations in February 2012.

In order to forecast the RES-E market development several variables have to be defined. Two basic figures account for the future RES-E quota: the total RES-E production benefitting from the TGC support scheme and the gross internal consumption. These two figures are necessary for the future planned RES-E quota and will serve as a ground for the TGC quota calculation, which differs from the RES-E quota due to technology banding in Romania. For the forecasting of the produced RES-E during the next 15 years first the installed capacity is planned by technology, based on current information about technical connection approvals and discussions with many potential market investors as well as taking into consideration assessments of the RES-E potentials of Romania, from a geographical, economical and technical perspective. Starting from the planned installed capacity the average capacity factor is applied for different technology in order to forecast the planned produced energy. Afterwards the development of the gross internal consumption is projected into the future, based on historical data and on actual information on the future economic development in Romania. Starting with the planned RES-E production, the TGCs are allocated compliant with current legal provisions and then applied for the produced energy for every technology separately and for every year based on the evolution of yearly new installed capacity. The TGC quota is afterwards calculated for every year as described in the previous chapter on the Romanian support scheme, i.e. the TGC quota is set so that all the TGCs on the market will have to be sold if the realized RES-E quota is smaller than the RES-E target quota established by law; if the RES-E quota realized is higher than the target RES-E quota, then only a number of TGCs will have to be traded up to the produced RES-E correspondent to the mandatory RES-E target. The figure below shows the process for the prediction of RES-E and TGC quotas within the market development scenarios.

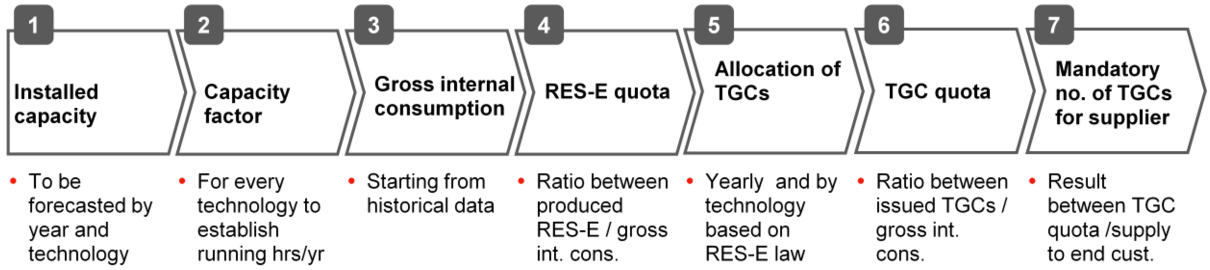

Fig. 25: *Process for developing the RES-E and TGC market evolution*.
Source: Own illustration.

4.1.1 Supplier's market development scenario

Based on the above described process the market based RES-E market scenario is constructed. Following assumptions are taken into consideration:

1. A forecasted installed capacity of 4430 MW until the end of 2016. As the Romanian support scheme applies only for power plants commissioned until the end of 2016, the installed capacity of RES-E is assumed to remain at a constant level of the year 2016 until 2027, representing the analyzed timeframe. The installed capacity from wind power plants will account for ca. 80% of total produced electricity which befits from the TGC incentive system. Biomass will account only for 2%, hydro power plants for 15% and biogas installed capacity for ca. 1%. The yearly planned installed capacity by technology is detailed in Appendix 1.
2. The running hours per year are presented in the table below and were calculated based on average capacity factors as published for Europe by the International Energy Agency[83]:

[83] IEA (2012).

Technology	*Running h/yr*	*Technology*	*Running h/yr*
Wind	1800	Biogas	5700
Hydro	2500	Biomass	6100
Solar	1200		

Fig. 26: *Used running hours/year for forecasted RES-E production*.
Source: IEA (2012).

3. The gross final consumption is forecasted to increase yearly with an average of 2,5%, starting from the planned figure for 2012.
4. The number of allocated TGCs is compliant with the current legal background for all technologies except for solar power. Currently 6 TGCs are allocated for every MWh of solar power produced. It is currently under discussion to amend the law to the extent that for solar power only 4 TGCs shall be allocated starting for power plants commissioned after 1st of January 2014. This modification was taken into consideration within this scenario.

The detailed outcome of the forecast process is shown in Appendix 1. The conclusion of this scenario is that, with the current regulations, incentives and technological possibilities the RES-E target quota set for Romania will not be reached until 2027. The evolution of the forecasted RES-E and TGC quotas compared to the mandatory RES-E target quota is depicted in the below graphic. As the majority of the forecasted installed capacity comes from wind power and the allocated TGCs for this technology are 2 TGCs until 2017 and 1 TGC afterwards, the TGC quota evolution is strongly influenced by this allocation.

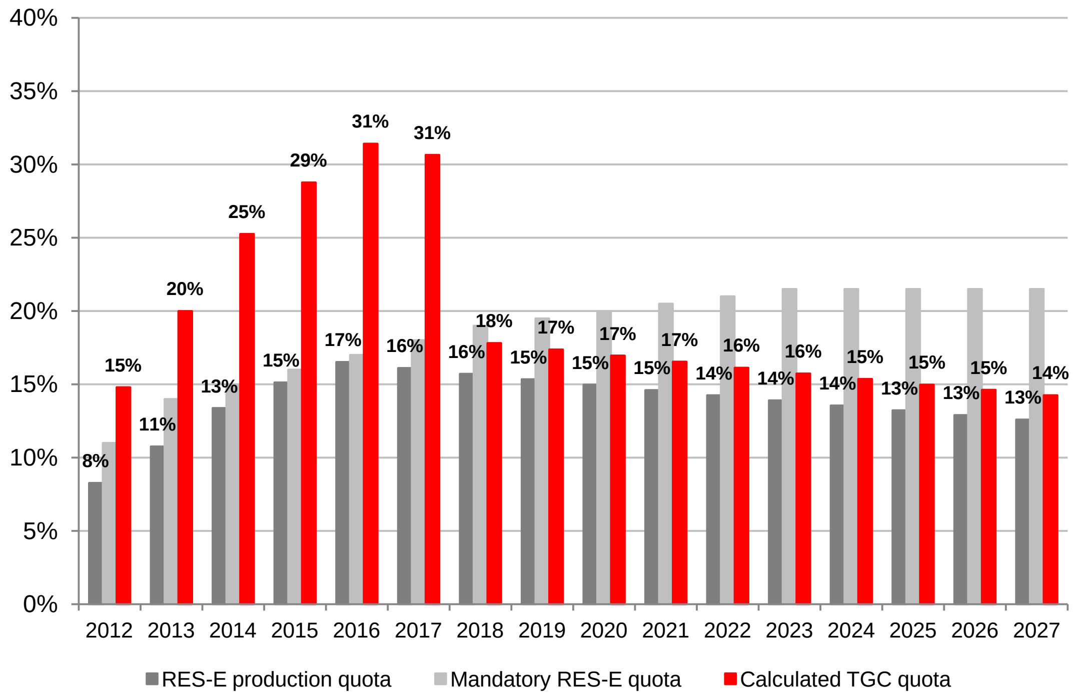

Fig. 27: *Market scenario - RES-E and TGC quota vs. mandatory RES-E target quota*.
Source: Own investigations.

