Role of National Support Policy in the large-scale integration of DER into the European electricity market

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SUMMARY

This report concerns a study of the DER support schemes in the different EU Member States, their effectiveness and if necessary how these might be moulded to become more cost-effective in the future to integrate much larger shares of DER in the European electricity supply system.
The report is part of a set of reports on DER integration issues and together they present a full and complete report on key issues of policy support, required changes in regulation and other issues that hamper more DER integration in supply.

This report topic, different policy support instruments for promoting DER (renewable energy and combined heat and power), must be seen in relation to other conditions relevant (or as instruments) like network and market regulation. We identify three different stakeholders' points of view that are important when analysing support mechanisms, i.e.:

- The point of view of the DER investor – is there a stable support scheme available?
- The point of view of the network operator – does the support scheme take into account the possible negative impacts of increasing (intermittent) power production?
- The point of view of society – the aim of society should be to reach a sustainable energy system at as lowest costs as possible.

It is generally accepted that increase of DER shares is one of the most important steps towards reaching a sustainable energy system. However to increase DER shares in supply the following basic conditions should be met also:

1. A stable support scheme should be available
2. the access of the electricity produced to the commodity market and balancing market should be ensured
3. Access to networks must be based on clear and transparent regulations.

DER increase should be in line, however, with efficient power system design. With increasing DER shares a number of member states have already started to integrate signals for DER operators in support schemes. Examples are:

- Differentiated time-of-day tariffs. Tariffs are higher in peak periods so that DER operators tend to produce in times that demand for electricity is higher.
- Providing feed-in premiums instead of fixed-feed-in tariffs gives also a market signal (when power is demanded and when not).
- Granting of support is combined with mandatory reporting of expected production. Not meeting this production can lead to reduction of tariffs for a limited period of time.

Based on these examples, this report aimed to answer the following questions:

1. What is a cost-effective FIT?
2. What is a cost effective Quota obligation system?

Feed-in tariffs
Feed-in tariffs provide support to renewable electricity generation or CHP production in the form of a fixed price per kWh produced. This price is significantly higher than the market price for electricity, paid for most traditional forms of power generation based on fossil fuels and nuclear energy. Power from these sources comes with significant external (environmental) costs that are not integrated in the power price.

Many European countries have chosen to create an externality corrective distortion of the conventional power market by supporting DER through feed-in tariffs, having no CO2 emissions per kWh produced (RES) or provide a reduction through better conversion efficiency (CHP). This feed-in tariff can be a fixed price per kWh produced or a premium provided on top of the market price (feed-in premium).

When the share of renewable energy and CHP is increasing, however, the traditional form of fixed feed-in tariffs (setting a price for each RES kWh produced) might not be efficient form the point of view of the market, network management and in the end also not from the point of view of society.

Therefore the following elements of an optimal feed-in tariff scheme are proposed:

- Limit the distortion from the point of the market by providing incentives to DER production mainly at peak hours. This can be done through:
    - Introduce feed-in premiums instead of fixed tariffs as the better match between supply and demand in the market, or
    - Introduce tariffs that differ per time of day (peak or off-peak hours)
- Support is a costly option, so *overcompensation* should be avoided, so the following has to be kept in mind:
    - Due to learning process with different technologies (wind turbines, PV panels), production costs are decreasing, which means that in some cases tariffs can slowly be reduced
    - Consider the introduction of stepped tariffs. For instance, for wind power– lower tariffs after a certain number of hours (e.g. 2000 full load hours per year) or
    - Lower tariffs after 5/10 years of production for all DER categories.
- From the point of view of the network – as little interference as possible or support to network management is needed. This can be done through:
    - Differentiate feed-in tariffs by time of use, avoiding production at times that power is not needed and has to be transmit over large distances.
    - Gaining support combined with mandatory reporting of expected power.
- Last but not least, one still has to keep the interest of the DER operator in mind, creating stable investment environment with :
    - Support being stable for a number of years or having a fixed regression rate.
    - Making investments attractive (e.g. return period 10-15 years) to start investments.

Quota System & TGC

An alternative form of support is provided in the form of quota systems. A major actor in the power supply system (usually the power supplier) has an obligation to reach a certain percentage of RES and/or CHP production per year. For this amount of production the supplier receives green certificates (e.g. per MWh of RES produced). These green certificates can be traded between different suppliers (i.e. sold by a supplier having a surplus of certificates to one being short in certificates). This system is usually referred to as Quota system, tradable green certificate (TGC) system or renewable portfolio standard.

Quota systems are often viewed as being unreliable due to the large variability in the green certificate price experienced. Cost effective quota systems should include some element of banking and other restrictions that limit the variations in certificate prices. However these limitations must allow the certificate price to increase in order to give the necessary investment incentive to produce enough certificates to fulfil the quota obligations over the long term.

Then a significant penalty for not meeting the renewable energy quota has to be introduced. A too low penalty for not acquiring enough certificates will undermine the certificate market, both by removing liquidity and by excluding the financial transfers to renewable producers and thereby the main idea of the scheme.

An efficient quota obligation system would induce competition among certificate producing technologies. The result is that some technologies will dominate others in the supply of certificates. In some cases the experience of having biomass related technologies especially co-firing contribute a major part to the certificate market has been seen as problematic. Technologies that require investments will not be supported as long as there are low cost fuel-switch options. First, as the low cost options are fully exploited the investment and capital intensive technologies as wind and later PV will be supported.

Recommendations
As both feed-in tariff schemes as well as tradable green certificates schemes are established in a number of European countries, no specific choice has been made for one of the schemes. Therefore, policy recommendations are split into specific recommendations for feed-in tariff schemes and tradable green certificates schemes.

The following policy recommendations are proposed:

- Countries with fixed feed-in tariff schemes should gradually move towards more market oriented systems such as feed-in premiums, providing a bonus for DER operators on top of the market price
- To ensure network integration, supported DER generation should meet other obligations of power system. This is mainly mandatory reporting of expected production.
- In countries having green certificate systems in place it is important to create a liquid market where not only low-cost options are realised → gradually increasing targets should lead to shift to other DER options
- DER should gradually be exposed to market risk like every generator (but keep subsidies in form of feed-in market premium or green certificates). Exposing DER to market risks is better for the electricity system than exposing DER to an artificial feed-in tariff system that does not have any relation with the system needs. Both feed-in premiums as quota obligation systems can provide this.

Finally, there will be a need for certain support scheme harmonisation within the EU, to reach more efficient exploitation of DER potentials EU wide. Due to the different history of support schemes in the EU Member States, harmonisation is something that should be carefully planned, trying to achieve a certain streamlining of basic conditions of support but not endangering strong points of the single support schemes of Member States.

1. COSTS AND BENEFITS OF DER INTEGRATION IN THE POWER SYSTEM

In European member states, the public goal of a sustainable electricity system is implemented through a number of technology-specific support schemes for renewable-based electricity generation (RES-E) and co-generation of electricity and heat (CHP). This drives the growth of distributed energy resources (DER) – largely connected to the distribution networks and increasingly to the transmission network (mostly larger scale RES-E) - to significant levels.

1.1 Current contribution of DER and outlook

The DER penetration in power systems of 25 European member states in 2005/2006 is shown in Figure 1.1. For calculating these DER penetration levels only sources which are connected to the distribution network are taken into account (this definition has also been followed in phase 1 of the project and is repeated in Annex A below). Therefore large-scale sustainable generation, i.e. offshore wind, co-firing biomass in coal power plants, large hydro (> 10 MW_e) and large CHP (> 50 MW_e) are excluded in Figure 1.1. The figure shows that eight countries have a DER share in total electricity production above 10%, and five of them above 15%. Differences between member states can be explained by different potentials for RES and CHP and by different energy policies in the past. The DER share in electricity supply has increased rapidly in a few MS but in others not yet. However, the recent agreement in EU on policy targets for renewable energy (20% in 2020), energy efficiency and climate change have enhanced the importance of policy support mechanisms in MS for meeting these targets that EU member states have to implement.

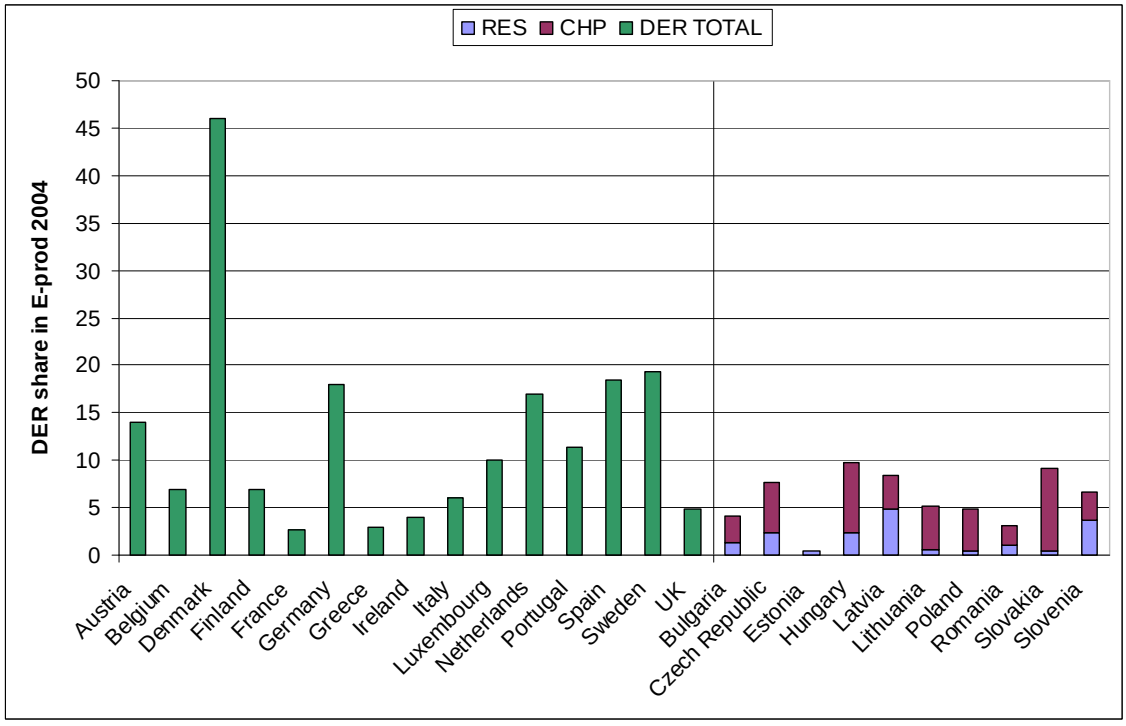


Figure 1.1 *DER share in total electricity production in 2004*

It should be noticed that within a country the DER share in supply varies strongly, because of different policies, and potentials of different renewable energy sources (e.g. wind, hydro) and

because of differences in sector (heat & electricity) demand (e.g. by industry, horticulture greenhouses, consumers).

1.2 The European Policy Background

The European Commission has put much attention on the promotion of renewable energy sources since the adoption of the renewable electricity directive (2001/77/EC) stating a target of renewable electricity consumption of 21% in 2010. Significantly higher targets have been announced in the 2008 Climate Action and Renewable Energy Package. Here the European Commission has proposed the revision of this directive, including targets for the year 2020. In its Renewable Energy Roadmap (2006) the EC demonstrated that a 20 percent target for the overall share of energy from renewable sources and a 10 percent target of renewable energy (RE) in transport are appropriate and achievable objectives, and that a framework that includes mandatory targets would be desirable.
The Brussels European Council of March 2007 reaffirmed the Community's commitment to the EU-wide development of renewable energies beyond 2010 and endorsed the targets. The Commission proposal of January 2008 builds upon the existing legislation in the field of RE, namely Directive 2001/77/EC (on the promotion of renewable electricity) and Directive 2003/30/EC (on the promotion of biofuels) an seeks to establish a common framework for the promotion of energy from renewable sources beyond 2010.

1.2.1 The new renewable energy directive

According to the Proposal for a new Directive on the promotion of the use of energy from renewable energy sources (COM (2008) 19 final – 23.1.2008), the new renewable energy directive will include the following new elements:

- The setting of **mandatory national targets** for the overall share of energy from renewable sources in energy consumption and in transport in 2020. The proposed directive sets a binding EU-wide target of producing 20% energy from renewable sources by 2020. The overall targets for each member state for 2020 are stated in the proposed directive and are set according to a complex formula aiming at distributing efforts as fairly as possible across the member states, taking into account economic growth projections and GDP per capita levels. 2005, the latest year for which reliable data on national RE shares is available, is taken as the base year.
- The requirement of **national action plans**. To ensure the overall targets are achieved, it is proposed that member states work toward a series of interim targets and establish national action plans outlining their strategies
- The standardisation of "**Guarantees of Origin**". Member states will be responsible for issuing guarantees of origin (GO) to producers of heat and electricity originating from RE sources. A voluntary GO regime was already included in Directive 2001/77/EC, the current proposal allows for the standardisation of information requirements, issuing, transfer and cancellation procedures. The current proposal also makes the GO regime applicable to more sectors, including the large scale heating sector.
- The possibility of **Intra-EU Trading of Guarantees of Origin**. Member States must recognise GOs issued by other member states and GOs may be transferred between persons (companies) in the Community.
- Possibility for exclusion of already subsidised renewable energy. Green power certificates can be cancelled, and hence made unfit for trading, in cases where the energy concerned already receives/received a form of government support.
- Establishment of environmental sustainability criteria for biofuels
- The harmonisation of hydropower accounting.

Flexibility of member states in achieving their target is ensured through:

- A renewable energy trading regime through the transfer of GOs that gives member states the flexibility in meeting their targets.
- Safeguarding of national support schemes already in place. The proposed directive stipulates that member states may, in order to safeguard the viability of national support schemes, impose objective, transparent and non-discriminatory limits on the transfer of schemes granted to existing installations and prevents overcompensation of RE producers. The proposed directive contains flexibility in that the choice of whether to have a national-based support scheme, or to trade on the basis of "virtual" GO's is left entirely up to each member state.

The main differences between the old and new directive:

- targets for renewable energy include energy as a whole, not only electricity. The EC recognised that the development of renewable heating and cooling has been stagnating.
- standardisation of GOs and possibility for a member state to meet his targets through purchase of GOs

Main policy implications:

- member states may chose to support renewable heat production instead or next to renewable electricity production
- The new directive may be a new incentive for RES-CHP, searching for an optimal balance between heat and electricity production, as production of renewable heat may be included in the national target
- possibility to buy RES produced abroad, where there may be higher potential for RES as well as lower costs of production.
- No single type of renewable energy support scheme is recommended. It remains solely up to the member states to choose how to support renewable energy.

In the currently valid EU RES-E directive (2001/77/EC), the Commission envisaged the promotion of one single type of support scheme, but this is not mentioned in the new Directive anymore. In the new directive finding the right form of support schedules is up to the individual MS. The new directive gives the possibility, however, to meet national targets through other instruments such as the purchase of GOs.
However, from and overall economic efficiency point of view for meeting the very ambitious RES targets, many experts and particularly companies that operate on different EU electricity markets strongly advocate to harmonise the sometimes very different support schemes across Europe in the next years.

1.2.2 Renewable energy targets

As the EU policy goals are defined in a share of renewables connected to both distribution and transmission networks (RES), it is also important to take into account large scale distributed energy sources directly connected to higher voltage networks. More importantly, the large increase of renewables does have increasing implications for the transmission networks since reverse load flows from distribution to transmission networks may occur. Figure 1.2 shows the part of final energy consumption that is met by energy production[2] from renewable sources in three sectors: electricity generation, heating and cooling, and transport for EU-27 countries. In this case renewable electricity generation includes hydro, wind and biomass-waste fired generation connected to all network voltage levels.

[2] By definition, energy consumption has to be equal to the sum of energy production plus energy imports minus energy exports. We suppose that trading of renewable energy remains limited as trading of guarantee of origins is opposed by some EU member states with a large part of green electricity.

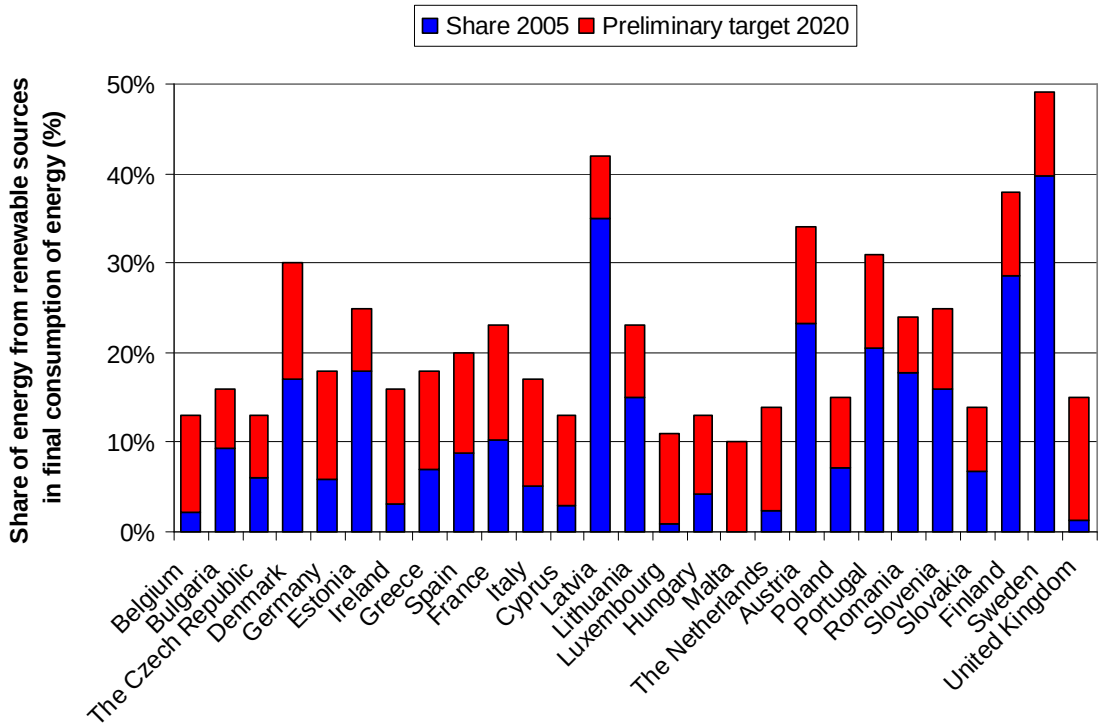


Figure 1.2 *Share of energy from renewable sources in final consumption of energy in 2005 and preliminary EC target for 2020 (source EC, COM 2008 (19) final)*

The figure clearly shows the large gap between the current and EC proposed energy share from renewable sources for most countries. The majority of EU countries, 16 of 27 countries, have to double their renewable energy share in final energy consumption. A large part of this new renewable energy is assumed to stem from new renewable electricity production. Since intermittent RES is increasingly adding more capacity than energy production to the system, the capacity credit decreases and renewable electricity production needs to increase even more in capacity terms.