4.1.2 ANRE scenario[84] for RES-E evolution

The ANRE scenario for the future development of RES-E production and TGC quotas is more optimistic than the market baseline scenario. In this scenario the Romanian market regulator forecasts that the mandatory RES-E quota will be reached and surpassed only during three years, between 2014 and 2016. Furthermore, a higher TGC quota is forecasted also during the years were the RES-E target quota will not be reached. The below graphic summarizes the evolution of RES-E quota and TGC quota during the next 15 years in the ANRE scenario.

[84] Cp. ANRE (2012b).

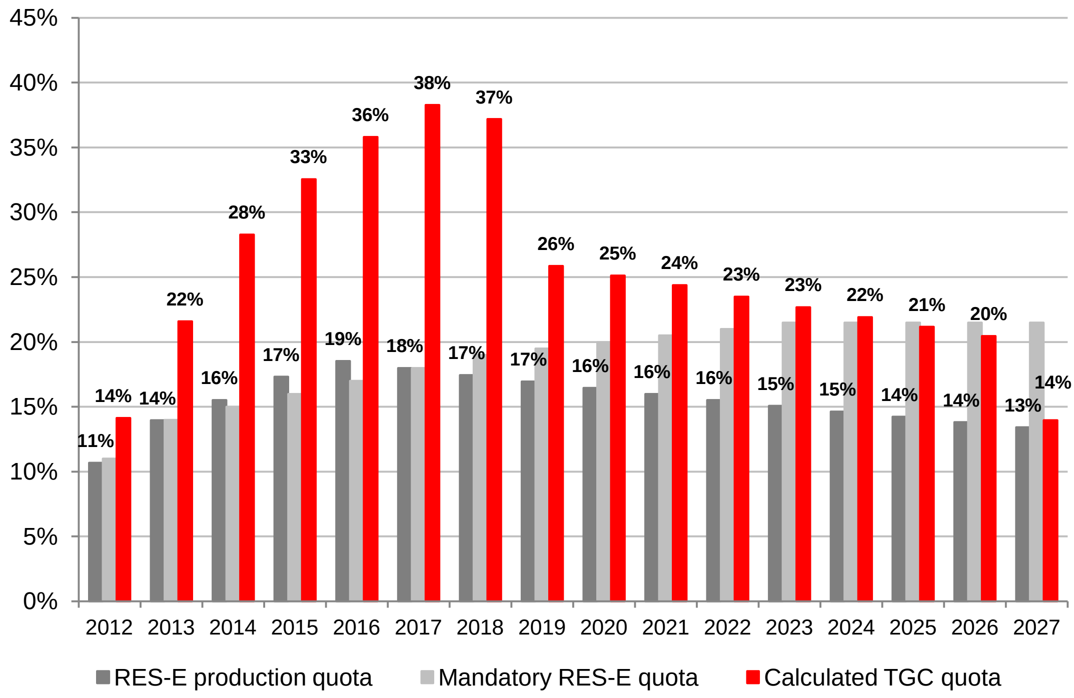

Fig. 28: *ANRE scenario - RES-E and TGC quota vs. mandatory RES-E target quota*.
Source: Based on ANRE (2012b).

These outcomes are based on a series of differences in assumptions, between the two scenarios:

1. ANRE forecasts 5% more installed capacity until 2016, reaching to a total of 4677 MW. The installed capacity for wind power accounts in this scenario only for 75% of the total RES-E capacity, whereas biomass accounts for 7%. The other two technologies have a similar proportion as in the market scenario. This means that a significant number of RES-E from biomass will have an impact on the RES-E and TGC quotas.
2. The capacity factors differ slightly from the market scenario, especially for and hydro solar power, where there is a difference of ca. 15% concerning the running hours per year of the specified production technologies.
3. The forecasted gross consumption is almost 25% higher than the market scenario figures.
4. The current discussion upon the modification of allocated TGCs for solar power is not taken into consideration. This means that a number of 6 TGCs is allocated for the whole analysis timeframe, which has an important impact on the number of issued TGCs on the market and hence on the calculated TGC quota.

Summarizing the outcomes of the two RES-E development scenarios it can be stated that both of them show that the RES-E production targets set for Romania will not be met until 2020. This conclusion highlights that the current support scheme in Romania has a few weaknesses that would eventually have to be addressed if Romania will want to reach the mandatory targets.

It has to be outlined, that the above assessed quotas apply only for RES-E that benefits from the TGC support scheme. Romania has also a significant hydro power resource, and produces currently overall ca. 23% RES-E from renewable energy sources, taking into consideration also large hydro power plants. This means that the hydro production will also have a supplementary impact on the 2020 targets, depending on the rainfalls during the years when the targets will have to be reached.

4.2 Proposal for a long term TGC procurement strategy

After having discussed the possible RES-E market developments in the previous chapter, in the following a long term TGC procurement strategy will be proposed for a Romanian power supplier, based on the market development scenario described above. For the development of an adequate long term procurement strategy and the assessment of the involved risks and opportunities, several steps have to be followed, which are depicted in the figure below.

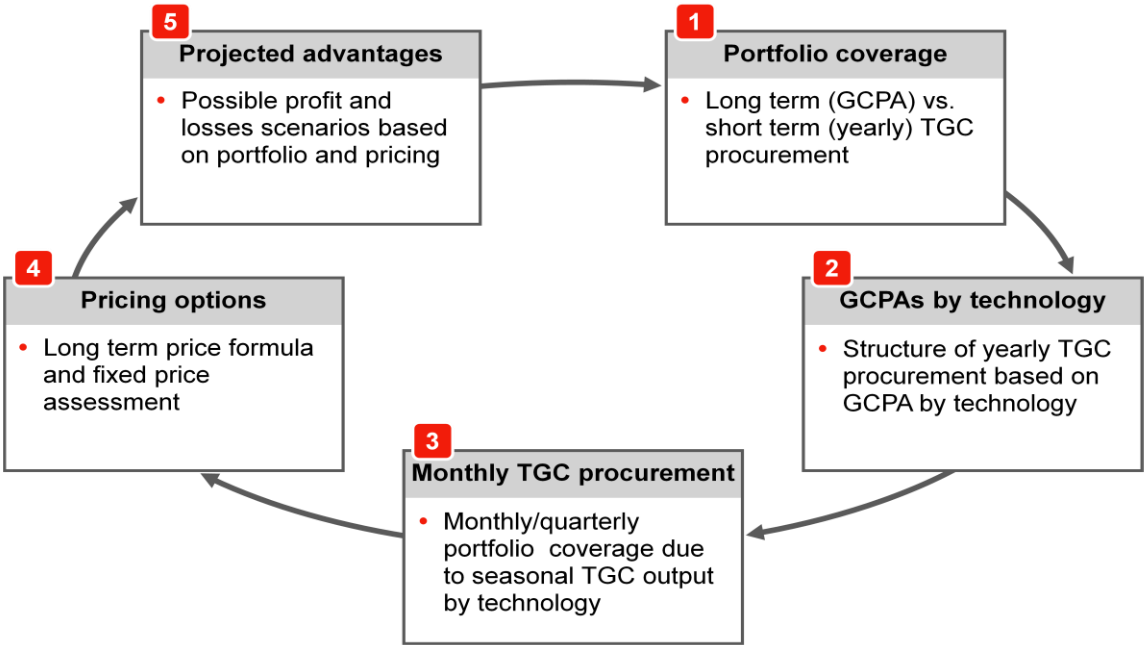

Fig. 29: *Process for the development of a long term TGC procurement strategy.*
Source: Own investigation and illustration.

For the proposed strategy we assume a power supplier with a current sales volume of 4 mio. MWh per year. The sold volumes will develop with the same rate as the gross internal consumption considered in the market based scenario in the previous chapter, i.e. an increase of sold volumes with yearly 2,5% is considered. The resulted TGC quota from the market scenario in the previous chapter is applied to the sold volumes of the considered power supplier in order to establish the projected necessary number of TGCs for the following 15 years. Based on these volumes the TGC procurement strategy is developed.

After having established the yearly necessary number of TGCs that the power supplier is obliged to purchase in order to comply with the mandatory TGC quota, the total coverage of the TGC portfolio is set. As the market development scenario is based on a series of variables that could change in time, a deviation of the calculated quota shall be considered for the setup of the strategy. We consider a deviation of +/- 25% from the calculated market scenario. This implies the fact that only maximum 75% of the necessary TGCs should be procured based on GCPAs and the remaining quantity either on the yearly spot market or through short term bilateral agreements. The coverage of 75% of the portfolio is presented in the chart below. Due to the fact that the RES-E market in Romania will be strongly influenced by the wind power plants, which receive 2 TGCs until 2017 and only 1 TGC afterwards, the TGC quota will increase until 2017 and afterwards decrease in line with the decrease of the available TGCs on the market.

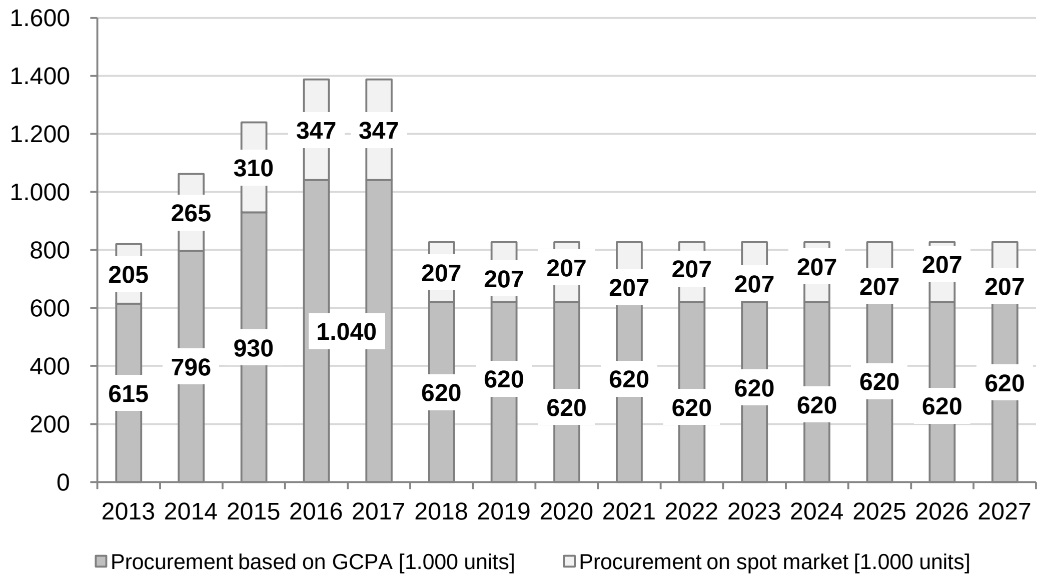

Fig. 30: *Proposal for 15 years TGC portfolio coverage.*
Source: Own investigation and illustration.

In order to cover the necessary TGC number by GCPAs a planning for the involved technologies is needed based on the current market evolution signs and investors interest in the RES-E market in Romania. Due to the very generous support scheme for solar power plants, the majority of potential investors wants to invest in solar power and is looking for opportunities to conclude GCPAs for 15 years in order to finance their projects. As the electricity price is only a very small part of the income for solar power, investors are willing to conclude long term agreements only for TGCs, not necessary needing a PPA for the produced electricity. Currently there are very few investors interested in biomass or biogas power plants, so that the possibilities to include TGCs from this source in the portfolio are restricted to the future installed capacity in this sector. Nevertheless, although the current market indications show that the investments in biomass will be modest, these power plants yield many TGCs due to their high capacity factor throughout the year.