1.2.3 Relevant other policy documents and EU directives

Other policy documents and directives of major importance for DER integration in Europe include the following:

- The Directive on the promotion of combined heat and power (CHP directive - 2004/8/EC), that defines high-efficiency CHP, demands from member states to draft CHP potential studies and gives MS the possibility to support high-efficiency CHP.
- Green Paper on a European Strategy for Sustainable, Competitive and Secure Energy (March 2006) – providing guidelines for a secure energy supply in Europe.
- Priority Interconnection Plan (January 2007) – this plan recognises the need to strengthen (cross-border) transmission lines to integrate larger amounts of RES electricity. This plan recognises the important role of transmission networks in further integration of RES-E in Europe.
- EU-Emission trading scheme, calculates externalities into the power price. The system will continue with a third trading period from 2013-2020.

1.3 Support policies for increasing shares of RES and CHP

The 2008 Climate Action and Renewable Energy Package as well as policy documents worked out in an earlier stage, aim at an increase of renewable energy supply (RES) and combined heat and power (CHP) in electricity production. Apart from these objectives, the EU aims at a greenhouse gas emission reduction of 20% in 2020 or even 30% pending post-Kyoto negotiations outcome. For energy efficiency EU has set a target of 20% in 2020. Part of this target may be achieved by deploying more CHP. Finally, security of supply may give rise to look for less fuel dependent sources for electricity production.

These three public objectives in EU MS can be achieved by deploying slightly more expensive technologies such as renewables in electricity production. More renewables can be induced by several types of policy measures (European directives, national legislation) like investment or production subsidies, soft loans, tax exemptions and other support schemes. Subsidies can take different forms like feed-in tariffs (FIT), feed-in premiums (FIP) or renewable portfolio standards (RPS) in combination with tradable green certificates (TGC).[3] Besides, network regulation influences the deployment of renewables in the power system through requirements to generators for connection and system use.[4] In order to meet the increasing EU goals, support policies are a key instrument.
Given the fact that the potentials and production cost per technology can differ enormously per region within and between the different EU countries and for exploiting these most efficiently a need for trade in RES-E is useful. At the same time a more harmonised and thus effective support seems beneficial and required for the future.

1.4 Structure of this report

This report (deliverable 1.2b) will analyse the renewable energy support schemes in 15 of the 27 Member States as regards their scope and level of support as well as their interaction with network regulatory issues. Chapter 2 will address the methodology of the study. Chapters 3 and 4 will address the results of the survey in the new and old Member States respectively. Chapter 5 provides a systematic overview of support schemes in the 15 countries analysed.
In chapter 6 (the final chapter), recommendations for an optimal support scheme are made. As this report does not aim at choosing between a feed-in tariff scheme or green certificates (linked to quota obligations), elements of an optimal support scheme for both systems are presented.

More detailed information about network regulatory issues are analysed in deliverable 1.2a- "Current state of and recommendations for improvement of the network regulations for large-scale integration of DER into the European electricity market" (Cossent, Gomez and Frias, 2008).
Deliverable 1.2c "Overview of progress, barriers and options for more DER integration into electricity supply systems" (Van der Welle, 2008) will mainly look at the cost-benefit issues of DER integration and will also propose some alternative policy measures.

[3] In task 1.2 of SOLID-DER the different production subsidy schemes are described.
[4] In task 1.1 of SOLID-DER attention is given to network regulation.

2. APPROACH, METHODOLOGY

2.1 Importance of support schemes

In order to meet the increasing EU renewable energy goals, support policies are an important instrument, introduced by all EU Member States. Two main support mechanisms can be distinguished, feed-in tariffs and quota systems.

2.1.1 Types of support schemes

Feed-in tariffs

Feed-in tariffs provide support to renewable electricity generation or CHP production in the form of a fixed price per kWh produced. This price is significantly higher than the market price for electricity, paid for most traditional forms of power generation based on fossil fuels and nuclear energy. Power from these sources comes with significant external (environmental) costs that are not integrated in the power price.

Many European countries have chosen to create an externality corrective distortion of the conventional power market by supporting DER through feed-in tariffs, having no CO2 emissions per kWh produced (RES) or provide a reduction through better conversion efficiency (CHP). This feed-in tariff can be a fixed price per kWh produced or a premium provided on top of the market price (feed-in premium).

Quota System & GCT

An alternative form of support is provided in the form of quota systems. A major actor in the power supply system (usually the power supplier) has an obligation to reach a certain percentage of RES and/or CHP production per year. For this amount of production the supplier receives green certificates (e.g. per MWh of RES produced). These green certificates can be traded between different suppliers (i.e. sold by a supplier having a surplus of certificates to one being short in certificates). This system is usually referred to as Quota system, green certificate system or renewable portfolio standard.

Alternative forms of support can be provided in the form of investment support (i.e. support for renewable energy technology) or tax exemptions for renewable energy technologies of RES power produced. However, the predominant types of support in EU countries are the feed-in tariffs and quota systems.

2.1.2 Support schemes and the power system

Successful support schemes lead to an increase of DER based electricity and this gives rise to two kinds of economic system inefficiencies:

- DER or RES production support schemes are often not in line with market based efficient system design, e.g. as in the design of these schemes no attention is devoted to the network and system integration costs due to a higher penetration of DER in the system. The support schemes are optimised on their RES-production impact as such instead of on their impact on the system as a whole. The consequences are increasing market distortions, prices and revenues and an overall much higher system costs.
- In systems with a relatively large penetration of DER in the system (say more than 10 %) a feed-in tariff system is becoming economically less efficient than at the take-off of RES-E. During the latest decade, this policy was a success and resulted in fast growing shares of RES in Germany, Denmark and Spain. At the same time its overall efficiency has declined substantially in the last years. More deployment of DER coupled with high fixed feed-in tar-

iffs not differentiated per technology, potentials and electricity (energy) market prices increases the cost-burden for end consumers, since efficiency gains of scale of production are not passed on to consumers in the form of lower tariffs. Therefore, a call for more efficiency is heard from many experts (see for instance IEA, 2007).[5] On the other hand, several countries with alternative fully market-based support schemes like RPS with TGC might not be able to meet their national RES targets for 2010 and need also amendments of their support instruments.

But before we answer the question whether a support scheme is successful, we have to analyse the impacts for the system by the three key players involved, namely the investors (DER operators), network operators and market or power system as such (often called the social or consumers point of view). Subsequently we can ask ourselves:

1. Do the support schemes lead to transparency, predictability conditions for the DER investors, meaning that these support schemes lead to a stable investment climate?
2. Is the support also "economically & technically efficiently manageable" from the point of view of network operator in the electricity supply system? Does the support take into account an efficient operation and planning of the network or does it lead to highly risky, inefficient operation of the network by DSOs due to increasing DER connections?
3. Is the support efficient from the point of society (e.g. system cost and prices for consumers)? The main objective of society is to reach a sustainable energy system at as low as possible overall system costs. Therefore, from the point of overall system costs both costs for DER production (and its support) also extra costs for the networks and of the market distortions are important. Depending on the specific situation in a country and the policy targets one has to strike a balancing solution on how to design the support schemes most effectively.

For answering question 1 the following issues are important:

- What is the level of support, its duration and possible rate of regression
- What additional forms of support is given, state guarantees, investment subsidies
- What non-technical barriers are there in the development of DER support

For question 2 the following is important:

- Does the support scheme take into account the operation of the market. E.g. is support differentiated per time of day, does electricity produced in peak receives more funding than electricity produced in off-peak?
- Are there any other price mechanisms that would improve the operation of DER in the networks?

For question 3 the following is important:

- RES and CHP should be supported at as low as possible costs from the point of view of society. Important indicators here are costs per kWh RES produced or tonne CO2 avoided.
- In some countries, production of RES technology forms an important industrial branch. Supporting RES electricity production from this particular technology may therefore be another additional objective. This will (indirectly) support employment in this field.

2.2 Stability of investment climate for DER operator

From the point of view of DER investors, there are three important issues (see Figure 2.1):

1. A stable support scheme should be available

[5] IEA (2007), 'Energy policies of IEA countries – Germany 2007 review'.

2. The access of the electricity produced to the commodity market and balancing market should be ensured
3. Access to networks must be based on transparent regulations.

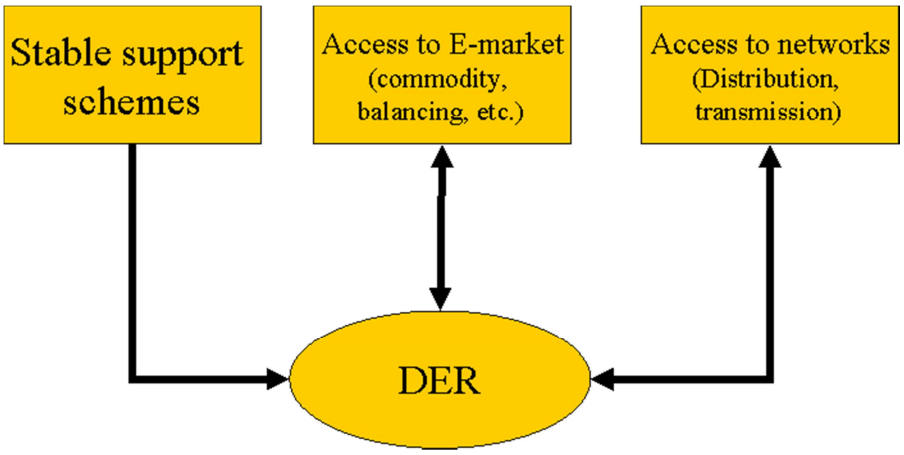


Figure 2.1 – Interrelationships with RES/DER support

It is important that the support for RES or CHP is stable in such a way that their investment is paid back in a number of years. The major requirements from an investor are:

- Duration of support should be given as long as a reasonable rate of return is yielded. Or in case stepped tariffs exist, this has to be known beforehand.
- The duration of the support, needed for a reasonable return on investments needs to be guaranteed by law or some kind of other regulation.
- Existence of other forms of support, investment subsidies etc. may support specific technologies.
- Overcoming non-technical, mainly administrative, barriers. With regards to network regulation, the most important is that this regulation is transparent and the investor knows what to expect.
- Access to the market must be ensured.

2.3 Support and network integration

An often heard complaint of network operators is that DER, and in most cases, this is related to wind energy, does not contribute to the safe and cost-effective operation of the power system. This is a complaint especially heard in the new member states, that more DER will increase their (capital & operational) costs.

So far support schemes for DER and network regulation have been treated in most countries as separate items. They both influence efficiency of the DER operators (see Figure 2.2) and (indirectly) also network operators in the system.

As mentioned before, DER operators are influenced by both network operation as well as support schemes. While support schemes are specifically introduced for the purpose of supporting DER operators, network regulation has as primary goal to streamline technical as well as economic transactions / processes in the electricity network. The objective of both instruments is therefore different. Both instruments can strengthen each other in its support for DER , but when not coordinated well, also weaken the effect of each instrument separately.

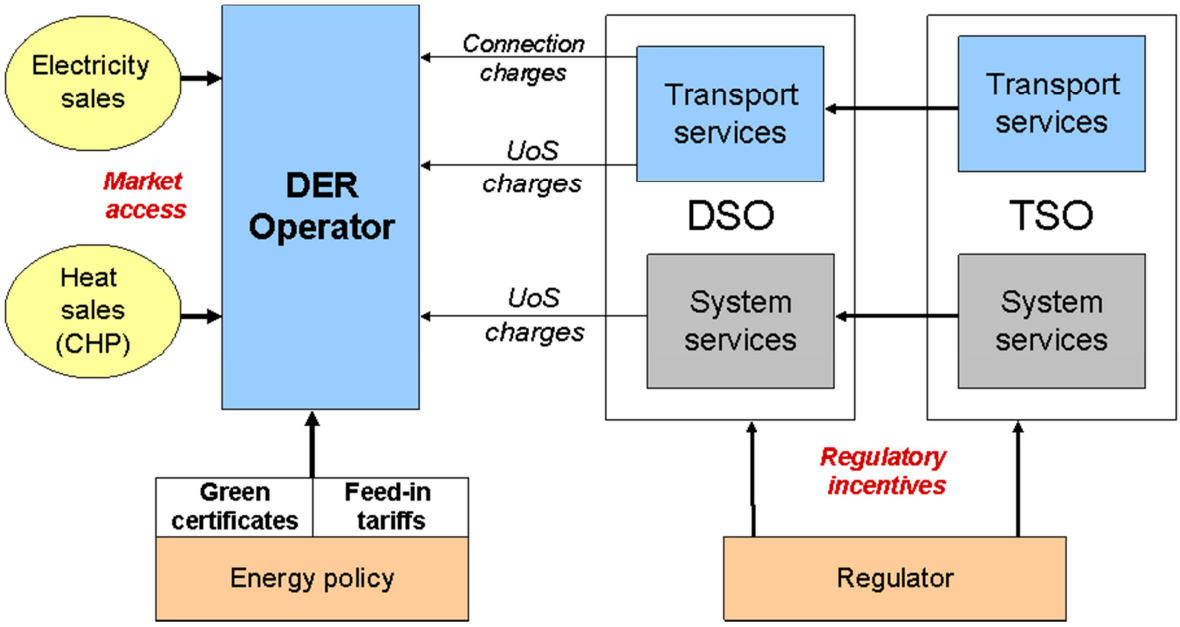


Figure 2.2 – Impact of support and regulation on DER operators

2.4 Methodology of the study

This study has been based on a standardised review undertaken in 14 countries, all SOLID-DER countries including Sweden and the UK.

Support for renewable energy sources (in some countries also for combined heat and power) has been introduced in all EU27 Member States in recent years. Some of these support schemes have been effective in reaching higher shares of DER, others have been less effective. Some support schemes are not well harmonized with other regulation regarding access and connection of DER to the networks and all very different in each country[6]. To know more about the current support schemes in place and to find out what an effective and cost-efficient support scheme has to include, a benchmarking of current support scheme of both EU15 and new Member States has been carried out. [7]

Benchmarking / comparing support schemes includes both comparing the same systems between countries (e.g. FIT) as well as comparison of different systems (FIT, RPS (Quota obligations &TGC). The analysis will include all support schemes in the new Member States as well as support schemes in the EU15 countries participating (Austria, Denmark, Germany, Netherlands and Spain). As none of the latter countries has a RPS in place, detailed information has been gathered from the UK and Sweden. Information from other recently finalized European projects (such as OPTRES) has also been used for this purpose.[8]

2.4.1 SOLID-DER questionnaire

The following questions were asked to each of the SOLID-DER project partners related to their national support schemes:

1. What is the predominant type of support mechanism used for DER used in your country?

[6] *Economic, policy and regulatory barriers and solutions for integrating more DER in electricity supply*, Phase I report SOLID-DER, December 2006.

[7] In the section DER market integration, a topic regarding the interaction between the support scheme, for instance constant FIT, and market integration and system operation has been included.

[8] A number of studies are available now, e.g. IEA, Platts RES report issue 139/1 October 2007.

- Price-based e.g. Feed-in tariffs/premiums or quantity based such as Quota obligations with tradable green certificates or tender systems

2. What additional form of support is provided (e.g. tax exemptions, investment support)?

3. Which disadvantages do these additional forms of support have?

If the answer is FIT, the following questions should be analysed (some systems are mixed so maybe these questions might be relevant for all systems):

4. Is the Feed-in tariff a flat price or a feed-in premium on top of the market price?
5. What is the level of support
    a. absolute level of support
    b. in % of average market price for consumers (retail supply price without tax)
    c. Compared to the production costs of the different DER technologies[9],
    d. What has been the main driver for the level of the premium/tariff (e.g. economics of particular technologies, avoided external damages or other external benefits)? Are there stepped tariffs?
6. What is the duration of the support?
7. Is the support regressive or constant for the duration of the support?
8. What differentiation is applied:
    a. Differentiation per type of DER source
    b. Differentiation per time of use?
    c. Differentiation per voltage level?
9. What growth of DER (RES/CHP) has been noticed since support is in operation?
    a. Is it sufficient to meet the national targets?
10. What was the total value (€) of support given through FIT in 2006 and what is expected for 2007. If there is a maximum please indicate this.
11. Are there any changes expected in the FIT scheme?

If the answer is RPS (quota obligations & TGC) for RES or CHP, the following questions are asked:

12. Average level of support:
    a. I.e. what is the average price level of green certificates?
    b. How does this average price relate to the average market price?
    c. How does the RES-E/DER sales price plus certificate relate to the production costs of DER?
    d. What DER technologies has perceived the support as sufficiently high and actually spread due to it? ("selection" of technologies)
    e. Are additional support schemes, tax exemptions etc in place , e.g. differentiating per technology, tax relief, investment incentives, soft loans?

13. What are the standards (more or less but not exactly quota) and placed on who, retail consumer or power suppliers or generators.
14. Which party is collecting GC (and is obliged to meet a certain RES target; e.g conventional producer, trader or consumer)?
15. Are there any sanctions or penalties in place for parties not meeting the target?
16. Are there any long-term targets (e.g. after 2010) for DER ensuring sustainability of the TGC scheme[10]?
17. What growth of DER (RES/CHP) has been noticed since support is in operation?
    a. Is the support sufficient to meet the national targets?
18. Are there any changes expected in the TGC scheme?
19. Is there a liquid competitive certificate market? Is it traded on a power/commodity exchange?

[9] Compare (average) production costs of different DER technologies to the respective FIT
[10] Long-term targets usually ensure a stable demand for green certificates.

20. Are there regulatory or other barriers for a liquid, competitive certificate market? What are these and how could they be mitigated?

2.4.2 SOLID-DER questionnaire - DER support and system operation efficiency

With higher shares of DER, support mechanisms should be adapted to become more compatible with market price signals in order to achieve a higher level of DER market integration. For that reason the following questions have been introduced:

1. Does the support mechanism implemented affect the optimal operation of DER, if it is controllable, from a system point of view, maximizing the social value of DER production?
2. Are there practical experiences in your country that show inefficient behaviour or system operational problems due to DER production because of the design of the implemented support mechanism?
3. What kind of regulatory actions are foreseen in order to obtain a better integration of DER in the electricity market?

In chapter 3 the results of the questionnaire for the 8 of the new Member States is described, followed by the 7 of the old Member states in chapter 4. Chapter 5 gives a cross-country comparison, followed by recommendations and conclusions in chapter 6.

3. DER SUPPORT SCHEMES IN THE NEW EU MEMBER STATES

In this chapter support schemes of 8 of the new member states have been analysed; Bulgaria, Czech Republic, Hungary, Lithuania, Poland, Romania, Slovakia and Slovenia.

3.1 Bulgaria

The most important form of renewable energy and cogeneration support in Bulgaria is the feed-in tariff.
Feed-in tariffs supporting energy production from renewable energy sources are defined in the *Law on Renewable and Alternative Energy Sources and Biofuels* (RES Law). The feed-in tariffs to support energy production from cogeneration are defined in the *Energy Law*.

The *Energy Law* defines in the following way the Feed-in tariff (or preferential price):

- The preferential price of electricity generated from renewable energy sources shall be determined at 80 percent of the average sale price of Public Suppliers for the preceding calendar year plus an addition (extra payment) determined by the SEWRC[11] depending on the type of primary energy source.
- In addition, during the next calendar year, support may not be less than 95 percent for the current year.

The SEWRC annually determines the prices of electrical energy produced from RES including from hydropower plants (HPP) with rated capacity up to 10 MW and CHP

Duration of the support
The RES Law specifies the duration of the support in following way:

- Mandatory purchase of energy shall be effected through PPA contracts
- The term of validity of these contracts is 12 years for renewable energy sources (including hydropower plants < 10 MW);
- The term of validity of these long term contracts for cogeneration is 8 years;
- As from the start of generation of electric power, but not later than 31 December 2010 - for all new producers of energy generated from renewable energy sources.
- Feed-in tariffs are provided as flat prices, with one exception, wind parks with average annual utilisation higher then 2150 hours, there is a stepped (lower) tariff.

The support depends on the end user prices and is *constant* for the duration of the long term contract but a procedure for *price indexation* exists in case of considerable changes, as stated in the Energy Law.

Support is differentiated per type of DER technology and there is an *indirect time component*. Hydro power plants that have upper reservoir (equalizer) containing enough water for more than 2 hours full capacity operation (to be used during the peak) receive temporarily a higher feed-in tariff. The same concerns hydro power plants, which have lower reservoir that allow the utilization of waters for irrigation.

Further developments
The level of support seems to be sufficient for meeting the national targets but it depends also on the development of the price of the technologies – particularly for wind and solar energy. It

[11] State Energy and Water Regulatory Commission (SEWRC), the Bulgarian energy authority

should be noted that some of the targets are not fixed yet and depend on the negotiations with the European Commission.

Regulatory actions foreseen in order to obtain better integration of DER in the electricity market are the following:

- The Regulator shall harmonise the secondary legislation with the Law on RES
- Feed-in tariff mechanism shall be perfected to stimulate DER to take part in system operation.
- By 31 December 2011 the Minister of Energy shall propose market based mechanism to be implemented for encouraging DG including CHP as it is explained above.

Additional forms of support

Additional form of (indirect) support for DER is provided through:

- Mandatory connection of operators generating electricity from renewable and alternative energy sources into the national grid;
- Reducing the administrative burden for the producers of energy from renewable and alternative energy sources and on construction of relevant facilities
- An individual, extra payment to the feed-in tariffs for different RES and high-efficient cogeneration technologies, the exact level to be approved by the European Commission.

Barriers

A number of barriers to the increased development of DER can still be noticed in Bulgaria, these are:

- The prices of electricity from RES are usually higher and the DSO's are reluctant to purchase it.
- Connection of RES generators to the grid needs investments, which are usually subject of debatable ground between parties. The "*Ordinance on the Connection of Consumers and Generators to the Transmission and Distribution Electricity Grid*" specifies the responsibilities of each party in order to accelerate connections and moderate discrepancies. Nevertheless the co-ordination could last very long time.
- No common methodology for extra payment calculation exists regarding grid needs investment.
- Administrative barriers are the main obstacle to the deployment of DER because they discourage the investors. The above mentioned provision of the Law however is too vague and not very productive.

Impacts of support

DER penetration is limited up to today. Main reason has been the high costs (an prices) of solar and wind generated electricity that have not developed before renewable energy support was in place. As support seems to be sufficient for investments in DER technologies, DER shares will increase, leading to problems with interaction due to many unresolved problems, for instance:

- Technologies for interconnection of wind / solar based generators injecting harmonics
- Need of electricity storage
- Some voltage stability problems
- Need of state-of-the-art relay protections and automation

Recommendations

Given the expected increase of DER generation, Bulgaria will have to introduce mechanisms in the support that will lead to higher contribution of DER in market/system integration.

3.2 Czech Republic

The predominant type of support mechanism used for DER in the Czech Republic is the feed-in tariff scheme. The *Renewable Energy Act*, adopted in May 2005, introduced a combination of feed-in tariffs and a green bonus scheme (a feed-in premium on top of the market price). CHP is supported through a green bonus only (differentiated by size of CHP).

The absolute level of support is differentiated by technology, and is in the range of 4 to 10 €ct/kWh for most RES categories (biomass, wind, small hydro). Exceptions are tariffs for bio-mass co-combustion which are far lower (around 1 €ct/kWh) and the tariff for PV electricity, being significantly higher, around 45 €ct/kWh. (see Annex B for tariffs).

The support level for DER in relation to market prices for electricity is:

- in % of average market price for consumers (retail supply price without tax) – price of electricity (without taxes and network services) in 2007 is about 1300 CZK/kWh (€ 46), based on the technology, feed-in prices are 100 to 300% of the regular electricity price.
- Compared to the production costs of the different DER technologies - No clear information about this, but the feed-in tariffs are set in such a way that the investment is paid back in 15 years.

Tariff levels

The support for investors will remain constant for 15 years. The only change applied in the tariff is a small increase based on the industrial price index. Each year the regulator may change the tariff for *new* installations. This tariff is usually announced in November of the previous year. The tariff for the subsequent year may not be lower than 95% of the value of the tariff in the previous year that it has been established.

The following tariff differentiation is applied:

- Differentiation in the feed-in tariffs is applied per type of DER source, this means technology, but also whether it concerns 100% biomass use or biomass co-firing (for bio-mass co-firing, only the green bonus on top of the market price can be gained). Further differentiation is applied for the year the installation was put into operation.
- For small hydropower plants another differentiation, based on time of use, can be applied. For eight hours a day (during peak), a higher tariff is applied than during the rest of the day (off-peak).
- CHP installations on fossil fuels can only apply for a feed-in bonus. Here the tariff is differentiated by size, smaller than 1 MW, 1-5 MW and larger than 5 MW (for this larger category the feed-in bonus is rather "symbolic").
- Furthermore, CHP installations smaller than 1 MW and those 1-5 MW can chose to supply power during peak hours so that they can receive a significantly larger payment (for tariffs see Annex B).

DER integration issues

The support mechanism is mainly set up to ensure stability from the point of view of the DER investor. However, it includes a few elements that ensure more optimal integration of DER into networks, these are:

1. possibility to choose a green bonus on top of the market price and
2. mandatory reporting of the expected production one day ahead
3. different time of day tariffs for small hydro and CHP.

(1) As an alternative to fixed feed-in tariffs green bonuses have been introduced, to those DER investors willing to operate on the market. This form of support should motivate DER producers to operate on the energy market and provide electricity at those times that demand is high. DER operators can choose fixed tariffs or green bonuses and may change from one system to the other once a year.

(2) Mandatory reporting of expected production one day ahead means:

- DER operators (with the exception of wind and solar energy and installations below 1 MW) have the obligation to notify the grid operator of the expected power production at 8 AM of the day before delivery the latest.
- When production is higher than 10% or lower than 15% of the notified amount, the feed-in tariff is lowered by 20% for each day such a deviation occurs.

(3) Small hydropower plants (up to 10MW) and small CHP plants (up to 5 MW) can chose to supply electricity in peak periods, receiving a higher tariff

As more intermittent resources (wind energy or solar energy) are not included in the mandatory reporting scheme this may lead to certain inefficiencies from the point of view of the network.

Other forms of support

Additional investment support is provided through a number of programmes (mainly supported out of the European Regional Development Fund:

- Operational Programme Entrepreneurship and Innovation (2007-2013) - Within the subprogramme Eko-Energie, managed by the Ministry of Industry and Trade, investment support is provided for heat and electricity production from RES. The support is provided to SMEs to a level of 40% of eligible costs. Support within a range of 0.5 – 100 million CZK can be provided through the Programme.
- Operational Programme Environment (2007-2013) - provides support for sustainable energy actions from the EU Cohesion Fund. Within the Priority Area 3 – Sustainable Energy, support is provided to heat and electricity production from biomass and biogas in public sector. The investment support could reach up to 85% of eligible costs and could range from 0.5 million CZK, the upper limit of support is not specified.
- Operational Programme of Rural Development - Within this programme managed by the Ministry of Agriculture, support is provided from EAFRD (European Agricultural Fund for Regional Development). Support includes also non-production activities in agriculture such as biogas production and energy utilisation.

Another, indirect form of support will be established in the form of environmental taxes. Environmental taxes are to be introduced in January 2008 within the framework of tax reform package, in accordance with the requirements of Directive 2003/96/EC. In the first step of environmental tax reform, excise tax for natural gas, electricity and coal will be applied. Electricity produced out of renewable energy will be exempted from this tax. This will mean an (indirect) benefit for electricity from RES.

Impacts of support

Since support is in operation a slight increase in the share of RES in electricity production can be noticed. The share of RES in renewable electricity production was 4.9% in 2006 (compared to 4% in 2004). However, according to expert estimates, it will not be enough to reach the indicative target of 8% in 2010. In 2006, each consumer paid CZK 34 per MWh to support renewable energy. → based on annual consumption in the Czech Republic this is about 1.5 bln CZK (€ 55 mln.) payment for renewable energy per year.

Recommendations

With increasing DER shares, it would be advisable to extend variable time of day tariffs to other DER sources and gradually move completely to feed-in premiums.

As support in the Czech Republic is provided for a relatively long time compared to other new MS (15 years instead of 10-12 in other countries) it would be good to analyse whether this does not lead to overcompensation of DER. Moreover, the combination of investment support with relatively long feed-in support may lead to “too attractive” investment opportunities financed through public funds.

3.3 Hungary

In connection with the new *Electricity Act* and the related market model a new governmental decree entered into force on January 1 2008 on the support scheme of RES and CHP. Feed-in tariffs remained in place as the predominant type of support scheme as was the case already.

While for most RES and CHP there is a stable output based support, limitations exist for wind energy. There is an *explicit quantity limit* on overall (grid connected) wind capacities of 330 MW (due to system operator's problem with balancing power) and is set for an undefined time period.

Level and differentiation of support
The RES tariffs are fixed in the Electricity Act, and on generated quantity weighted average it is *uniform for any RES technology*. However, the investment and operating costs are taken into account when the supported quantity and time horizon are determined in the Hungarian Energy Office resolutions. These are determined in such a way that the supported plant should achieve an internal rate of return (IRR) of 7.5% - 8%. This is valid for DER plants above 500 kW only. DER below 500 kW does not need a licence from HEO, and receives the FIT as long as the decree is in force. Therefore they may achieve a higher return if their unit cost is not much larger than that of larger DER plants.

There is only a limited differentiation of feed-in tariffs, this is:

- project installation date (existing, newcomers)
- renewable – weather-dependent and non-weather dependent, waste, cogeneration
- size of the plant:
    - In case of hydro generation and CHP;
    - new RES-e plant above 20 MW receives lower tariff;
    - small DER below 500 kW do not need a licence from the HEO
- and age of equipment (new/used).

Apart from that there are three different zone-times (peak, off-peak, deep-off-peak) for which different FIT apply.

The average feed in tariff level for RES-E set in the Electricity Act is[12]:

- 2007: 9.7 eurocent/kWh (24.71 HUF/kWh)
- 2008: indexed with inflation (consumer price index of 2007) to 10.4 eurocent/kWh (26.46 HUF/kWh)
- This is given for most of RES-E, except new plants above 20 MW capacity, which receive lower tariffs.

Conditions of the tendering procedure for new wind-generators will be published in different legislation (*not available yet*). Tenders may be issued if the electricity system is judged suitable to integrate more than the currently allowed maximum 330 MW.

The economics of particular technologies is still considered because small plants above 500 kW have to apply for a so called combined energy permit (licence) to the Hungarian Energy Office, and the tariff is provided only for a time horizon that provides appropriate return for the given plant applying for the energy permit.
The Hungarian Energy Office calculates this the time horizon (the number of years) on a case by case basis, based on the feed in tariff, the performance parameters, and investment and operational costs of the applicant plant (or in the case of wind, performance and cost data of a benchmark wind plant are used).

[12] The complete table feed-in tariffs, validity time horizon, indexation rules for RES and CHP is given in Annex B (Source: Governmental Decree 389/2007)

Thus, in this hybrid way, the costs do form the basis of support, despite the tariffs not being differentiated (but the number of supported years and quantity limited). For example, for green field investments in biomass and biogas it is usually around 10 years, for wind 10-15 years. This is valid for DER plants above 500 kW only; DER below 500 kW does not need a licence from HEO, and receives the FIT as long as the decree is in force. Therefore they may achieve a higher return if their unit cost is not much larger than that of larger DER plants.

The *Hungarian Energy Office* (HEO) is obliged by law to calculate the return of investment of each given project based on the business plan submitted by the licence-applicant. Methodologies and results of the calculations are published on the website of HEO (*not available yet*).

Level of support in relation to market/retail prices of electricity[13]
The electricity price is a result of negotiations between customers (so far non-households consumers only) and traders and there is no obligation to publish them. In the case of household and small industrial consumers – who can also be supplied within the regulated (so-called universal) service – the maximum price is regulated and published. Under these figures the *average electricity price for small customers* (excl. VAT) is about 21 HUF/kWh, (8.24 eurocent/kWh) plus the system operation and network fees which are about 14 HUF/kWh (excl. VAT). Altogether about 35 HUF/kWh (13.73 eurocent/kWh) (excl. VAT) in 2008.

The average RES-E FIT is 10.38 eurocent/kWh, so the

- RES-E FIT/household electricity price ratio (without UoS charge) is 1.26 (126%)
- RES-E FIT/household electricity consumer price ratio (with UoS charge included) is 0.76 (76%)

The specific extra cost of RES-E and CHP DER support together and pass through is approximately 2 HUF/kWh that is 0.78 eurocent/kWh (at 1 EUR = 255 HUF)

The competitive *average producer market price* in 2007 was around 13 HUF/kWh (5.10 eurocent/kWh) so

- RES-E FIT/competitive price is 2.04, that is 204% (10.38 - 5.10 = 5.28 eurocent/kWh support content, that is 104% support on top of competitive price).

There is unconfirmed news that the competitive producer price is higher now than in 2007, at around 15-17 HUF/kWh (around 6-7 eurocent/kWh), which means that the support content decreased to around 4 eurocent/kWh without the FIT level decreasing.

Impact on RES-E and CHP production
The 2010 target of 3,6% RES in gross electricity consumption was already overachieved in 2005, but then RES-E decreased due to stricter conditions of support for biomass co-firing in large plants as well as price increase of biomass. Renewable electricity production remained above the target, however, both in 2006 and 2007.

Table 3.1 - Table of RES-E and CHP 2003-2007

	Years				
	2003	2004	2005	2006	2007 (first half)
RES-E (GWh)	257	884	1721.8	1319.3	735
CHP-E (GWh)	na	2029	2567.4	3062.6	1652
RES-E/gross electricity consumption (%)	0.6	2.20	4.53	3.8	N/A

Source: http://www.eh.gov.hu

[13] It is difficult to give such kind of %, because there is not a relevant, transparent average market price in the Hungarian electricity market (no electricity exchange existing).

There was no maximum in the support given through FIT. The system operator handled a fund which was financed by the electricity consumers through a system use charge element. When the fund had a deficit the regulated system use charge element was increased in a way to cover the loss of the system operator as well. The fund has been ceased since January, 2008 as now the traders pass through individually their additional costs due to RES-E and CHP-E purchase. The specific extra cost and pass through is approximately 2 HUF /kWh (0.8 eurocent/kWh)

Table 3.2 - Additional costs due to RES-E and CHP-E purchase

	Years				
	2003	2004	2005	2006	2007 (forecast)
RES-E (M€)	N/A	22,6	55,5	55,8	65
CHP-E (M€)	N/A	43,4	68,2	128,9	128,6
Total (M€)	N/A	66	123,7	184,7	193,6

Source: http://www.eh.gov.hu

Upcoming developments

Changes within the Hungarian support scheme were recently introduced by new decrees at the end of 2007. Main changes of the new decree are related to:

- All traders supplying end-user customers are obliged to buy green and cogenerated electricity according to their market share. RES electricity allocation is carried out by the system operator MAVIR.
- No more central fund and system use charge element to finance the support scheme. Traders – constrained with competition - can decide on what extent they charge the cost of distributed electricity to the consumers.
- All supported DER generators belong to the special balancing group of the system operator, MAVIR.
- DER generators are obliged to submit generation month-a-head, week-a-head, day-a-head schedule. For ± 5 % (in the case of wind ±30 %) deviation from the schedule generators concerned pay an extra charge to the system operator (interpretation of this point of the decree is under negotiation; e.g. whether monthly deviation or daily deviation will be sanctioned).
- New biomass plants will not receive FIT if they use cut wood logs. Extension of support of already operating ones that use cut wood logs can be requested, and HEO will revise the return of investment of the plant and based on this will decide on granting or denying extension.
- Outside the FIT decree, in the Electricity Act and the general enforcement decree of the Act the support of "household small power plant" (up to 50 kW) is introduced. Households just pay the cost of net electricity use, if they use up all their own production. If households feed in the network, they receive 85% of electricity retail price for the surplus over their consumption supplied.