Concerning the potential in the wind sector, an looking to the TGC quota shape during the next 15 years, it would be safe to include an important share of TGCs coming from wind power plants in the portfolio in order to reflect the ratio of the TGC quota development in the portfolio, especially regarding the years 2013-2017. Nevertheless, for investments in the wind sector, investors need a GCPA as well as a PPA to obtain favorable financing conditions, as the power price represents one third of the total income per MWh of produced electricity from wind power. This fact implies the necessity for a supplier to also deliver forecasting services and to assume the imbalances resulted from the wind power. This option is only possible either for power traders who have the possibility to offer forecasting services, or for other producers from wind power who have experience in this sector and could offer their services to new comers on the market. At this moment the majority of the foreign investors would like only to build up the RES-E power plant in Romania and outsource all the administrative burdens to the buyer. It is also preferred by the investors to have a contractual price for the energy that includes all supplementary costs, so that the credit institutions offer better conditions based on the fact that they can calculate a fixed income from the planned power plant. These aspects lead to the conclusion, that it is of high importance that the GCPAs for wind power are linked also to PPAs. Based on the assumptions that we consider in this analysis a power supplier, not a power trader, the possibilities to deliver forecasting services are very limited and this could lead to an impossibility to conclude enough GCPAs in order to cover a big part of the necessary portfolio. Taking into consideration these aspects following portfolio configuration is proposed: GCPAs with solar power producers up to an installed capacity of 40 MW, wind power GCPAs with a capacity of up to 50 MW and biomass GCPAs for power plants up to 20 MWp. The below chart shows the average TGC portfolio coverage for 15 years by technology based on the TGCs. Wind power hold only ca. 20% from the portfolio, whereby the rest is covered by TGCs from biomass and solar power plants.

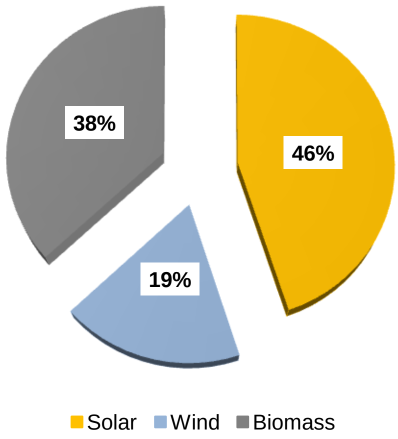

Fig. 31: *Planned average TGC portfolio configuration by technology, 2013-2027.*
Source: Own investigation and illustration.

The proposed coverage of the portfolio will result in a different TGC number per year, based on the allocated number of TGCs for the different technology. In the following graphic, the planned procurement of TGCs from the proposed projects is depicted compared to the necessary total number of TGCs to be procured through GCPAs. It can be noticed that during the years 2013-2017 the discussed strategy results in less TGCs as planned, but this is due to the fact that only a small part of the portfolio is covered by wind TGCs, whereby the market development will be defined by a majority of TGCs from wind power. The missing TGCs during this period will be procured yearly either on the centralized market or through short term bilateral contracts.

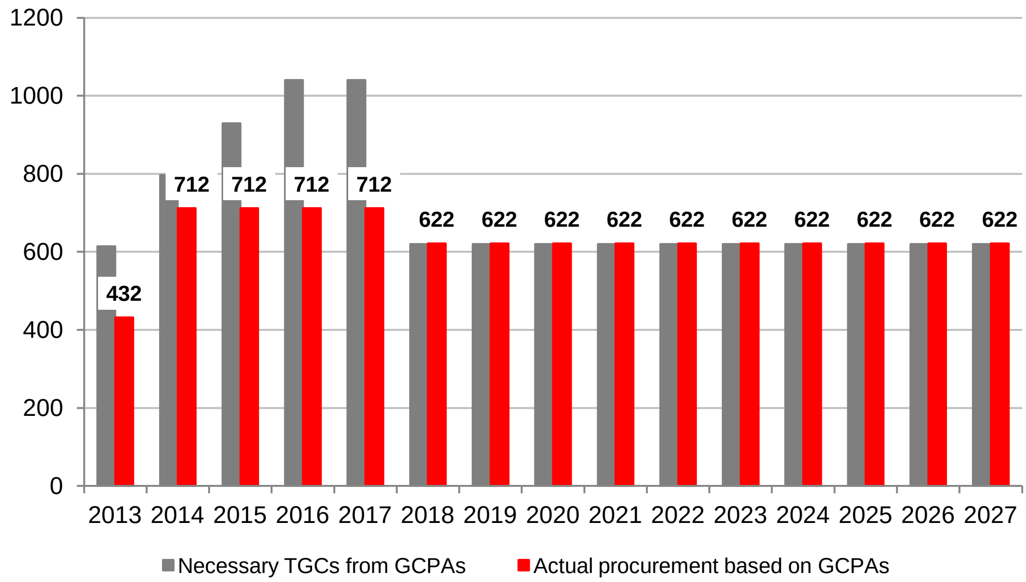

Fig. 32: *Planned yearly TGC procurement based on GCPAs*.
Source: Own investigation and illustration.

Another important topic to be analyzed in a further step is the monthly procurement of TGCs due the seasonality of the RES-E power plants. The latest amendments to the RES-E law in Romania (Law 134/2012) stipulate that the suppliers have to prove the yearly mandatory quota of TGCs on a quarterly basis. This provision is per se difficult to accomplish, as the yearly quota is calculated starting from the total RES-E production during one year. As during the year there will be new power plants commissioned until the end of the year and the majority of TGCs are issued from wind power that has production peaks mainly during autumn, the TGC procurement towards the end of the year will be higher than at the beginning of the year. This means, that in order avoid quarterly the payment of the maximum price in an Opcom managed Fund defined by the new law, it is important to accomplish quarterly the yearly TGC quota by planning a long position of TGCs in the portfolio for the first two quarters, as there will be not enough TGCs on the market that every supplier can accomplish the quota. In this respect an analysis of the monthly and quarterly number of TGCs from the proposed strategy should be conducted. Following two charts show the monthly and quarterly profiles for the planned TGCs starting from the above mentioned portfolio configuration, by technology.