The following interaction issues may become important when DER shares increase:

- For a given deviation from the schedule generators have to pay an extra charge to the system operator. The tolerance is larger for wind operators (5% general vs. 30% for wind). This rule is disputed now and interpretation may change to dampen it.
- Time of use differentiation of feed-in tariff for DER so as to achieve more production in peak demand periods and reduce lower production in low demand off-peak periods. However, for e.g. biomass, the night (deep off peak) tariff does not seem sufficiently low to motivate biogas storage or in the case of CHP to supply heat from heat storage in low electricity demand off-peak periods.
- Intentions to involve DER both in the supply side of reserve market and also on the demand side to pass on some of the balancing cost to those DER plants, which cause them. Not yet successful in practice. Apart from the sanctioning deviations from the submitted schedule, one of the possibilities of supply side is that the capacity limit for

bids in the tertiary (minute, hour reserves) market can be fulfilled in a combined way by the bidder.
- In the case of large CHP: employment of the unit by the system operator beyond the heating season is not taken into account during the calculation of the yearly efficiency of that generator.

The Hungarian generation portfolio is an inflexible one and the individual capacities of the large (centrally dispatched) power plants are too high compared to the load-flow (demand) of the Hungarian system. That is why there is an over-supply situation in Hungary in the low demand dawn periods; although the peak demand is quite high in peak-periods. Until distributed generators cannot (do not) want to take part in the system operation, MAVIR will not support their connection to the system referring to security of supply issues (support of the connection by MAVIR is a prerequisite for a licence by HEO).

A positive change: a counter-incentive has been removed in the new FIT decree for CHP against participating with supply bids in the reserve market: the combined efficiency calculation does not include generation if requested by the System operator, therefore participation in reserve supply does not threaten failing the efficiency threshold and losing the FIT for the cogenerated electricity part.

Additional forms of support
Additional form of support is provided through:
- Investment support based on an application system to the Operative Programs of New Hungary Development Plan (this is the National Development Plan II, which is co-funded by the EU);
- Energy tax (i.e. electricity tax) exemption for RES-E producers for own use

Disadvantages of these additional forms of support are:
- Complicated and sometimes not transparent procedure
- Usually larger value investments qualify only to participate in the tenders
- It does not provide a level playing field for small capitalization and large companies.

Recommendations
Hungary has taken some important steps in integrating DER into the electricity network, e.g. through time of day tariffs and the obligation to report electricity production to the system operator.

Questions are raised to:
- The calculation of the FIT by the HEO (new methodology not yet approved)
- Combination with other forms of support. Investment support may give too much support for certain investors and a level playing field does not exist when only some investors receive support (in contrary to FIT where in principle all investors receive support.

3.4 Lithuania

The main form of renewables support in Lithuania is, as from 2001, a feed-in tariff. According to regulation power generation by wind, biomass, solar power plants and hydro power plants with a capacity of less than 10 MW is promoted. The feed-in tariff is a flat price at the moment.

With regards to CHP:
- Suppliers are obliged to purchase and to sell to consumers all electricity generated in cogeneration regime in CHP power plants, when they are supplying heat to the district heat supply networks of cities.

- The heat supplier must purchase heat generated by an independent producer if he fulfils particular conditions. For example, heat producer must have a heat < 1 MW and not less than 1% of maximum capacity demand in the district heat supply system.

Table 3.3 – Feed-in tariffs in Lithuania

	Tariff, LTL cents/kWh	Tariff*, Euro cents/kWh
Hydro power plants**	20	5.79
Wind power plants	22	6.37
Biomass power plants	20	5.79
Biomass PP (after 1st January 2008)***	22-24	6.37-6.95

* 1 EUR – 3,4528 LTL

** Only for hydro power plants with the capacity of less than 10 MW

*** Biomass PP (operation started before 1st January 2008) 22 LTL cent/kWh, Biomass PP (operation start after 2008 01 01) – 24 cent/kWh.

The electricity price for household consumers is approx, 33 LTct/kWh (9.56 €ct/kWh). Support price for RES is 61 - 67% of electricity price for consumers in the household sector.

Table 3.4 - Comparison with the production costs of the different DER technologies14,

Technology	Minimum – average generation cost, €/MWh	Support level €/MWh
Wind PP	56-63	63.7
Agricultural biomass	60-102	57.9
Solid biomass (forestry residues)	92-102	57.9
Small hydro	55-78	57.9

As can be seen in table 3.4, the level of support is below marginal generation cost for some technologies and comparable to generation costs for other technologies (e.g. wind power). In addition the generation cost in new projects has tendency to increase, because of the increased construction, fuel cost, etc.

The Promotion Procedure sets forth that fixed feed-in tariffs will be applied until 31 December 2020. At the moment the support is constant. There are plans to replace the support of renewable energy sources through a tradable green certificate system by the year 2021.

Impacts of support

The effectiveness of the support scheme for the promotion of renewable electricity for the period until 2005 was analysed in the OPTRES project. The results have showed that in this period the Lithuanian effectiveness indicator for RES electricity generation was one of the lowest in EU-25. However, recently the situation in RES generation has improved significantly. The biggest impact of FIT support system can be noticed on development of wind power plants. The capacity of wind power has increased from 1 MW in 2004 to 49 MW in 2006. It is expected that capacity of these power plants will reach 200 MW in 2010.

However, wind energy is facing a lot of barriers that limits its growth:

- increasing investment cost per kW,
- low rate of return,
- long and complex planning and projection procedures in some territories,
- environmental requirements or high land price.

[14] Compare (average) production costs of different DER technologies to the respective FIT

All these problems could decrease investments and slow down the further development of wind energy in Lithuania.

The installed capacity of small hydro PP has doubled from 13 MW in 2001 to 27 MW in 2006. However, the further capacity increase for this type of power plant is expected to be moderate. Recently the installed capacity of small scale biomass CHP power plants is also increasing. Support for the solar and geothermal electricity is too low; no such projects were implemented so far.

With regard to the requirements of the European Parliament and Council Directive 2001/77/EC the national target established for electricity produced from RES should account for 7% in the overall electricity consumption by 2010. In 2006, the share of electricity generated using renewable energy sources from total electricity consumption in Lithuania was 3.6% (Table 3). So, the share of RES-E in the total electricity consumption practically was not increasing in last 5 years (it was 3.4% in 2000) because almost all green electricity was from hydro PP, and their production is dependent on annual precipitation.

Table 3.5 - Electricity generation from RES

GWh	2000	2001	2002	2003	2004	2005	2006
RES generation, GWh	340	327	358	333	429	458	436
Gross consumption, GWh	10088	10773	11234	11958	12079	11820	12054
RES-E share, %	3.4	3.0	3.2	2.8	3.6	3.9	3.6

Total volume of support given through FIT in 2006 was about € 3.2 million (taking into account that the average electricity generation price was 25 €/MWh). It is expected to be 8.8 million EUR in 2007 (electricity generation price 26 €/MWh). Total sum for buying supported electricity was € 5.58 mil. in 2006, (€ 15.5 mill. is expected in 2007).

Table 3.6 - Maximum electricity volume with guaranteed support and actual production (2006)

	2006	2006 fact	2007	2007 expected	2008	2009
Wind power plants, GWh	96.2	13.7	182	105	259.6	320.4
Small hydro power plants, GWh	106	55.8	114	89	118	122
Biomass power plants, GWh	39.1	25.6	79.1	64	103.1	127.1

So far the support mechanism was important seeking to use efficiently operation of DER. However, increasing investment cost per kW are low rate of return for wind power plants are factors reducing attractiveness of their construction. Significant increase of natural gas prices can create unfavourable conditions for small CHP using this fuel. The share of distributed generation is quite low at the moment, and it doesn't significantly influence the system operation.

Additional forms of support

- Priority for transportation. The transmission network operator must ensure priority for transportation of electricity generated using renewable energy sources in a case, when the capacity of transmission network is limited
- Network connection discount. Generators whose power plants are using RES for electricity generation are subject to a 40% discount for the connection to the network of operating energy companies;
- Exemption from the pollution charge. For the purpose of promotion of electricity generation in power plants using bio-fuel, an amendment of the Law on Environmental Pollution Charge was made. As from April 2005, according to this amendment physical and legal persons, are exempted from the payment of the pollution charge for emissions of air pollutants which emerge during combustion of biomass;

- EU Structural Funds. EU Structural Funds may provide support for investments into construction of power plants which generate electricity using renewable energy sources. The Lithuanian Environmental Investment Fund provides soft loans for the financing of environmental projects and subsidies for financing of renewable energy projects;

Recommendations
Based on the information presented above it seems that the level of feed-in tariffs is relatively low and does not promote new investments to a large extent. Therefore increase of tariffs should be recommended.
At the same time tariff variation per time of day will have to be considered.
Priority of transportation / dispatch is probably not the optimal form of support as it benefits one source of production although capacity for transmission may be limited. With increasing shares if DER, this is not the way to achieve better network integration.

3.5 Poland

In Poland the main support mechanism used for DER, both RES and CHP, is a tradable certificate system:

- Green certificates for RES are in place since 1 October 2005
- Red certificates for CHP are in place since 1 July 2007

The following tables (3.7 - 3.9) give an overview of the green certificate prices (for RES), the green certificate market results and sales prices on the market.

Table 3.7 - RES-E, GC prices over 2005-2007

		2005	2006	2007
Average market price of energy	[Pln/MWh]	-	117,49	119,70
Average price level of GC	[Pln/MWh]	-	211,85	239,20
Average market price + GC price	[Pln/MWh]	238,96	329,34	358,90
Average production cost of DER	[Pln/MWh]	-	175	175
GC price /average market price	[%]		180 %	200 %
$\frac{average\ market\ price + GC}{RES/DER production\ cost}$	[%]		188 %	205%
Compensation fee	[Pln/MWh]	-	240,00	242,40
Penalties	[Pln/MWh]	-		

Table 3.8 - Green Certificate Market Results

			2006	2007
OTC trading	volume	[MWh]	2 887 803	3 173 007
	min	[Pln/MWh]	82,00	99,00
	max	[Pln/MWh]	244,00	242,10
Continuous Trading	volume	[MWh]	330 070	654 953
	min	[Pln/MWh]	175,00	236,22
	max	[Pln/MWh]	243,00	240,70
Auctions	volume	[MWh]	401 580	410 550
	min	[Pln/MWh]	175,00	236,68
	max	[Pln/MWh]	240,00	240,46
Total volume	-	[MWh]	3 619 452	4 238 510
Average OZEX		[Pln/MWh]	211,85	239,20

These results show that prices of TGC vary between 99 – 241 Pln/MWh, the average being around the high end. This is is very close to the level of the compensation fee.

Table 3.9 - RES-E/DER sales price plus certificate relate to the production costs of DER

RES technology	Capacity		2004		2005			
		Cost of RES-E production[15]	Avg. RES-E sales price[16]	Avg. profit	Avr. Energy Price	GC price	Avg. Energy price + GC	Average profit
		1	2	3=2-1	4	5	6 = 4+5	7=(6+5)-1
		[Pln/MWh]	[Pln/MWh]	[Pln/MWh]	[Pln/MWh]	[Pln/MWh]	[Pln/MWh]	[Pln/MWh]
Small hydro	<5MW	306	239	-67	118	200	318	18
Wind	30 MW	292	239	-53	118	200	318	26
Large hydro	100 MW	237	239	2	118	200	318	81
Biomass	10 MW	214	239	25	118	200	318	104
Co-firing	2000 MW	133	239	106	118	200	318	185

Impacts of the TGC system

In Poland the GC support mechanism proved to be financially most beneficial for the co-firing of biomass (wood and wood waste) (see table 3.9). This technology was classified as RES in order to motivate the conventional power generators to take determined actions towards reducing CO2 emissions and increasing RES shares.

The primary intention behind this the implementation of the green certificate system, to create new capacities of RES/DER, failed as majority of power plants chose to introduce co-firing within the present energy production capacities.

The market was supplied with significant volume of RES-E energy which resulted in reduction of the prices to a level considered insufficient for the development of wind and small hydro technologies. The changes of the RES-E volume over the period of 2005-2006 are presented in table 3.10.

In 2006 the Minister of Economy increased by the Ordinance [2] the obligatory RES-E shares to the level presented in table 3.10 with the purpose to increase the demand for green certificates enabling better functioning of the Green Certificate Market.

Table 3.10 - Green certificates issued in 2006 (RES-E production 2005 / 2006) by technology

RES technology	Production period: 1.01.2005 – 31.12.2005		Production period: 1.01.2006 – 31.12.2006		Change in 2006 compared to 2005	
	Energy volume	GC	Energy volume	GC	By the Volume	
	[MWh]	[pieces]	[MWh]	[pieces]	[MWh]	[-]
Biogas	104 465,28	324	116 691,86	317	12 226,58	4 ↑
Biomas	467 975,68	226	503 846,21	52	35 870,53	3 ↑
Wind	135 291,63	288	256 814,96	372	121 523,33	2 ↑
Hydro	2 175 559,10	4 113	2 029 314,01	3 338	-146 245,09	5 ↓
Co-firing	877 009,32	299	1 314 336,6	132	437 327,28	1 ↑
Total	**3 760 301,01**	**5 250**	**4 221 003,66**	**4 211**	**460 702,65**	

Source: Annual Activity Report of the President of ERO [6]

The obligation to purchase and present for cancellation the certificate of origin is placed on every energy company that is selling the energy to the final consumers connected to the grid within the Polish territory.

[15] According to the Analysis of the RES-E market. EP Warszawa, prices in first quarter of 2005

[16] Does not include income from the CO_2 emission trade

Table 3.11 - Obligatory shares of RES-E in annual sales of energy by energy companies

Year	Share of RES-E in sales	
	Previous Regulation [3]	**Current Regulation [2]**
2005	3,1	**-**
2006	3,6	**-**
2007	4,8	**5,1**
2008	6,0	**7,0**
2009	7,5	**8,7**
2010	9,0	**10,4**
2011	9,0	**10,4**
2012	9,0	**10,4**
2013	9,0	**10,4**
2014	9,0	**10,4**

Source: The ordinance of the Minister of Economy [2,3].

If the company is not able to meet the targets set in the secondary legislation [3] presented in the table 3.11 it has to pay a compensation fee which is calculated in accordance with the following formula:

$$Oz = Ozj \times (Eo - Eu)$$

Where the symbols mean:

Oz – the compensation fee expressed in PLN,

Ozj – the compensation fee unit amounting to 240 Polish zloty per MWh[17],

Eo – the amount of electricity, expressed in MWh, stemming from the obligation to acquire certificates of origin referred to in Article 9e s.1 and to present them for cancellation, in the particular year,

Eu - the amount of electricity, expressed in MWh, stemming from the certificates of origin, which the energy undertaking presented for cancellation in the particular year.

In 2007 the compensation fee unit was 242,40 Pln.

The targets for the RES share are set in the Ordinance [2, 3] They can be met either by acquiring green certificates or by paying the compensation fee that constitutes the income of the National Fund for Environment Protection and Water Management, and is paid into a designated account of this fund until 31 March of each year, for the previous calendar year. The entity that for any reason fails to meet the target is subject to the penalty.

The amount is calculated using the following formula:

$$K = 1{,}3(O_z - O_{zz})$$

Where the symbols mean:

K – penalty for the year;

Oz – the compensation fee to be paid expressed in PLN,

Ozz – the compensation fee already paid by the company expressed in PLN,

Targets for renewable electricity implementation have been laid down in national law. Every 5 years the Minister of Economy presents a report describing targets for the share of energy from renewable sources in national electric energy consumption. Current document describes targets until the year 2014. Polish national indicative target for the year 2010 is 7.5%.

[17] The compensation fee unit Ozj is subject to annual valorisation by the mean-annual consumer price index from the calendar year preceding the year for which the compensation fee is calculated, determined in the communication of the President of the Central Statistical Office and announced in the Official Journal of the Republic of Poland 'Monitor Polski'. The President of ERA announces the compensation fee unit after its valorisation in the Bulletin of the Energy Regulatory Authority not later than on 31 March of every year.

Table 3.12 - National targets for renewable energy[18]

Year	Electric energy from RES	
	Current plan consistent with Directive 2001/77/EC in year 2010	
	TWh	%
2005	3,12	2,2
2006	3,72	2,6
2007	4,61	3,2
2008	5,8	4,0
2009	7,74	5,3
2010	**11,10**	**7,5**
2011	11,18	7,5
2012	11,33	7,5
2013	11,48	7,5
2014	11,63	7,5

Every two years, the Minister Economy in cooperation with the Minister of Environment draws up a report containing the analysis of implementation of quantitative targets and the results achieved in the production of electricity in renewable energy sources.

The green certificate system and the regulations that went with it first of all allowed good identification of all the renewable energy resources. So far Poland was able to meet the targets. However there are concerns that there are not enough new sources built to meet those increasing targets in the future. Majority of the obliged entities fulfil the obligations. Penalties are applied in single cases.

The system is in operation since 2005. It is considered by different stakeholders that the system works and that it is too early for changes. For that a careful evaluation will be needed first.

The stiff level of the compensation fee influences the maximum price of the certificate. In 2007 the prices of GC during continuous trading barely varied. The results are presented in table 3.9 The RES-E producers did not compete and sold the certificates at the highest prices regardless the cost of the technology (see table 3). The certificates are traded in bilateral contracts or on the power exchange.

Additional forms of support

Additional forms of support provided in Poland are the following:

- Obligation on supplier of the last resort to purchase all RES-E connected to the grid on his territory. The price is announced each year by the President of ERO and calculated as an average level of energy price on the competitive market in the previous calendar year. There are financial sanctions for not fulfilling the obligation.
- Support for RES with capacity greater than 5 MW:
    - Reduced cost for the connection to the grid applied until the end of 2010 - 50% of the actual cost of the connection;
    - Separate balancing rules for the distributed generation – laid down recently in so called system ordinance [1]. The entries of this act allow balancing of wind energy within special balancing groups (made of one or more sources). It also allows adjusting planned energy production up to 2 hours prior its generation.
- Support for RES with capacity smaller than 5 MW in form of the exemptions from:
    - fiscal fee for the issuance of the certificate of origin;
    - annual fee for the Green Certificate Register;
    - fee for issuing the license for generation of electricity in RES;
    - annual licence fee paid to the State Budget.

[18] *Source*: Report describing targets for the share of energy from renewable sources in national electric energy consumption in years 2005-2014 by the Ministry of Economy [4].

- RES in general is exempt from excise tax.
- Investment support from:
    - National Energy Protection and Water Management Fund (NFOSiGW)
    - Operational Programme Infrastructure and Environment

Recommendations

- Provide targets for a longer time period, making it attractive to invest in other technologies. Increase the current RES targets for the period 2010-2014.
- It is positive that the penalty is set at a factor 1.3 higher than the compensation fee. This compensation fee could however be increased as it is at almost the same level as the TGC price.
- Assess whether investment support should be given to DER investments when there is already a TGC. It could, however, be limited to certain technologies that are not promoted enough through TGC.

3.6 Romania

In Romania the following types of support are in place:

- For electricity produced from renewable energy sources – quota obligations for suppliers and tradable green certificates, in use from November 2005.
- For electricity produced in high-efficient cogeneration – bonus system (feed-in premium). The system was established by Government Decision in 2007, and is currently under development.

The prices of tradable green certificates are limited by Government Decision between a minimum price of 24 Euro/MWh and a maximum price of 42 €/MWh. From the beginning of the TGC market (2005) the price has always been above 40 €/MWh.

The average price of TGC is roughly 41 €/MWh and average price of electricity on the wholesale competitive electricity market is roughly 55 €/MWh. So, in total, a DER producer receives about 96 €/MWh. The 96 €/MWh seems to cover present costs of DER production, but in the future prices on the TGC market might begin to drop due to the new E-RES generation installed.

The growth of DER has been insignificant since the TGC system has been put into place, but many projects are under development or announced. The TGC system has so far supported DER projects like wind power and small hydro.

Electricity suppliers are obliged to purchase yearly quotas of TGC. The quotas are established till 2012 by a Government Decision (GD). Another GD is under discussion with new quotas till 2020. The suppliers, the licensed entities selling electricity to consumers, are collecting the GC. TGC are traded monthly on Opcom, the Romanian Power Exchange. The market considered as being liquid, with 14 sellers (RES-E producers) and 65 buyers (suppliers selling electricity to end-users).

DER integration issues

The intention is to improve the TGC scheme by raising the price limits and by giving some certainty to investors regarding the recovery of investments.

In the Romanian case, the electricity produced by DER is sold on the market, at market prices. If the producer (using eligible DER) does not succeed to sell the electricity, it will receive the imbalance price, which is usually lower than average market price.

DER sources are divided in controllable electricity generation and incontrollable electricity generation. In case of controllable electricity generation, there is an obligation to pay for deviations from the notified hourly schedule (it must be notified at 15.00 hours, the day before). The incontrollable electricity generation (for instance wind generated electricity) is exempted from these imbalance payments. This imbalance payment exemption generates a complicated market procedure and some distortions (there is no incentive for a reliable forecast of the generation). The regulatory authority is studying the possibility to eliminate the exception from imbalance payments for incontrollable electricity generation.

Other types of support:

- For investments over € 1 million, a new Investment Law will allow different incentives such as tax exemptions and co-finance of the connection to the network. The law is under discussion, but the same support can be obtained without the new law, under the State aid rules, according to the regulations issued by the Competition authority. The approval of the Competition authority on a case by case basis will be needed even after the new Investment Law will be approved.
- A mandatory take-off of the electricity produced from eligible sources (RES without the exception of large hydro and efficient cogeneration) – called priority generation is used on the competitive wholesale electricity market. The priority production scheme uses a pricing of electricity at imbalance costs, which are usually lower than DER generation costs.

Recommendations

- Improve the TGC scheme by raising the price limits and by giving some certainty to investors regarding the recovery of investments
- Introduce a penalty that is significantly higher (e.g. 50% above) the maximum TGC price to motivate suppliers to buy TGC
- Set ambitious targets until 2020, so that a stable environment for investors is created.

3.7 Slovakia

The support mechanism in use in Slovakia for renewable energy and CHP is represented by a fixed feed-in price. Regional energy utilities purchase this electricity from electricity producers based on a certificate of origin of electricity from renewable sources. DSOs purchase the electricity for this fixed price for the coverage of internal losses in the distribution system.

The *Regulatory Office of Network Industries* (RONI) determines the fixed price for generation of electricity produced from renewable energy sources and CHP. This fixed price of electricity is determined for the year 2008 as the fixed price with the assumed payback period of investment of 12 years. The level of support is determined so that it covers production costs of the producer with the specified payback period of investment.

The duration of support has not been so far limited and it was legalised for the first time by the regulatory office Decree No. 2/2005 with the date of effect since the year 2006. The fixed price is determined separately every year again.

Fixed prices are determined for the following categories of renewable energy technologies:

- Hydro power with an installed capacity up to 5 MW
- Solar energy
- Geothermal energy
- Biomass combustion
- Co-firing of biomass or waste with fossil fuels
- Biogas combustion

And for the following categories of CHP technologies:

- Combustion turbine with combined cycle plant and electric capacity up to 50 MW
- Combustion turbine with heat recovery
- Combustion engine
- Backpressure steam turbine and condensing steam turbine with heat extraction
- Stirling engine
- Fuel cell
- Rankin organic cycle

Every year the issued number of applications for the issuance of certificates on origin from RES and CHP plants is increasing and naturally, the installed capacity of those generating stations has a rising tendency. The specific financial relations are recorded by the Regulatory Office; however, such data are not made available.

The Ministry of Economy of the Slovak Republic in co-operation with the regulatory office and other specialised institutions is drafting a new Act on Renewable Energy Sources. Changes are expected also in relation to amendments made to the Energy Act, based on which the regulatory office will be able to determine the fixed prices of electricity from individual types of RES for a longer period of time, compared to the present situation. The fixed price is now determined separately for every year.

DER integration issues
Long-term practical experience with DER exists in the field of small hydropower plants and co-generation plants. With regard to such plants no serious negative effects on the power system are known yet. The present scope of installed capacity and production from other renewable energy sources (wind, solar) is rather small, so their likely negative effects do not appear to a large extent in the system. It is expected that the development with regard to the extension of especially wind parks will be carefully controlled and directed in order to prevent any larger problems that these plants could cause to the system, if their installed capacity increases.

Barriers and future developments
The main barriers to the growth of DER shares are so far:
- Missing long-term stable conditions in the system of feed-in tariffs from RES. Due to missing guarantee of fixed purchase price, banks are reluctant to finance RES projects.
- The missing obligation to purchase electricity from RES and its binding character in law represents a large barrier for further development.

In its Program Declaration for 2006–2010 the Slovak government has committed to establish preferential conditions for increased utilisation of renewable energy sources. In this regard, according to the strategic document of Ministry of Economy SR (issued in 2007), the following legislative measures are considered to be taken:
- To establish the obligation for distribution companies to preferentially purchase electricity generated from RES and in CHP to cover losses in the distribution system. (At present there is only the provision in the electricity market rules which sets this obligation for the DSO).
- By law, to deal with the long-term guarantee of fixed feed-in prices – fixed prices are calculated under the assumption of a 12 year payback period of investment, the validity of the fixed price should also be guaranteed for this period of time (but which is not the case now).
- When installing the equipment using RES with an installed capacity above 5 MW, to issue a certificate on the compliance of the investment plan with the long-term energy policy.
- To simplify the legislative conditions for the producer of electricity from RES using the equipment with the capacity up to 5 MW in relation to business activities and permits for the construction of generating stations.
- To determine, by law, the right for preferential access into the system for the producer of electricity from RES.

- To extend the regulatory period for price regulation imposed on electricity generation from RES by more than 7 years.

One of the possibilities of supporting the higher use of RES could be the amendment made to valid legal regulations that would enable the regulatory office to also determine minimum prices for individual types of RES, when imposing price regulation on electricity generated from RES. These would have to be determined so that:

- The conditions were established to increase the share of electricity generated from RES in total electricity consumption,
- The average payback period of investments (12 – 15 years) was achieved under the condition that the technical parameters and economic effectiveness are fulfilled.

Recommendations:

- The RONI has to set a long-term guarantee of fixed feed-in prices at 12 years (based on the payback time stated in the Regulatory Office Decree).
- In the longer term, feed-in premiums should be considered.

3.8 Slovenia

The predominant type of support for renewable energy in Slovenia is the feed-in tariff. The system allows the producers that are eligible for support to sell their electricity at these feed-in tariffs or, alternatively they can also sell electricity at the market. In the later case they are entitled to a premium, which represents the difference between the subsidised and market-based prices (top of the market price).

On the basis of calls investment support is available to electricity producers producing from renewable sources (in the frame of Ministry of the Environment and Spatial Planning). Calls include support for: use of renewable sources in households, use of biomass and preparation of the documentation for use of renewable sources. For example, a call in 2007 included investment support for installation of PV systems in households. The maximum funding was limited to 2.5 €/Wp and to € 2100 for the whole system.

Other initiatives aimed at increasing production from renewable sources include:

- The RECS certificate system - a way of certifying the production of electricity from renewable sources.
- Guarantees of origin of electricity from RES and cogeneration facilities.
- Obligation to publish the structure of production sources.

The average price for households (annual consumption of 3500 kWh) in 2006 (without tax) was 8.75 €ct/kWh. The average price for an industrial customer (annual consumption of 50 MWh) in 2006 (without tax) was 11.23 €ct/kWh.

The support is regressive: after 5 years of operation the support is reduced by 5 % and after 10 years by 10 %. The Government of the Republic of Slovenia determines the purchase prices for all types of qualified producers at least once per year.

Table 3.13 – Feed-in tariffs in Slovenia

Source	Rated power	Feed-in-tariff (€ct/kWh)	Top of the market price (€ct/kWh)
Hydro power stations	P ≤ 1 MW	6.1	2.4
	1 MW < P < 10 MW	5.9	2.2
Biomass power stations	≤ 1 MW	9.4	5.6
	> 1 MW	9.1	5.4
Wind power stations	≤ 1 MW	6.0	2.3
	> 1 MW	5.9	2.1
Geothermal power stations		5.9	2.1
Solar power stations		37.4	33.6
Other power stations using renewable sources		12.1	8.3
Power stations using wastes	P ≤ 1 MW	5.3	1.6
	1 MW < P < 10 MW	4.9	1.2
CHP power stations (district heating)	P ≤ 1 MW	7.3	3.5
	1 MW < P < 10 MW	6.9	3.1
Industrial CHP	P ≤ 1 MW	7.1	/

Impact on DER growth

The total production from DER (excluding large hydro) is low (3.6 % of total consumption in 2006) therefore is difficult to estimate the influence of FIT.

The growth of production is relatively slow, also due to the growth in consumption (3.5 % growth in 2006/2005). The new acquired DER in 2006 have the installed power of approx. 4 MW. With such a slow growth it will be difficult to meet national targets.

Data regarding the costs of the FIT system are not available. However, the total production from DER in 2006 was 468 GWh and taking into account that most of the DER are small hydro (FIT of 6.15 €ct/kWh) we can estimate an approximate amount of support. I.e. 468 * € 61458 = € 28.8 million.

The system operator of the network to which a DER facility which is eligible for support (i.e. excluding large hydro) is connected has to buy all the electricity produced in the facility. This may maximize DER profit, but a conflict with actual network conditions may arise (e.g. in cases of low consumption).

Due to the relatively low production share of DER it does not influence network operation on a larger scale. There are some cases of local system operational problems (voltage levels, protection operation).

Barriers

The main barrier of the Feed-in tariff system is the length of the contract. Electricity purchase at guaranteed prices from qualified producers is defined on the basis of 1 to 10 year contracts. In practice this contracts are shorter than 10 years making investments in some renewable sources less attractive.

Recommendations

- Consider a longer FIT period. Today, tariffs are agreed for maximally 10 years, while for some DER sources a longer period of support is needed.

3.9 Main findings

The overview of support schemes in the eight countries mentioned above shows the following:

- All new Member States have introduced support schemes
- Poland and Romania have introduced a Renewable Portfolio Standard with quota obligations, all other countries Feed-in Tariffs
- In those countries with feed-in tariffs in place the duration is in the range of 10 to 15 years
- All countries, except Lithuania have included support for CHP also. Support differs per country and is usually limited to small-scale CHP (up to 5 MW).
- So far only Hungary was able to meet its 2010 RES target.

Although support has primarily been introduced to support new investments in DER, market interactions have been covered in a no. of countries also.

- In two countries, Czech Republic and Slovenia, there is a choice between FIT and premiums.
- Differentiation per time of day for controllable DER in the Czech Republic and Hungary
- Bulgaria: stepped tariffs for wind energy
- Czech Republic: choice between fixed tariff or green bonus every year
- Hungary: tariffs are not technology but IRR specific. All technologies receive the same tariff, but the duration differs.
- Mandatory reporting of planned production of DER, in Hungary (all), Czech Republic (controllable DER > 1 MW) and Romania (controllable DER) sanctions exist for deviation
- Special regime for small DER (< 500 kW) in Hungary
- Slovakia, support for DER not guaranteed. In other countries, DER investors have guarantee that support stays the same for the time tariffs exist. Indexation rules do exist for tariffs for new investors in later years.

Experiences:

- The TGC in Poland has lead to the promotion of the cheapest options, little or no investments in new technologies.
- The level of support in Romania and Poland, the two countries with TGC is, however, similar to that in the countries with FIT (when comparing as % of energy prices).

4. DER SUPPORT IN THE EU15

DER support schemes of the SOLID-DER countries Austria, Denmark, Germany, the Netherlands and Spain have been assessed (having a feed-in tariff scheme) as well as those from Sweden and the United Kingdom (having a renewable portfolio standard combined with green certificates).

4.1 Austria

The predominant type of support mechanism used for DER in Austria is the Feed-in tariff (based on the *Green Electricity Act* (2002, amended in 2006). FIT are supporting small hydro power, wind, solid biomass, biogas, PV, geothermal as well as (already installed) fossil fuel based CHP. The Feed-in tariff exists of a flat price for green electricity and a premium for electricity from existing fossil CHP.

The duration of the support is:

- According to Green electricity Act 2002: 13 years
- According to Amendment 2006: small hydro 13 years, other RES sources 10 years (stable) + a lower rate for the 11th (75%) and 12th year (50%).

Tariffs are differentiated per type of DER sources (not per time of use or voltage level) and are annually adjusted. The absolute level of support is given in tables 4.1 and 4.2.

Table 4.1 – Feed-in tariff levels in Austria

€ cents/kWh	***2007***	***2006***
Small hydro	*3.3 – 5.95*	*3.8 – 6.3*
Wind	*7.54*	*7.55*
Solid biomass	*11.09 – 15.64*	*6.3 – 15.65*
Biogas	*11.29 – 16.94*	*7.9 – 16.95*
PV	*30 – 46*	*30 – 46*
Geothermal	*7.30*	*7.3*

Table 4.2 – Feed-in tariff in % of average market price (retail supply price without tax)

€ cents/kWh	***Average flat rate 1st HY 2007***	***in % of market price****
Small hydro	*5.58*	*128 %*
Wind	*7.76*	*177 %*
Solid biomass	*13.00*	*297 %*
Biogas	*13.80*	*316 %*
PV	*38.00*	*750 %*
Landfill- and sewage gas	*7.13*	*163 %*
Geothermal	*9.45*	*216 %*

* Average market price 47.73 EUR/MWh

Additional form of support is provided through:

- Investment support from the Environmental Investment Fund for:
  - Biomass CHP – for the heat related investment costs only;
  - Renewable electricity power plants (wind, hydro power, PV, biogas) for self supply or off-grid plants;
  - Small hydro power revitalisation resp. new installation in extreme locations up to a capacity of 2 MW;
  - Small fossil fuel based CHP.
- Investment support according to the Green Electricity Act Amendment 2006 for medium hydro power and new fossil CHP with a capacity of more than 2 MW

The following growth levels of DER (RES/CHP) can be noticed since support is in operation:

- 2002: 4,655 GWh supported green electricity
- Forecast 2007: 6.823 GWh (prognosis according to status quo Nov. 2006)
- Forecast 2008: 6.355 GWh (prognosis according to status quo August 2007)[19]

The share of electricity from renewable energy sources (except large hydro) currently amounts to around 8 %. In order to meet the 10 % target by 2010, there is an additional demand of around 1,300 GWh.

The total value (€) of support given through FIT in 2006 and for 2007 was (for all RES eligible for support):

2006: 219 Million €
2007: 286 Million. € (Prognosis)

DER integration issues

With the introduction of efficiency criteria for cogeneration (new plants) and the introduction of a premium for heat from cogeneration in 2006 the FIT should encourage optimal operation of DER in terms of environmental as well as economical aspects. Due to missing efficiency criteria for existing cogeneration plants, currently many biogas plants are operated uneconomically. An aid programme is currently under preparation.

A flexible tariff system taking into consideration base and peak-load has been proposed by the Ministry of Agriculture, Forestry, Environment and Water Management but is not included in the draft amendment of the green electricity act. Since the amendment from the Green Electricity Act in 2006, the DSO is obliged to purchase green electricity fed into the grid.