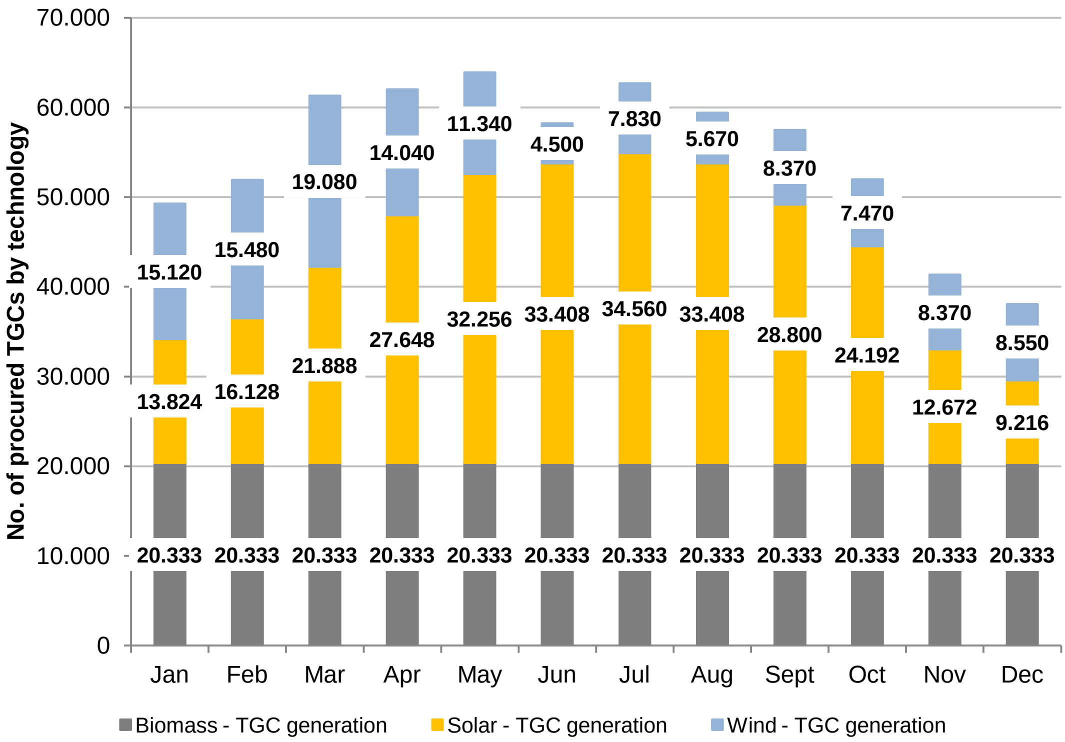

Fig. 33: *Planned monthly TGC portfolio coverage by technology*.
Source: Own investigation and illustration.

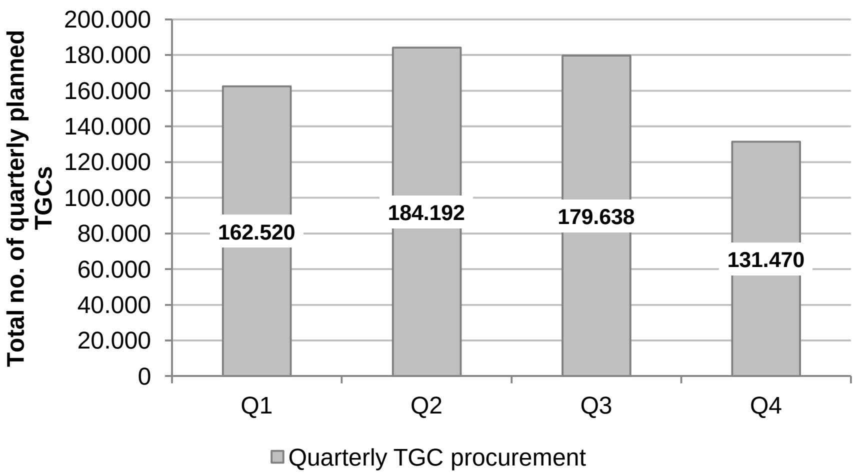

Fig. 34: *Planned quarterly TGC portfolio coverage*.
Source: Own investigation and illustration.

It can be noted that more TGCs will be procured in the first two quarters compared to the last two quarters, accounting this way for the risks describes above, of having to pay the maximum legal TGC price for the quarterly non-accomplishment of the forecasted yearly TGC quota.

After having defined the volume based strategy for the long term TGC procurement, the pricing options have to be assessed in order to choose the best pricing methodology for the long term TGC contracts. Two main pricing methods can be discussed regarding TGCs. The first option is a fixed price over the whole contractual period and the second one is a price formula based on market prices. The investors prefer the fixed price formula as it provides for more safety on the cash flow of the project.

As the Romanian TGC system established a minimum price, a maximum price and a penalty price for every TGC sold, there are several pricing indications for the future. Based on the quota calculation procedure established by ANRE and described in detail in Chapter 3.2 of this thesis, it can be assumed that, as long as the target RES-E quota established by the Law 220/2008 is not reached, the TGC quota will be set as high as to offer to all the producers the possibility to sell their TGCs. This means that, as long as the realized RES-E quota will not reach the RES-E quota, TGCs will be traded close to the maximum price, as the TGC market will be short. When the RES-E target quota will be reached and surpassed, then the TGCs will be traded at minimum price, because the TGC market will be long. Considering these assumptions and the two RES-E market developments in the previous part of this chapter, the TGC prices could develop like in the below chart.

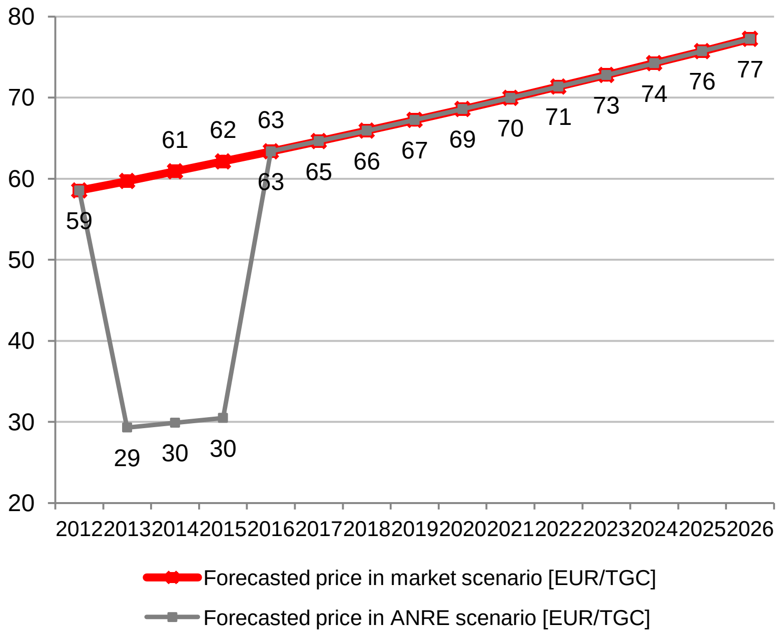

Fig. 35: *Price difference in ANRE scenario vs. supplier scenario*.
Source: Own investigation and illustration.

In the ANRE scenario the target RES-E quota will be reached only during the years 2014-2017. This means that during these years the TGC price will be at the minimum level. As during all other years and also in the market scenario of the supplier, the RES-E target quota will not be reached, the TGCs will be traded at the maximum legal price. The average TGC price for 15 years in the ANRE scenario is at 61 EUR/TGC and in the market scenario it lies at 67 EUR/TGC.

Starting from these prices and the two pricing methods discussed, the investors and suppliers on the Romanian market have developed two preferred options: either an average fixed price at about 42 EUR/TGC for 15 years or a price formula based on the weighted monthly average market price on PCCV/Opcom minus a discount of ca. 20%. Both options include certain opportunities and threats, as summarized in the below table.

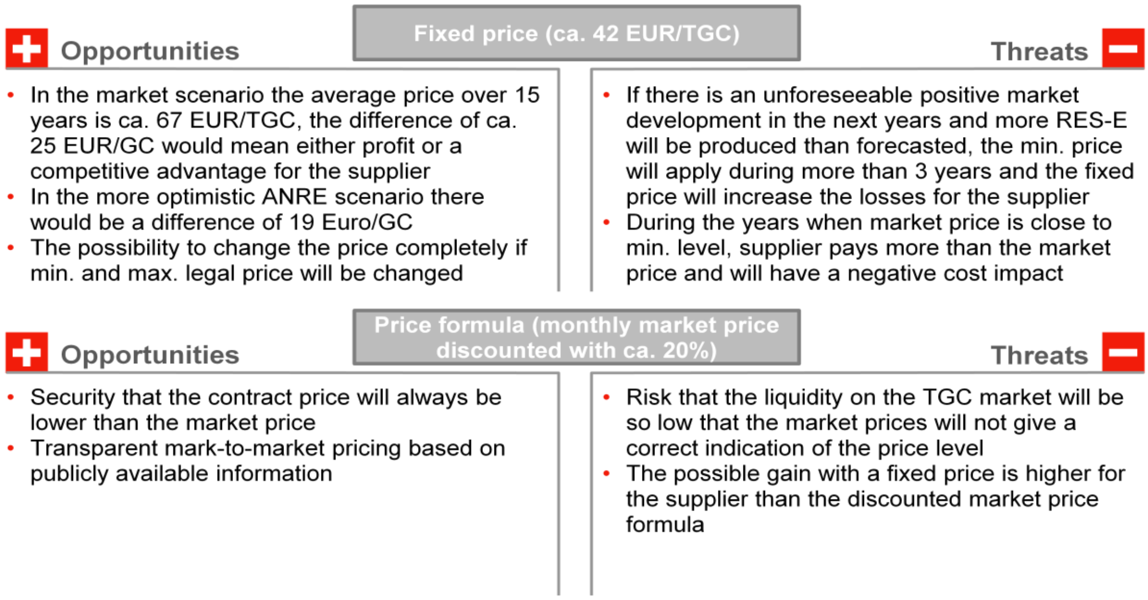

Fig. 36: *Opportunities and threats for the GCPA pricing options discussed*.
Source: Own investigation and illustration.

From a risk adverse supplier's perspective, the price formula will always be safer, as it is directly linked to a transparent market and all the modification of circumstances in future will be reflected in one way or the other in the market price. Of course, regarding the liquidity risk and the correct indication of the market price, there options to calculate a rolling weighted average price three months, as this is the timeframe when suppliers have to prove their TGC quota to the regulator and the market activity will be incentivized by these legal provisions.

A calculation of the possible advantages and disadvantages of the two pricing methods combined with the two market development scenarios show that if the ANRE scenario will be realized, then the fixed price formula shows a significant loss during the years 2014-2017. Although this loss will be recovered throughout the contract duration the supplier will have to prove its financial results on a yearly basis and will be judged on the market based on the yearly results. This means that the fixed price formula implies too much risk for a supplier for the timeframe when the market price will be at the minimum level. The following chart shows that the fixed price formula results in the highest advantage if the market scenario will prove correct. Nevertheless, there are too many uncertainties regarding the variables considered for the setup of the market scenario. The safer option for a supplier will be to go with the discounted market price and be on the safe side that during the years when the market price could go to the minimum level then the supplier is certain not to have any losses from the TGC procurement. No matter which of the two scenarios will apply in future, the supplier will always pay less or exactly the market price. The detailed figures for the price developments can be found in the Appendices 3 and 4.

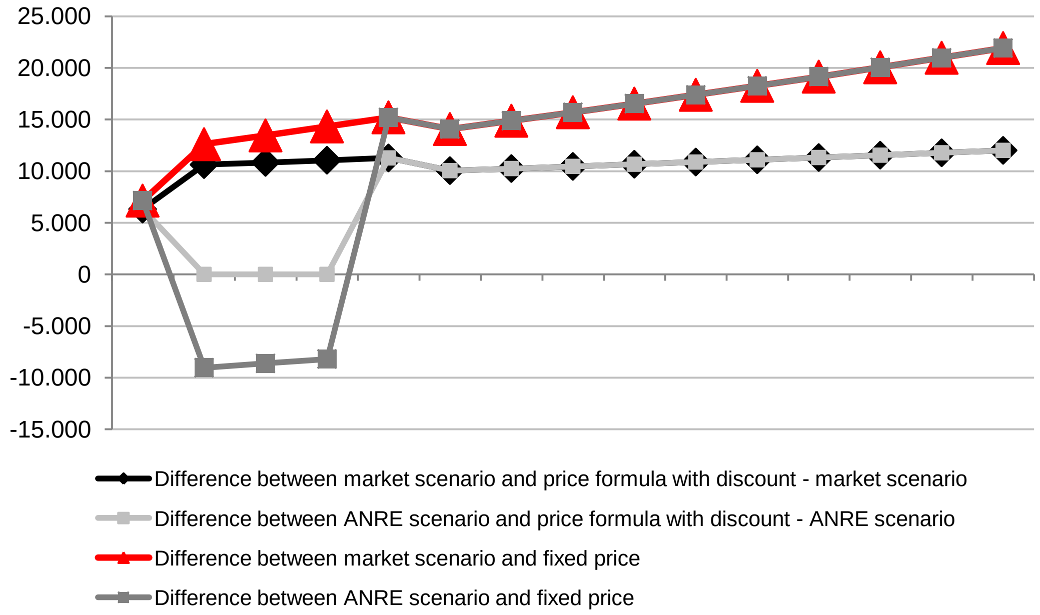

Fig. 37: *Projected yearly profit and losses with proposed pricing vs. baseline scenarios*.
Source: Own investigation and illustration.