4.2 Denmark

The predominant type of support mechanism used for DER in Denmark is a feed-in tariff scheme. Both fixed feed-in prices as well as feed-in premiums are in place for the following RES and CHP sources:

- Feed in premiums are used for wind power onshore
- There is a tendering procedure for offshore wind parks. The off-shore price is for 12 and 14 years respectively in the two most recent tendered windparks.
- Feed in premiums also for new biomass based CHP a feed-in tariff of 80 €/MWh is guaranteed for a period of ten years, followed by 54 €/MWh for the next ten years.
- For biogas a FIT of 100€/MWh is fixed.
- For old onshore wind turbines there is a flat feed-in tariff. For the more recently installed wind power plants this has been changed to a premium.

Differentiation per time of use is considered but not yet existing. There is no voltage difference. Only small CHP can receive fixed FIT: CHP>5 MW only receives feed-in premium in case it is fuelled by biomass. PV support is based on net-metering

Apart from these feed-in tariffs, additional form of support is provided through:

- Compensation to wind turbines for their balancing costs (3€/MWh) for which they are responsible

[19] * a high share of small hydro power (and landfill and sewage gas power plants) will abandon the support scheme due to higher revenues on the market.

- Compensation to landowners which experience reduced property prices due to nearby installation of wind turbines.
- There are nearly no tax exemptions or investment support – the investment support for household biomass boilers was abolished recently. Only limited support exists for solar heating in new dwellings (up to 20% subject to a number of criteria)
- Priority access exists for small CHP (less than 5 MW)
- For small and medium scale CHP the support has been individually fixed for each existing plant for a period of up to 20 years.

The absolute level of support is the following:

- The two last tenderings for offshore resulted in 70 and 66€/MWh respectively, but only for the first 50.000 MWh. (12 and 14 years operation) The last tendering of Rødsand II was abandoned by both participants in the consortia due to the claim of rising turbine prices making the windpark uneconomical. (Investments elsewhere are more attractive). A renewed tendering resulted in a price of 84€/MWh corresponding to an increase of 27%.
- For onshore the premium for new turbines has been increased from 13 €/MWh + 3€/MWh balancing compensation to 33.6 €/MWh + 3€ compensation for the first 22.000 full load hours corresponding to 7-9 years production.

In % of average market price for consumers (retail supply price without tax) this means:

- Approximately 36.6€/114€ = 32% For the tendered off-shore the subsidy is up to 84€/114€ = 74%

For onshore turbines the subsidy covers 50-70% of production costs. For off-shore the price exceeds the expected costs.

With the political agreement in February 2008 the conditions for renewable energy has been considerably improved. Premiums have more than doubled and tendering for two additional windparks has been scheduled for completion in 2012 at expected prices above those reached in the Horns Rev II tendering.

Developments of DER

There was a very high growth prior to the reduction in FIT and very little since then – new growth expected with the recent increase in subsidy levels. For small and medium scale CHP the growth was high in the nineties with the three-step FIT, but has been very limited since then.

The support for increasing DER shares is intended for meeting the national targets.Energinet.dk had expenses of 230 million € for production subsidies in 2006, but this number was low due to the high prices on NordPool for this year. This reflects the fact that there it is still a large fraction of FIT and not premiums in the average subsidy scheme. For 2007 a figure around 350 million € must be expected. There is no maximum, consumers pays it all via the TSO tariff part.

DER integration issues

- The change from FIT to fixed subsidy to existing small and medium size CHP has improved the efficiency and functioning of the market. The tendency to dropping prices at low demand and high wind was reduced.
- The previous combination of wind and decentral CHP on FIT was inefficient in activating the flexibility of the CHP.
- New regulatory / policy actions foreseen: Better access to balancing markets for wind, use of heat storage, heat pumps in combination with CHP could increase the efficiency. (increase prices at times of excess wind)

4.3 Germany

Since the first adoption of the Renewable Electricity Feed-in Law in 1990, the predominant type of support mechanism used for DER in Germany remains the feed-in tariff. This Law was replaced by the Renewable Energy Sources Act (EEG) in 2000 and this Law has been amended in 2004. A recent Amendment in June 2008 will enter into force on 1 January 2009.

The EEG guarantees RES operators fixed tariffs for electricity fed into the grid for a period of 20 years. The fee paid depends on defined tariff in the year the equipment was installed.

The EEG includes a degression rate for the FIT paid, i.e. an annual percentage reduction. The degression for the various technologies is adjusted in each case to the technical learning curve. The amended EEG (2004) sets out the degression rate for all technologies.

Additional form of support provided:

- No special tax exemption but it can used as surplus investment which is counted as negative income for the system owner. Due to the fact, that most plants a build on loan this may leas to an overall tax reduction.

The Feed-in tariff is a flat price differentiated by technology. Table 4.3 shows the main tariff differentiation.

Table 4.3 - Feed-in tariff levels in Germany

Technology	Subcategory	Feed-in tariff (2007)	Degression rate
Wind power on land	Basic tariff	5.17	2%
	Increased tariff	8.19	
Wind power offshore	Basic tariff	6.19	2%
	Increased tariff	9.10	
Geothermal power	Below 20 MW	8.95	1%
	Over 20 MW	7.16	
Hydro-electricity	Micro HP – up to 500 kW	9.67	1%
	Micro HP – up to 5 MW	6.65	
Solar PV – not installed on buildings		37.96	5%
Solar PV – installed on buildings	Up to 30 kW	49.21	
	From 30 to 100 kW	46.82	
	Over 100 kW	46.30	
Biomass	Up to 150 kW	10.99	1.5%
	Between 150 – 500 kW	9.46	
	Between 500 kW and 5 MW	8.51	
	Between 5 – 20 MW	8.03	
	• *CHP bonus*	*2.00*	
Landfill / sewage gas	Up to 500 kW	7.33	1.5%
	Between 500 kW and 5 MW	6.35	

The growth of DER (mainly RES) has been significant to reach the national targets up to 2010. The share of electricity generated from renewable energy sources reached 14.2% in 2007 (up from 11.7% in 2006) but this is partly caused by higher than usual wind conditions last year. The national RES target of 12.5% for 2010 has, therefore, been met already.

Major changes are established with the amendment of the EEG by the first of January 2009 with other prices. The effect of this cannot be foreseen yet.

The total value of support given through FIT in 2006 reached € 5.8 billion. To come at the additional costs of renewable energy support, the avoided costs of conventional electricity supply has to be subtracted (€ 2.5 billion), coming to an additional cost of € 3.3 billion for renewable electricity support. The resultant surcharge payable for renewable electricity was 0.7 €ct/kWh in 2006, amounting to less than 4% of the average price of domestic electricity.

Figures for 2007 are not known yet but are expected to grow significantly due to the sharp increase of RES electricity production in that year.

4.4 The Netherlands

The predominant support mechanism for renewable electricity and renewable gas is a feed-in premium on top of the market price. According to a recent revision the premium is no longer a fixed amount per kWh over the project lifetime but rather it is varying with the electricity revenues. The original support scheme started in 2003 and has been suspended since august 2006. Since April 2008 it has been reopened again.

Additionally, some technologies can use tax incentives like (EIA – deduction of corporate tax) and green fund financing (via income tax of individual investors). Guarantees of origin are issued but are used for the voluntary market[20].

The main driver has been to meet the EU target of 9% in 2010. There is no industry politics and employment has never been an issue on a national level. The current government launched an ambitious 2020 plan for an energy and climate issues, but current budgets don't meet the targets realistically speaking.

Stepped premiums apply for wind onshore (based on production hours) and waste incineration (based on plant efficiency).

Wind, waste incineration and solar PV are to receive 15 years of support; bioenergy options are set to 12 years.

The actual premium varies with the realisation of the electricity revenues. The subsidy base is the ex-post financial gap based on average production costs which are fixed for the duration of the project. So at the start of the project, one knows that during the support period each year the subsidy will be

- Base Value fixed t=0 -/- Correction Value measured t=x

The following categories are eligible for support, but the budget available for new projects is reconsidered on a yearly basis. For RES-E the categories are:

- Wind offshore
- Land fill gas, Industrial waste water and Municipal waste water
- Anaerobic digestion of biomass with animal manure
- Anaerobic digestion various
- Solid biomass thermal conversion < 10 MWe
- Solid biomass thermal conversion 10 - 50 MWe
- Liquid biomass thermal conversion < 10 MWe

[20] Guarantees of origin for the voluntary market concern RES-E already paid for by the government through the support scheme. As such it is double counting, doesn't help initiate additional projects and has an adverse effect on public support for extending the renewable energy share

- Liquid biomass thermal conversion 10 - 50 MWe
- Waste incineration
- Solar-PV 0-3.5 kWp
- Solar -PV 3.5-15 kWp
- Solar -PV 15-100 kWp

Table 4.4 – RES feed-in premiums in the Netherlands (2008) (base value -/- correction value)[21]:

RES Category	**€cent/kWh**	**Remark**
Wind onshore	3,6	Based on 2200 full operating hours per year+
Land fill gas / Industrial waste water and municipal waste water	0	
Biomass: Anaerobic digestion of biomass with animal manure Anaerobic digestion various Solid biomass thermal conversion < 10 MWe Solid biomass thermal conversion 10 - 50 MWe	6,2	Based on 8080 hours of total production per year. Is equal to 3880 hours per year of *renewable* electricity production*
Waste incineration	-0,6-1,6	With steps dependent on efficiency
Solar-PV 0.6-3.5 kWp	33	

+ subsidy is recalculated for 1760 hours to account for bad wind years. However, between 1760-2200 hours the subsidy is not enough to compensate for less wind market revenues. Less wind hours are considered as operational risk for the wind unit operators.
* It is assumed that only a part of the total biomass production is really green (the environmental advantage is calculated). Therefore green electricity will be produced only in a part of the operating hours.

Exemptions:
- The RES categories liquid biomass, thermal conversion of solar energy and Solar-PV categories > 3.5 kWp are not subsidized at the moment.
- Also wind-offshore and co-firing of biomass are excluded from the subsidy scheme: no base values are calculated.

Some remarks with regard to the correction values:
- Correction values include in many cases the relevant realised year-averaged day-ahead electricity price. For example for PV the correction is coupled to the consumer price.
- Besides the costs for imbalance and program responsibility are part of the correction values for the category wind onshore. These costs are set on 11% of the baseload day-ahead (APX) market prices. These balancing and program responsibility party costs thus increase the market premium.
- In the future also the influence of a lot of wind supply on day-ahead prices may necessitate an upward correction of the subsidy amount (profile factor, at the moment zero influence is measured and therefore no correction takes place).

Feed-in premiums for CHP are still not decided upon. The categorisation of CHP eligible for subsidies is not yet clear. The new subsidy scheme for CHP is currently being devised with definitive categories and feed-in premiums being available during the *second half of 2008*.

DER developments

[21] Please note: in the table the total of base value -/- correction value is showed. Normally the correction is ex-post. The amount of subsidy in the table contains the best ex-ante estimation of the correction value for 2008, since the support scheme is only recently put in place and consequently no ex-post correction values are available.

It is unclear yet if the new feed-in tariff system will be sufficient in meeting the national targets. This depends on large scale co-firing which is in turn dependent on the price of biomass fuel at the time of operation. This is a large uncertainty since the Netherlands has considerable co-firing electricity production.

In the period 2003-2006 (representing start and ending of old MEP system of fixed feed-in premiums) a total of € 1456 million was spent, which included € 320 million for CHP.

For the coming years:

- The yearly budget for RES-E/CHP will evolve from € 10 mln in 2008 to a structural €336 mln per year from 2014 onwards. The total budget over the whole period will be €1,4 billion.
- Apart from that, every separate technology category has a 'budget ceiling'. Since the support is laid down in 10, 12 or 15 year long contracts the category budget ceilings exceed yearly budgets.
    - The ceiling for wind on land is €796 mln,
    - waste incineration has a ceiling of € 187 mln,
    - Land fill gas, Industrial waste water and Municipal waste water: € 10 mln,
    - Biomass: 289 mln,
    - Solar PV € 46mln.

The differentiation in feed-in premiums is purely based on fuel/technology/size combinations and stepped feed-in approaches apply to waste incineration and to wind onshore. There is no differentiation for peak and /off peak production, not any other differentiation for network characteristics.

DER integration issues:
The Netherlands currently face some problems with DER integration on the transmission level as well as on the distribution level. Periodically, the Netherlands have to cope with the way the German system is designed. If there is RES production in the North of Germany, the inverse load is transferred through German/Dutch interconnectors. Furthermore, sometimes uncontrolled operation of DER (wind and CHP) enlarges system operational problems, as was the case in the aftermath of the interruption on 4 November 2006, when uncontrolled DER made it difficult for system operators to re-establish the normal system conditions.22

At the moment, there is one problem known at distribution level. New wind and CHP production, subsidized under the old subsidy scheme, is now put into operation and is experiencing some limitations in providing energy to the grid due to restrictions in transformer capacity from distribution networks to transmission networks in two regions. This is strongly linked to the connection of several large power plants to the grid in the coming years, the limited capacity of the transmission network and the procedure of connection by the TSO. At the moment the connection policy is under scrutiny of the responsible Ministry of Economic Affairs. The Ministry announced to consider priority access for renewables and CHP. Apart from that, it is important to recognise that the rise in CHP production is only minor driven by the support mechanisms.

Power producers are responsible for day-ahead predictions for production (so-called programmes). The TSO predicts consumption and real-time balances it with production. When producers generate more than they proposed, this potentially leads to imbalance and the TSO has the right to incur a penalty on this (depending on the problem it causes).

Typically, wind producers are confronted with the highest degree of unpredictability. Most producers 'sell' the program responsibility to the utility for around 0,4 to 0,8 ct/kWh (i.e. 10-15 % of the spot market price). A number of utilities have a portfolio of different generating options

[22] UCTE (2007), Final report - System disturbance on 4 November.

in varying locations and are able to better predict/mitigate deviations between program/realisation. To them, imbalance costs are typically smaller.

4.5 Spain

The main support mechanisms for DER in Spain are price-based. DER generators have two options to sell their production; they can either receive a feed-in tariff or a feed-in premium over the market price. In the latter case, a cap and floor mechanism has been introduced for some technologies, i.e. if the market energy price plus the premium is higher or lower than some fixed values, the energy produced will be remunerated at those cap and floor values instead of the market price plus the premium. As a result, the generator is protected against low market prices whereas excessive payment is prevented when high market prices occur. The concerning regulation is *Royal Decree 661/2007* from May 2007.
Moreover, a tendering scheme has been designed to off-shore wind farms and regulated by Royal Decree 1028/2007. However, the tenders have never been called yet. This would happen as follows: when a RES producer is willing to build an off-shore wind farm in a specific location, the tendering process is opened. Bids would consist of a feed-in premium to receive during the whole lifetime of the installation subject to certain technical requirements. The maximum value for the bids is set at 8.43 c€/kWh and a cap at 16.40 c€/kWh.

Due to high energy prices in 2005 and 2006, most of the largest renewable and CHP generators (>10 MW) have selected the market price option. In June 2007, these generators accounted for 20% of total market sales including 96% of total wind power.

In addition to FIT and feed-in premiums, every DER receives an incentive or a penalty for keeping their power factor between certain limits that is expressed as a percentage, between -4% and 8% of a fixed value in terms of €/kWh. These limits are set for three different time periods that are peak, off-peak and valley.

Moreover, CHP plants are economically incentivized to operate at high efficiency. This incentive is calculated as a function of the minimum efficiency requirements, the actual plant efficiency and the per-unit cost of the primary fuel of the plant.

The main driver to fix the level of support has traditionally been the level of development costs of each technology and its relation with the targets set at national level. The recently passed *Royal Decree 661/2007* (RD) was necessary to modify certain aspects of the DER regulation. In this RD, the level of DER FIT and premiums was modified due to the abnormally high market prices of the previous years which made excessive the remuneration for these generators.
The FIT and premiums are held all along the lifetime of the installations, although they do not remain unchanged throughout it. In most cases, they both have two differentiated tariff periods (e.g. 0-15 years, 15 years onwards) that vary from one technology to another. An exception is made in the case of wind power and biomass or biogas powered plants, where the premium over market price is removed after 20 and 15 years, respectively.

FIT and premiums are reviewed either quarterly, for cogeneration plants powered by fossil fuels but coal; or annually, for the rest of technologies. This review is made on the basis of the RPI (*retail price index*) evolution and the prices of the primary fuel used. Furthermore, a review is made after every four-year period. Differentiation is made between different technologies and primary fuel consumed. In the following table the whole classification is detailed.

Table 4.5 – classification of DER in Spain

Group a	Cogenerations or any other installation powered by waste energy		
	a.1	Cogeneration plants	
		a.1.1	Natural gas powered CHP
		a.1.2	Fuel-oil, diesel-oil or LPG powered CHP
		a,1,3	Biomass or biogas powered CHP
		a,1,4	Other CHP
	a.2	Plants powered by a waste energy coming from a process or machine whose purpose is different from electricity and/or mechanic power generation	
Group b	Electricity production from RES, biomass or biofuels		
	b.1	Solar plants	
		b.1.1	Photovoltaics
		b.1.2	Solar thermal power
	b.2	Wind power	
		b.2,1	On-shore wind power
		b.2.2	Off-shore wind power
	b,3	Geothermal,wave or tidal energy powered plants	
	b.4	Hydro smaller than 10MW	
	b.5	Hydro between 10MW and 50MW	
	b.6	Biomass from energetic crops,forestry residues or green areas prunes	
	b.7	Biomass from animal farming, biofuels or biogas	
	b.8	Biomass from industrial processes	
Group c	Plants powered by other different fuels with poor calorific value (E.g. Municipal Solid Waste)		

Co-firing of biomass and/or biogas is included within group b.6, b.7 and b.8, and therefore receives support. This support is only applicable to the proportional share of electricity production attributable to biomass/biogas measured over total primary energy consumption. Nevertheless, co-firing of biomass/biogas will not be considered to compute to the fulfilment of RES targets.

Differentiation of tariffs
Only CHP and plants powered by means of biomass, biofuels or residues that chose the FIT alternative (no market access) may opt to a time-of-use (ToU) differentiation. Being this the case, they would be paid a slightly higher FIT during peak periods, and lower than usual FIT while at off-peak hours. In addition, the year is divided into winter and summer days, coinciding with the official date of change of time.

No specific differentiation is made by voltage level at connection point. However, this factor can be implicitly taken into account when segmenting by the size of the plant and kind of technology.

Table 4.6 - FIT and premiums structure in 2007 for most common DER technologies (€ct/kWh)

Technology	Power Range	Start year	End Year	FIT	Premium	Cap	Floor
Windpower (on-shore)	No differentiation	0	20	7,32	2,93	8,49	7,13
		20	Onwards	6,12	0		
PV	P≤100 kW	0	25	44,04	N/A		
		25	Onwards	35,23			
	100 kW<P≤10 MW	0	25	41,75			
		25	Onwards	33,40			
	10<P≤50 MW	0	25	22,98			
		25	Onwards	18,38			
CHP (Natural Gas)	P≤0,5	After 10 years, an age correction is applied that depends on the installed capacity		12,04			
	0,5<P≤1			9,88			
	1<P≤10			7,72	2,78		
	10<P≤25			7,31	2,21		
	25<P≤50			6,92	1,91		

DER development

Despite the fact that rates of growth have been quite uneven for the different technologies, the share of DER has been growing since the support started. During 2006, nearly 19% of the demand was met by DER and in June 2007 more than 22% of the energy sold at the electricity market had this origin.

The following figure shows the evolution of the installed capacity for the main DER technologies, up to September 2007.

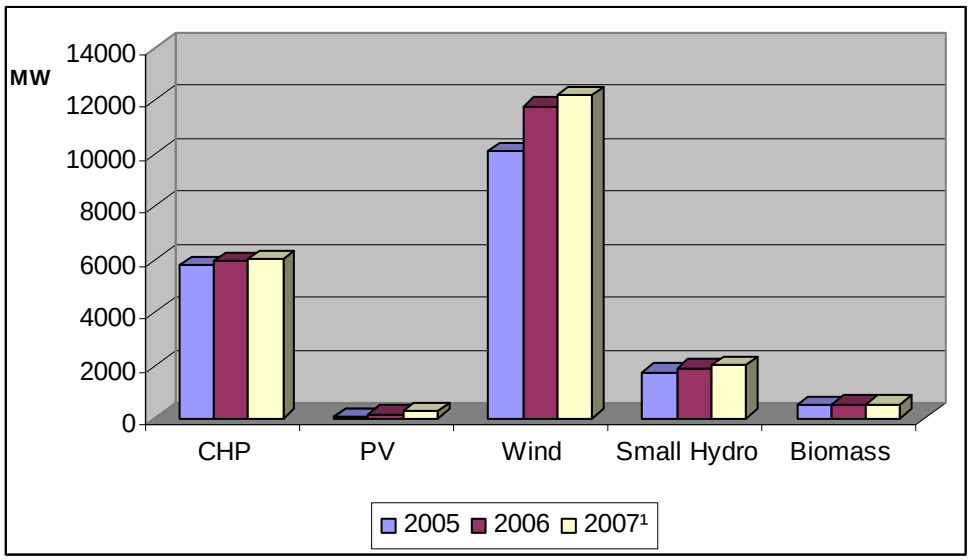


Figure 4.1 - Evolution of the installed capacity for the main DER technologies in Spain

The CHP development was slowed down by the increase in the fossil fuels prices and the fact that their remuneration was not related to the fuel costs until RD 661/2007 was passed on May 2007. In the case of biomass, the main problem lies in the poor development of the technologies, market and logistics necessary to ensure an adequate supply of fuel to the installations. Moreover, small hydro plants usually encounter administrative barriers and difficulties to find new locations. On the contrary, wind and photovoltaic power installed and energy produced have been steadily rising, favoured by the regulatory support.

The target share of RES over gross electricity demand indicated by EU Directive 2001/77/EC for Spain amounted to 29.4%. In 2006, RES accounted for 21% of total electricity production in Spain: 9.4% large hydro, 8.5% wind, 1.5% small-hydro and 1.6% other sources. This share is expected to increase, mainly thanks to solar technologies, CHP and wind power.

At national level, the targets were set as a value of installed capacity for each RES technology. The same was made for CHP. These targets and the accomplishment levels are shown below.

Table 4.7 - DER targets in Spain

	Installed capacity 09/2007[MW]	*Target for 2010 [MW]*	*Percentage achieved*
CHP	6.345	9.215	69%
PV	375	371	101%
Solar thermal power	11	500	2%
Wind power	12.852	20.155	64%
Wind power (repowering)	0	2.000	0%
Hydro =< 10MW	1.329	2.400	55%
Solid Biomass	392	1.317	30%
Biogas	180	250	72%
Municipal Solid Wastes	271	350	78%

Some technologies seem to be able to reach, or at least get very close, to the national targets with slightly higher growth rates. This is the case of wind power, PV or biogas. On the other hand, others have a significant capacity installed but are far from achieving the proposed level of development, such as CHP, small hydro or biomass. Finally, solar thermal power has not developed as it was expected and there are hardly a few MW installed that correspond to pilot plants.

In 2006, the support for DER amounted to around € 1642 million, which corresponds to more than 9% of total electricity costs in 2006. DER selling at the market (premium) accounted for approximately 74% and sales to the DSO (FIT) accounted for around 26%. The high percentage of generators that decided to sell at market price plus a premium can be explained by the high energy prices at the spot market in the preceding years.

DER integration issues
The premium on the top of the market price is seen as a more efficient incentive than the constant feed-in tariff. Generators receive the market price signal as a good indicator of the value of the energy at each hour of the day. However, the constant premium still can distort the efficient behaviour of some generators. For instance regarding controllability for system balancing, a generator will not offer a bid to decrease its output, if that is required by the system operator, because the incentive it receives for every kWh supplied is very high.

Small CHP and biomass, biofuels or residues plants under a FIT scheme can benefit from a time-of-use differentiation precisely to maximize the social value of their production.

Energy programs and system unbalances
At the moment, all DER units higher than 10 MW or group of RES/CHP connected at the same network node with a total installed capacity higher than 10 MW should be part of a generation control centre to talk with the system operator in order to follow dispatch and control orders. All of them should present a production program for the next hours. Under constant feed-in tariffs, DER generators are allowed to deviate 5% without any penalty. Generators under premium on top of the market price have the same obligations as ordinary generators regarding production programs and energy unbalances. Aggregation is allowed to minimize program unbalances. The limit capacity which obliges to participate in a generation control is expected to reduce from the current 10 MW to just 5 MW.

4.6 Sweden

In Sweden a “renewable portfolio standard” (RPS) with green certificates has been in place since May 2003. The system comprises wind, solar, biomass, geothermal and small hydro along

with peat based CHP. Electricity suppliers (i.e. companies distributing electricity to end users) are required to purchase electricity certificates corresponding to a certain proportion of the electricity that they sell, known as their *quota obligation*. In order to fulfil their obligations, the suppliers are required to submit an annual return to the Swedish Energy Agency with details of the amount of electricity that they have invoiced to their customers during the previous year, together with certificates corresponding to a certain proportion (quota) of their sales. These returns are required by not later than the 1st of March each year. In addition to electricity supply companies, the requirement to purchase a certain proportion of certificates (i.e. a quota obligation) also applies to electricity intensive companies and to electricity users who have used electricity that they have themselves produced, imported or purchased on the Nordic electricity exchange.

The Swedish renewable energy obligation is presently set at 15.1 %, and will be increasing to 17.9% in 2012. The increase in the goal has come into force at the 1st of January 2007 with the aim to further stimulate RES development. The goal is an additional renewable generation of 17 TWh from 2002 to 2016. Up to 2006, 5.7 TWh of this was accomplished.

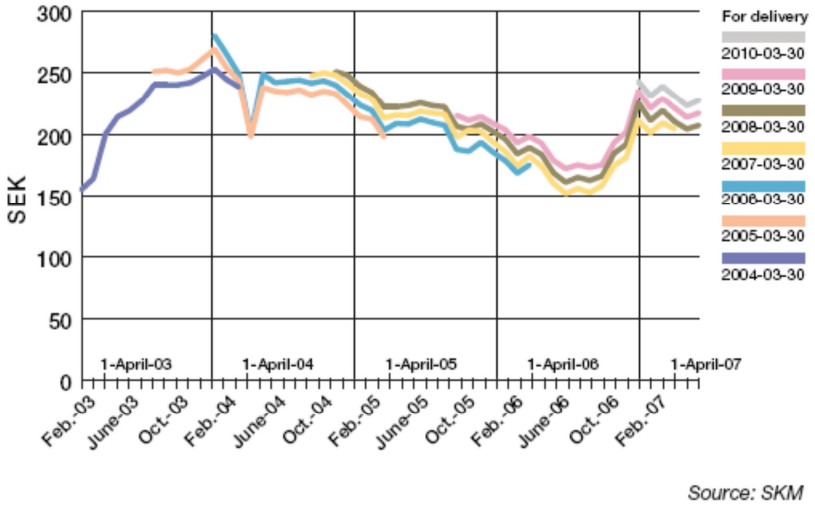
A penalty (quota obligation charge) is included and is fixed at 150% of the average price in a year. This corresponds to approximately 30€/MWh in 2007. For the first years of the system the penalty was capped at low levels and thereby served as a cap to the certificate prices. This resulted in an under fulfilment of the targeted quota (77% fulfilment in 2003).

The large electricity intensive manufacturing industries are wholly or partly exempted from the quota obligation. For 2006 the exempted industries amounts to 40 TWh corresponding to 29% of total consumption. Revisions in the number of exempted companies and rules for exemption qualification is under consideration.

The certificate trading scheme is complemented by targeted support for wind power production in the form of an *environmental premium tariff*: 6.5 öre/kWh (7 €/MWh) for onshore wind; and 15 öre/kWh (16 €/MWh) for offshore wind for 2006. This will be progressively phased out by 2009 for onshore wind.

DER development

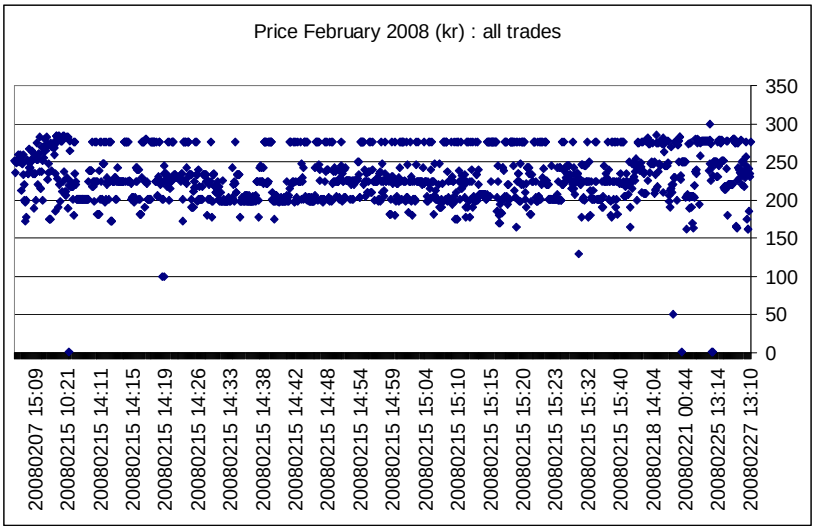
Prices for certificates have dropped in the last years and were at 21 €/MWh in the first half of 2007.



Source: Swedish Energy Agency 2007

Figure 4.2 - Certificate prices 2003-2007

The graph shows the development in Swedish kroner with a gradual reduction of price from the beginning of 2004 after the first increase and until the end of 2006. From then there was an increase up above 200 SEK (equivalent to 21.5€/MWh). The forward contracts also reveals the cost of carrying forward the certificates and probably some slight risk premium as the excess of accumulated certificates is being reduced.



Source: Swedish Energy Agency, 2008

Figure 4.3 - Certificate prices in February 2008 (SEK/MWh)

Figure 2 illustrates that trade takes place at very different prices even though average price develops gradual. This reflects the different nature of the contracts, where some are based on long term agreements and previous agreed prices for transactions. Volumes are also not reflected in this graph. The upper line reflects a price level correspond to the expected penalty, whereas the low prices seems unexplainable.

In Sweden the certificate system has been followed by an increase in the cheap renewable options mainly in biomass. In 2006 the share of biomass was 70.7% with an additional 4.6% from peat. Wind only contributed 8.1% to the production of certificates.

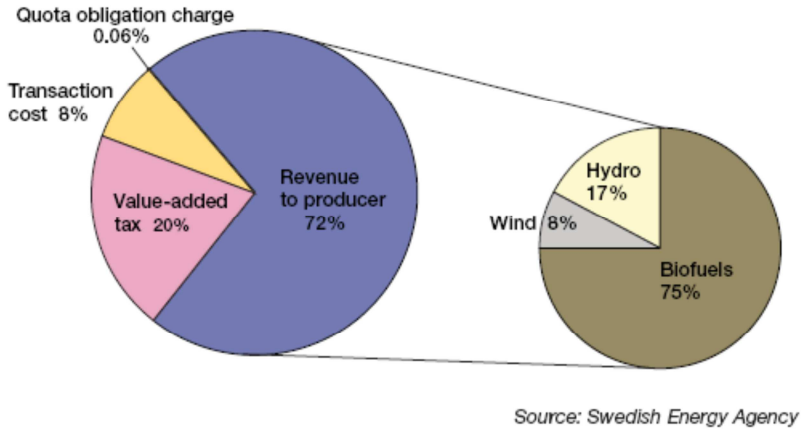


Figure 4.4 – Estimated breakdown electricity consumers' costs for electricity certificates (2006)

As a majority of the renewables is related to biomass used in larger electricity plants the generation of certificates will be specifically dependent on these larger plants. This introduces the

problem of adjustment of quotas at the time of phase-out of these larger plants. In Sweden this has been solved by reducing the quota drastically at the time of phase out from 17.9% in 2012 down to 8.9% in 2013. This creates a bit of uncertainty in the expectations as there might occur changes to these phase-out plans. The reduction is intended to result in a smooth development in new renewable generation capacity, but it is difficult so set the adequate quota level in order to reach this goal. In reality the target of a quota for renewables has been abandoned relative to a target of new renewable generation capacity.

4.7 The United Kingdom

In the UK renewable electricity is strongly supported by a renewable portfolio standard (Renewables Obligation) with mandatory supply of renewables alongside several grant programmes. Renewables are an important part of the climate change strategy and as such renewable energy is exempt from the Climate Change Levy (CCL).

4.7.1 The Renewable Obligation Certificate scheme in the UK

The main support mechanism for renewables is the Renewables Obligation (RO) that was introduced in April 2002. The obligation requires energy suppliers to source an annually increasing percentage of their sales from renewable sources. The generators of renewable electricity receive a Renewables Obligation Certificate (ROC). The ROCs are tradable between suppliers but they are only valid in one period.

The renewable target to be achieved by the UK in 2010 from the RES-E Directive is 10.0% of gross electricity consumption. Under the Renewables Obligation (RO) targets have been set out to 2015 (excluding large hydro): 10.4% in 2010, increasing by 1% per year to 15.4% in 2015. This target has been guaranteed to remain at least at this level until 2027. An aspirational target of 20% RES-E in 2020 has been asserted. In Energy White Paper (Dti 2007), the government mentions an aspiration to get about 20% of total electricity supplies renewable in 2020. See Table 4.7 for further details.

Every year the suppliers have to provide certificates for cancellation and in the case of non-compliance pay a penalty (a buy-out price). The buy-out revenues paid by electricity suppliers for non-compliance are recycled back to the suppliers in proportion to the number of certificates they used for complying with the obligation. This mechanism increases the incentive to hold Renewable Obligation Certificates (ROCs) and increases the ROC price above the buy-out price because the market is short. High prices in the first year gave the ROC market a kick-start. A medium-term target has been specified for 2016 and duration of the scheme is guaranteed until 2027. This provides long-term security for achieving targets and for renewable energy investors. The ROC minimum buy-out price has been gradually reduced. The buy-out price in 2006/2007 was 33.24 £ per MWh.

The RO requires electricity suppliers to supply an increasing percentage of electricity from RES (excluding large hydro) until 2016-17, although the RO will remain in place until 2027 Electricity suppliers meet their obligation:

- by surrendering Renewables Obligation Certificates (ROCs) to the electricity regulator Ofgem as evidence of renewable electricity generation;
- by paying the non-compliance ‘buyout’ price; or
- by a combination of the two.

ROCs are issued for every 1 MWh of eligible renewable electricity generated from an accredited generating station. Separate ROCs are issued to generators in Scotland (SROCs) and Northern Ireland (NIROCs), but the three types of certificate are fully tradable and all can be used by any electricity supplier for compliance with the RO.

The buyout price is adjusted annually in line with retail price index. Payments are fed into a buyout fund that is recycled annually to electricity suppliers in proportion to the number of ROCs they surrendered in the compliance period. This provides an added incentive to meet the obligation by holding ROCs and keeps the trading price of ROCs above the buyout price (see table below for buyout price and indicative "worth" of ROCs).
Annual compliance periods run from 1 April one year to 31 March the following year. ROC auctions are held quarterly. In the April 2006 auction over 261,000 ROCs were purchased at an average price of £40.65 (the lowest price for any lot was £40.60).