Summing up the findings of the analysis, a long term TGC procurement strategy where the TGC portfolio can be covered at ca. 75% by GCPAs at lower than market prices and which includes TGCs from different technologies in order to minimize the risks arising from the seasonal production of RES-E will always result in an advantage for the power supplier. As the current regulatory provisions are still to be clarified, the calculated advantage can be used either as profit for the supplier, if the invoiced TGC value to the customers is based on the average market price, or as advantage to be passed on to eligible consumers and be used as competitive advantage for the supplier if the invoiced TGC value to the customers will be done at TGC procurement price.

5 Conclusion

The starting point of this master thesis was the awareness that in order to reach the EU targets of RES-E produced until 2020 and further, the countries need to implement efficient and effective support schemes to incentivize the RES-E production, especially the one from newer RES-E technologies, which still much higher investment costs than the classical fossil fuel energy sources.

Based on this idea, the emphasis of this thesis is the quota systems for the support of RES-E in Europe. An overview of the European current RES-E situation is given at the beginning and afterwards the focus shifts on the TGC systems in different European countries, like Sweden, Poland, Italy, Belgium and Romania. After a detailed description of the system functioning an assessment of the lessons learned from the countries that implemented these systems earlier in the years 2002-2003 is presented. The main concern of the assessment is whether TGC systems or price based support schemes are more efficient and effective and under the TGC systems, which performed better throughout the years, looking mainly at the yearly new installed capacity and at the costs incurred to the end customers.

In the last chapter a case study in Romania from a power supplier's perspective was presented. Different market evolution scenarios were developed and a TGC procurement strategy was discussed, that could profit from possible advantages and mitigate possible threats of the Romanian TGC system for a Romanian power supplier, as obliged party in the Romanian support scheme. The proposed long term procurement strategy depends and various variables that could have an influence its further applicability, as the RES-E market is only at the beginning in Romania and factors like legislative changes, investors behavior, customer's reaction on the ever rising electricity costs could have a major impact in this strategy. It is very important to shape the strategy in a dynamic way, so that it can be adapted ongoing based on the latest market information.

5.1 Opportunities of a long term procurement strategy of TGCs

The opportunities of the discussed long term procurement strategy can be regarded from different perspectives. First, the power supplier's willingness to base its TGC procurement strategy on long term contracts could have a major positive influence on the development of the RES-E market in Romania. As mentioned before, long term contracts could be a very important instrument on the way to incentivize smaller investors to develop RES-E projects in Romania, as these investors need financing for the projects and it becomes a vicious circle, if suppliers are not willing to conclude long term contracts because they estimate that the market price of TGCs will go down due to the increasing installed capacity, then smaller new projects are not bankable and the RES-E market cannot develop in a fast pace.

For the supplier the proposed strategy could either imply a competitive advantage on the retail market, as he can invoice lower prices to its customers if its own costs for the TGC procurement are constantly lower than the market price. On the other hand, as it is not clear how the handling of the invoice to end customers will be carried out in the end, if the TGCs will be invoiced at market price, based on the regulators legislation, then a lower TGC procurement price could mean profit to the supplier. Nevertheless, in order to make this system socially bearable for the customers, suppliers should do their best in order to procure TGCs at the lowest possible price and still encourage through their behavior the development of smaller projects. If the TGC market belongs to the big incumbent producers who have enough financial background as to finance very big projects, then the possibilities to influence the prices remain very improbable. The proposed strategy tried to account for both of these aspects because in the end effectiveness and efficiency are the most important criteria in the evolution of RES-E markets.

5.2 Challenges involved by the long term contracting of TGCs

Of course there are also challenges and threats involved by the discussed strategy, which can have an impact on the future development of the RES-E development. There are regulatory and legal risks that have to be borne in mind, both from the investors and from the suppliers. As could be noticed in the majority of TGC systems, there are several regulatory changes and adjustments throughout the years that can be of major importance for the profitability of the projects and the further development of the market.

There are also threats from the GCPAs concluded. Within the present thesis only the economical aspects of GCPAs were highlighted. It has to be mentioned that legal issues also play an important role, both for the bankability of the projects and for the flexibility of the suppliers to deal with these contracts on the long run. There is a difference of interest in this context, as investors need the security that GCPAs cannot be terminated during the contractual period and suppliers need the flexibility to terminate the contract if there is a significant change in the law.

Concluding, there are still several issues of the TGC system that need to be addressed in the next period in Romania and it has to be seen if the current forecasts and expectations will be met, based both on the reaction of potential investors and of the local market.

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Appendices

Appendix 1

FX exchange rate [EUR/ Local currency]	2003	2004	2005	2006	2007	2008	2009	2010	2011
Poland	-	-	-	4,20					
Romania	-	-	3,55	3,66	3,40	3,52	3,90	4,25	4,30
UK	0,80								

Fig. 38: *Exchange rates for local currencies.*
Source: Own illustration.

Appendix 2

MWp	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Wind	1500	2100	2800	3300	3700	3700	3700	3700	3700	3700	3700	3700	3700	3700	3700	3700
Hydro	400	430	450	470	500	500	500	500	500	500	500	500	500	500	500	500
Solar	30	70	100	120	130	130	130	130	130	130	130	130	130	130	130	130
Biogas	2	10	15	20	30	30	30	30	30	30	30	30	30	30	30	30
Biomass	30	40	50	60	70	70	70	70	70	70	70	70	70	70	70	70
Total	**1962**	**2650**	**3415**	**3970**	**4430**	**4430**	**4430**	**4430**	**4430**	**4430**	**4430**	**4430**	**4430**	**4430**	**4430**	**4430**

Fig. 39: *Market scenario - forecast of yearly RES-E installed capacity by technology*.
Source: Own investigations.

Year	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Gross internal consumption [TWh]	47,50	48,69	49,90	51,15	52,43	53,74	55,09	56,46	57,87	59,32	60,80	62,32	63,88	65,48	67,12	68,79
Production of ESRE [TWh]	3,93	5,24	6,68	7,74	8,66	8,66	8,66	8,66	8,66	8,66	8,66	8,66	8,66	8,66	8,66	8,66
RES-E production quota	**8,3%**	**10,8%**	**13,4%**	**15,1%**	**16,5%**	**16,1%**	**15,7%**	**15,3%**	**15,0%**	**14,6%**	**14,2%**	**13,9%**	**13,6%**	**13,2%**	**12,9%**	**12,6%**
Mandatory RES-E quota	**11,0%**	**14,0%**	**15,0%**	**16,0%**	**17,0%**	**18,0%**	**19,0%**	**19,5%**	**20,0%**	**20,5%**	**21,0%**	**21,5%**	**21,5%**	**21,5%**	**21,5%**	**21,5%**
Calculated TGC quota	**14,8%**	**20,0%**	**25,3%**	**28,8%**	**31,4%**	**30,7%**	**17,8%**	**17,4%**	**17,0%**	**16,5%**	**16,1%**	**15,7%**	**15,4%**	**15,0%**	**14,6%**	**14,3%**
Issued TGC [1 000 units]	7.032	9.733	12.610	14.718	16.472	16.472	9.812	9.812	9.812	9.812	9.812	9.812	9.812	9.812	9.812	9.812

Fig. 40: *Market scenario - RES-E and TGC quota development.*
Source: Own investigations.

Appendix 3

MWp	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Wind	1864	2466	2898	3220	3420	3420	3420	3420	3420	3420	3420	3420	3420	3420	3420	3420
Hydro	487	537	587	637	687	687	687	687	687	687	687	687	687	687	687	687
Solar	43	78	113	130	140	140	140	140	140	140	140	140	140	140	140	140
Biogas	8	11	14	17	20	20	20	20	20	20	20	20	20	20	20	20
Biomass	157	239	290	345	410	410	410	410	410	410	410	410	410	410	410	410
Total	**2559**	**3331**	**3902**	**4349**	**4677**	**4677**	**4677**	**4677**	**4677**	**4677**	**4677**	**4677**	**4677**	**4677**	**4677**	**4677**

Fig. 41: *ANRE scenario - forecast of yearly RES-E installed capacity by technology*.
Source: Based on ANRE (2012b).

Year	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Gross internal consumption [TWh]	58,36	59,45	60,56	61,70	63,52	65,41	67,34	69,34	71,39	73,50	75,68	77,92	80,23	82,61	85,05	87,57
Production of ESRE [TWh]	6,24	8,30	9,40	10,69	11,77	11,77	11,76	11,75	11,75	11,75	11,75	11,75	11,75	11,75	11,75	11,75
RES-E production quota	**10,7%**	**14,0%**	**15,5%**	**17,3%**	**18,5%**	**18,0%**	**17,5%**	**16,9%**	**16,5%**	**16,0%**	**15,5%**	**15,1%**	**14,6%**	**14,2%**	**13,8%**	**13,4%**
Mandatory RES-E quota	**11,0%**	**14,0%**	**15,0%**	**16,0%**	**17,0%**	**18,0%**	**19,0%**	**19,5%**	**20,0%**	**20,5%**	**21,0%**	**21,5%**	**21,5%**	**21,5%**	**21,5%**	**21,5%**
Calculated TGC quota	**14,1%**	**21,6%**	**28,3%**	**32,6%**	**35,8%**	**38,3%**	**37,2%**	**25,9%**	**25,1%**	**24,4%**	**23,5%**	**22,7%**	**21,9%**	**21,2%**	**20,5%**	**14,0%**
Issued TGC [1 000 units]	8.257	12.830	17.124	20.090	22.750	25.040	25.040	17.936	17.933	17.930	17.784	17.676	17.586	17.496	17.405	12.229

Fig. 42: *ANRE scenario - RES-E and TGC quota development.*
Source: Based on ANRE (2012b).

Appendix 4

Year	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	**Avrg.**
Forecasted price in market scenario [EUR/TGC]	57,39	58,54	59,71	60,90	62,12	63,36	64,63	65,92	67,24	68,59	69,96	71,36	72,78	74,24	75,72	77,24	**66,86**
Forecasted price in ANRE scenario [EUR/TGC]	57,39	58,54	29,31	29,90	30,49	63,36	64,63	65,92	67,24	68,59	69,96	71,36	72,78	74,24	75,72	77,24	**61,04**
Price formula discount 20% - market scenario [EUR/TGC]	43,04	43,90	44,78	45,68	46,59	47,52	48,47	49,44	50,43	51,44	52,47	53,52	54,59	55,68	56,79	57,93	**50,14**
Price formula discount 20% - ANRE scenario [EUR/TGC]	43,04	43,90	29,31	29,90	30,49	47,52	48,47	49,44	50,43	51,44	52,47	53,52	54,59	55,68	56,79	57,93	**47,18**
Fixed price [EUR/TGC]	42,00	42,00	42,00	42,00	42,00	42,00	42,00	42,00	42,00	42,00	42,00	42,00	42,00	42,00	42,00	42,00	**42,00**

Fig. 43: *Yearly average prices in the different forecast and pricing scenarios*.
Source: Own investigation.

Appendix 5

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	**Total**
Value market scenario	25.288	42.512	43.362	44.229	45.114	40.199	41.003	41.824	42.660	43.513	44.383	45.271	46.177	47.100	48.042	**640.677**
Value ANRE scenario	25.288	20.869	21.286	21.712	45.114	40.199	41.003	41.824	42.660	43.513	44.383	45.271	46.177	47.100	48.042	**574.441**
Price formula 20% discount - market scenario	18.966	31.884	32.521	33.172	33.835	30.150	30.753	31.368	31.995	32.635	33.288	33.953	34.632	35.325	36.032	**480.508**
Price formula 20% discount - ANRE scenario	18.966	20.869	21.286	21.712	33.835	30.150	30.753	31.368	31.995	32.635	33.288	33.953	34.632	35.325	36.032	**446.798**
Fixed price	18.144	29.904	29.904	29.904	29.904	26.124	26.124	26.124	26.124	26.124	26.124	26.124	26.124	26.124	26.124	**399.000**
Difference between market scenario and price formula with discount - market scenario	6.322	10.628	10.840	11.057	11.278	10.050	10.251	10.456	10.665	10.878	11.096	11.318	11.544	11.775	12.011	**160.169**
Difference between ANRE scenario and price formula with discount - ANRE scenario	6.322	0	0	0	11.278	10.050	10.251	10.456	10.665	10.878	11.096	11.318	11.544	11.775	12.011	**127.644**
Difference between market scenario and fixed price	7.144	12.608	13.458	14.325	15.210	14.075	14.879	15.700	16.536	17.389	18.259	19.147	20.053	20.976	21.918	**241.677**
Difference between ANRE scenario and fixed price	7.144	-9.035	-8.618	-8.192	15.210	14.075	14.879	15.700	16.536	17.389	18.259	19.147	20.053	20.976	21.918	**175.441**

Fig. 44: *Calculated advantages for different pricing scenarios.*
Source: Own investigations.