Table 4.8 - The original obligation targets, buyout price and ROC prices

<table>
<tr><th rowspan="2">Year</th><th>Targets</th><th colspan="2">Non-compliance buyout price</th><th>Amount recycled (Eng and Wales)</th><th colspan="2">Total "worth" of ROC (Eng and Wales) (buyout + recycle)</th></tr>
<tr><th>% supply (consumption target)</th><th>£/MWh</th><th>€/MWh*</th><th>£/MWh</th><th>£/MWh</th><th>€/MWh*</th></tr>
<tr><td>2002-03</td><td>3</td><td>x</td><td>x</td><td>x</td><td>x</td><td>x</td></tr>
<tr><td>2003-04</td><td>4.3</td><td>30.51</td><td>44.24</td><td>22.92</td><td>53.43</td><td>77.47</td></tr>
<tr><td>2004-05</td><td>4.9</td><td>31.39</td><td>45.52</td><td>13.66</td><td>45.05</td><td>65.32</td></tr>
<tr><td>2005-06</td><td>5.5</td><td>32.33</td><td>46.88</td><td colspan="3" rowspan="12">Not yet known</td></tr>
<tr><td>2006-07</td><td>6.7</td><td>33.24</td><td>48.20</td></tr>
<tr><td>2007-08</td><td>7.9</td><td colspan="2" rowspan="10">Increases in line with retail price index</td></tr>
<tr><td>2008-09</td><td>9.1</td></tr>
<tr><td>2009-10</td><td>9.7</td></tr>
<tr><td>2010-11</td><td>10.4</td></tr>
<tr><td>2011-12</td><td>11.4</td></tr>
<tr><td>2012-13</td><td>12.4</td></tr>
<tr><td>2013-14</td><td>13.4</td></tr>
<tr><td>2014-15</td><td>14.4</td></tr>
<tr><td>2015-16</td><td>15.4</td></tr>
<tr><td>Duration</td><td colspan="6">One ROC is issued to the operator of an accredited generating station for every MWh of eligible renewable electricity generated with no time limitations.</td></tr>
<tr><td>Guaranteed duration of obligation</td><td colspan="6">The Renewables Obligation has been guaranteed to run until at least 2027. Supply targets increase to 15.4% in 2015, and are guaranteed to remain at least at this level until 2027.</td></tr>
</table>

* Exchange rate used £1: €1.45

In the UK there are quarterly spot-market auctions run by the Non-Fossil Purchasing Agent, but volumes traded are small (about 1.5% of annual certificates issued, notwithstanding that this may reflect re-trading of an even smaller number of certificates) and declining. The majority of certificates are generated and retired within vertically integrated utilities, while a smaller but still sizable amount is brokered on terms that are not generally observable.
In a review of the RO (Dti 2006), Dti noted the problem of a very low liquidity on the ROC market. Measures aimed at increasing liquidity were suggested and implemented afterwards resulting in a somewhat higher liquidity in recent years. There is no central exchange for ROC, but Ofgem holds a register of all issued ROCs and suppliers can bilaterally trade ROCs among each other. Some suppliers delegate trade in ROC to private agencies, such as the Non-Fossil Purchasing Agency Ltd (http://www.nfpa.co.uk). The auction trades the acquired ROCs on a quarterly basis.

Compliance with the RO was about 69% in 2004/2005, while the level of compliance was even lower in the previous years. Hence, the effectiveness of this instrument in achieving the set targets in the short run could be questioned.

Only certain renewable sources are eligible under the Renewables Obligation. These are:

- Landfill gas
- Sewage gas
- Hydro of 20 MWe net or less
- Hydro exceeding 20 MWe net commissioned after 1 April 2002
- Onshore wind
- Offshore wind
- Other biomass
- Geothermal power
- Tidal and wave power
- Photovoltaics

The following limits have been placed on biomass co-firing within the RO:

- From compliance period 2009-10 a minimum 25% of co-fired biomass must be from energy crops;
- 2010-11 minimum 50% of co-fired biomass must be from energy crops;
- 2011-16 minimum 75% of co-fired biomass must be from energy crops;
- After 2016 co-firing will not be eligible for ROCs.

4.7.2 Additional incentives and support for Renewables

Since 2002 RES-E has been exempt from the Climate Change Levy (CCL), which is a tax on electricity consumption (excluding domestic and transport sectors) of £4.30/MWh (6.26 €/MWh).

Guarantees of Origin (REGO) are issued by Ofgem, the British gas and electricity regulator, upon request from the producer. Consequently, a producer can receive three kinds of certificates: ROCs, Levy Exemption Certificates (LECs) from the CCL and REGOs.

Additional support is also provided through capital grant schemes and enhanced capital allowances (tax incentives) for investments in eligible energy technology plant and equipment.

Other support for specific RES

- Off shore wind project have been receiving capital grants by the DTI, with grants per individual project of approx. 10 million GBP, which is roughly equivalent to the costs of grid connection to the distribution system.
- For biomass there is the Bioenergy Capital Grants Scheme (about 66 million GBP) and the Energy Crops Scheme run by Defra.
- Solar photovoltaic power:
    - 10 million GBP committed to Domestic and Large Scale Field Trials for a diverse set of PV installations from homes to offices
    - Major Photovoltaics Demonstration Programme (PV MDP) with 31 million GBP capital grants in 2002-2006

- CHP: Defra (2004) sets out the government strategy to achieve 10 GWe of CHP capacity in 2010 and mentions the following support measures:
    - Fiscal Incentives:
    - Climate Change Levy exemption on fuel inputs to Good Quality CHP and on all Good Quality CHP electricity outputs;

- eligibility for Enhanced Capital Allowances to stimulate investment;
- Business Rates exemption for CHP power generation plant and machinery;
- a reduction in VAT on certain grant-funded domestic micro-CHP installations;
- a Government announcement to possibly reduce VAT on micro-CHP.

4.7.3 The level of support compared with end user prices

The average electricity price for domestic end-users was about GBP 80-100 in 2006 (BERR 2007). Other end-user prices (industrial) are also reported in BERR (2007). The ROC price of GBP 33.24 amounts to about 33-42% of average market price for consumers.

Table 4.9 – Costs of DER technologies in the UK

Technology	Cost in GBP per MWh	Level of support in GBP per MWh	%
Hydro <1,25 MW	84	33	39%
Hydro 1,25 – 20 MW	67		49%
Hydro >20 MW	77		43%
Sewage gas	63		52%
Onshore wind	40		83%
Offshore wind	75		44%
Landfill gas	45		73%
Solar PV	555		6%
Tidal	108		31%
Gasification of MSW	159		21%
Biomass - standalone	66		50%
Biomass - cofiring	27		122%

Source: Enviros (2005)

In 2007, the price of a Renewables Obligation Certificate moves around the 40 GBP per MWh. The general trend is that ROC prices have been declining from 54 GBP per MWh in 2004 to 45 per MWh in 2006, and 40 GBP per MWh in 2007 (€58). In 2006, the wholesale electricity price was quite volatile and moved between 45 and 90 GBP per MWh, but on average the level was about 65-70 GBP per MWh.

4.7.4 Major issues and the resulting development of RES

The following remarks can be made to the support fore renewable energy and CHP in the UK:

- The targets for the obligatory supply are set up to 2027, ensuring long-term demand for RES-E.
- High targets and the redistribution of buy-out revenues make RES-E investments economically viable.
- The certificate system mainly develops the lowest cost technologies and does not stimulate new promising technologies like wave, tidal or PV.

- New measures were introduced as of 1 April 2005 to secure the buyout fund in the event of a shortfall occurring. These are surcharges on late payments and mutualisation. This was done to address the uncertainty in the ROC market when the buyout fund resulted short during the first compliance period due to the credit standing of two important electricity suppliers.
- Grid connection issues and severe competition on the electricity market disadvantage RES-E despite of the support programmes.
- No direct disadvantages are noted. However, it has been argues that due to the diverse forms of support it is difficult to find out the possible level of 'oversubsidization'

Since the start of the RO scheme, the level of renewable electricity has been growing[23]. The figure below shows the development of renewable electricity capacity. Total electricity generation from renewables in 2006 amounted to 18,133 GWh, an increase of 7.5 per cent compared to 2005. The main contributors to this substantial increase were:

- 1,072 GWh from onshore wind (+43 per cent),
- 248 GWh (+62 per cent) from offshore wind
- 134 GWh (+3 per cent) from landfill gas and
- 119 GWh (+12 per cent) from municipal solid waste combustion.
- There was no increase in co-firing of biomass with fossil fuels and
- a 350 GWh decrease (-8 per cent) in large scale hydro generation which can be attributed to drier weather.

Only 23% of generation from renewables was from large scale hydro in 2006 compared with 26½ % in 2005. Hydro (taking both large and small scale together) remains the most important renewables technology in output terms closely followed by landfill gas and wind (both onshore and offshore), with the co-firing of biomass the next most prominent. In 2006, 25 % of the electricity generated from renewables was from hydro sources, 24 % from landfill gas, 23 % from wind, 14 % from co-firing, and 13 % from other biofuels.

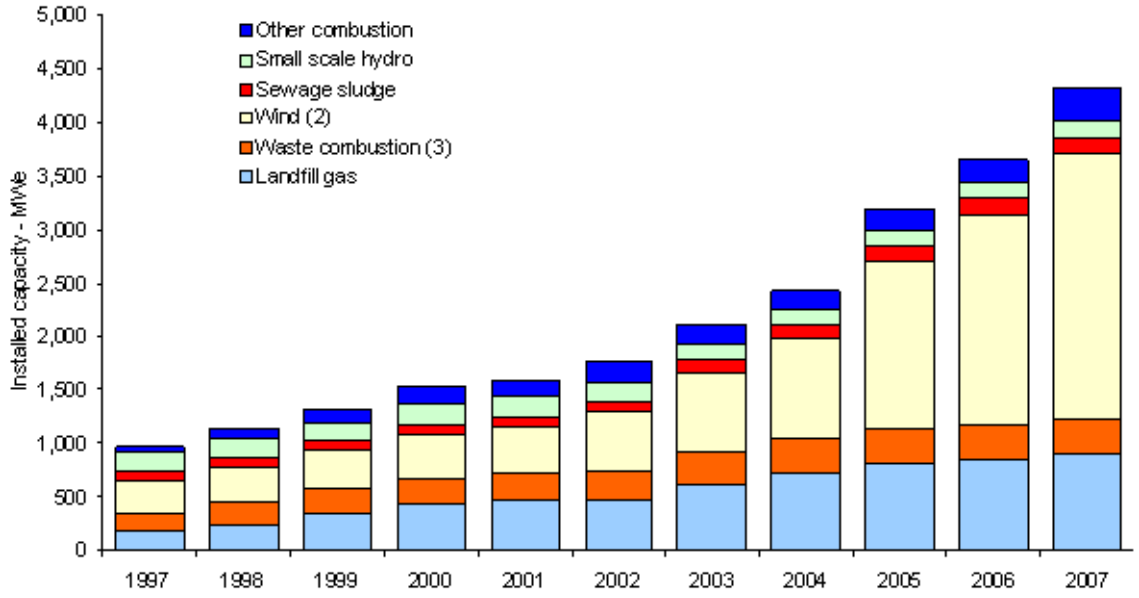


Figure 4.5 – Renewable energy capacity development in the UK[24].

[23] Source: http://www.restats.org.uk/

[24] Large scale hydro capacity was 1,359 MWe in 2007. Wind includes both onshore and offshore and also includes solar photovoltaics (14.3 MWe in 2007) and shoreline wave (0.5 MWe in 2007). All waste combustion plant is included because both biodegradable and non-biodegradable wastes are burned together in the same plant.) Source: http://www.restats.org.uk/

There are no major changes expected in the support for renewables. In 2007, a consultation was held on possible reforms of the RO containing only limited number of small adaptations[25].

4.8 Main findings

The main difference between support in the EU15 and the support in new member states is that the first have far longer experience with renewable energy support.

Countries like Austria Denmark Germany and the Netherlands have changed their forms of support at least once or twice in order to find a more optimal support scheme that on one hand does create a stable environment for investors, but on the other hand does not create too much of a financial burden for society. Moreover, different methods for market and network integration are applied already.

Good examples are the fact that DER operators are responsible for balancing in the Netherlands and Denmark and the price mechanism Spain has introduced for keeping the power factor in certain limits.

Another general development that can be seen is the gradual move from fixed feed-in prices to premiums as can be seen in Denmark. The Netherlands have introduced feed-in premiums since 2003 already. Spain provides the possibility for choice between premiums and fixed prices. Given the relatively high electricity prices, the majority of DER operators has in recent years chosen for the feed-in premium. Austria has still fixed feed-in tariffs, but is considering introducing time of day tariffs.

Germany seems to stick to fixed feed-in tariffs (also in the amended Energy Efficiency Law for 2009), but does provide a fixed degression rate for RES technologies each year, taking into account technological developments and anticipating on lower investment costs per kW installed.

A specific case is Denmark. Here very favourable tariffs existed for wind energy and CHP until 2001/2002. This has led to an enormous increase of DER capacity. Since then tariffs have been decreased, almost leading to a standstill of new capacity. Since a few years, conditions have become more favourable again for DER operators. At the same time a tendering scheme has been introduced for offshore wind energy.

A certain risk for long duration of support may be oversubsidisation. E.g. the UK several additional support programmes exist next to the Renewables Obligation. For Denmark, oversubsidisation has already been the reason to substantially decrease support a number of years ago.

[25] For details see http://www.berr.gov.uk/consultations/page34162.html

5. COMPARISON OF SUPPORT SCHEMES IN THE EU

In this chapter the different support schemes per country are compared and general recommendations are given for their possible adaptation for situations with increased DER shares. A schematic overview of support schemes in tables is given in section 5.2.

5.1 Assessment of support schemes

In this assessment of support schemes there have been no attempts to recommend feed-in tariff schemes instead of tradable green certificates or vice versa. Both types of support are considered as two given systems. Within each of these schemes, however, there is a possibility for improvement, especially with increasing DER shares. As some countries provide additional forms of support, e.g. through investment support or tax exemptions, the complete picture is a little bit more complex. This also makes an explicit choice for FIT or TGC less appropriate.

5.1.1 DER technologies supported

In the 14 countries studied, support is provided to the following renewable energy sources (see also figure 5.4):

- Biogas combustion, mostly biogas gained through anaerobic digestion (e.g. manure), in some countries support is also provided to landfill and sewage gas.
- Biomass combustion, concerns solid wood matter and agricultural waste. Some countries support also power production through waste incineration.
- Co-firing of biomass in fossil fuel fired power plants (usually in combination with coal)
- Geothermal energy
- (Small) hydropower
- Solar energy
- Tidal and wave energy
- Wind energy (onshore and offshore)

Furthermore, several countries provide support to combined heat and power.

Table 5.1 – DER technologies supported

Source – RES	Country	Remark
Biogas combustion*	BG, CZ, DE, HU, LT, PL, RO, SK, SI, AT, DK, NL, ES, SE, UK	For some countries, the same tariff applies to landfill and sewage gas also
Biomass combustion	ALL	
Co-firing of biomass	CZ, HU, PL, SK, ES	
Geothermal energy	BG, CZ, DE, HU, LT, PL, RO, SK, SI, AT, ES, SE, UK	
Hydropower (small)	BG, CZ, DE, HU, LT, PL, RO, SK, SI, AT, ES, SE, UK	The definition of small-scale hydro differs per country and is between 5 and 20 MW.
Landfill and sewage gas	AT, DE, NL, UK	Identified as specific category in these countries
Solar energy	BG, CZ, DE, HU, PL, RO, SK, SI, AT, DK, NL, ES, SE, UK	
Wave or tidal energy	ES, UK	

Wind energy onshore	ALL	
Wind energy offshore	DK, DE, NL, UK, ES	DK has a special tendering scheme for off-shore wind
Waste incineration	HU, SI, NL, ES	
CHP (fossil fuel based)	BG, CZ, DE, HU, PL, RO, SI, SK, NL, ES	Usually limited to small-scale CHP (e.g. 5 MW)

* through anaerobic digestion (e.g. manure)

From the table it is clear that some types of renewable energy are only supported in countries where there is a technical possibility (e.g. wind energy offshore or tidal energy in coastal areas). Practically all countries support electricity production using the following technologies:

- Biogas combustion
- Biomass combustion
- Wind energy
- Solar energy (with the exception of Lithuania)

Co-firing of biomass is only supported in a limited no. of countries. This is also the case for power production through waste incineration.

5.1.2 Predominant support category

Of the 17 countries studied here, 4 have introduced a quota obligation system with green certificates (UK, Sweden, Poland and Romania).

The other 13 countries have introduced feed-in tariff schemes. Feed-in tariffs can be split into:

- Fixed feed-in prices – per kWh a fixed tariff is applied. As a result, the revenue for the DER operator remains constant for the duration of the support.
- Feed-in premiums – per kWh a fixed bonus is applied on top of the market price. As a result, the total revenue of the DER operator changes with changing electricity prices on the market.
- Or a combination, where DER operators have the choice between fixed tariffs or price premiums.

Table 5.2 shows the support given in each of the country. In addition, Denmark and Spain have introduced a tendering system for offshore wind power.

Of the old EU 15 member states, Denmark and the Netherlands have introduced a feed-in premium, Spain gives investors the choice to opt for fixed feed-in tariffs or for premiums. Austria and Germany have introduced only feed-in tariffs. Of the new EU12, the Czech Republic and Slovenia have introduced feed-in premiums next to the fixed feed-in tariffs. The other countries only have fixed tariffs.

Table 5.2 - Predominant type of support given

Country	Support scheme	Recommendations
Poland, Romania, Sweden, UK	Quota obligation combined with tradable green certificates	Evaluate effectiveness of the scheme
Austria, Bulgaria, Estonia, Germany, Hungary, Latvia, Lithuania, Netherlands, Slovakia,	Feed-in tariffs	Introduce feed-in premiums
Czech Republic, Slovenia, Spain.	Feed-in tariffs or feed-in premiums	Gradually move to feed-in premiums only
Denmark, the Netherlands	Feed-in premiums	Evaluate effectiveness of the scheme

Feed-in premiums provide incentives to produce electricity at times that it is most wanted. Therefore, taking into account the need to integrate increasing DER shares into national and European electricity markets a price premium is recommended instead of a fixed price. This could be introduced gradually:

- Countries having a fixed feed-in tariff only should consider to introduce feed-in premiums as an alternative for DER operators
- Countries with both feed-in tariffs and feed-in premiums should gradually move to feed-in premiums only
- When having feed-in premiums only, there remains the need to annually update the tariffs (for new projects) taking into account developments on the electricity markets. E.g. with increasing electricity prices feed-in premiums may decrease.

5.1.3 Tariff level and duration of support

At the moment one cannot say that the level of support for renewable energy in the EU15 is higher than in the new Member States. All countries that have put in place feed-in tariff/premium support have based this on a certain return on investments and this usually corresponds with the duration of the support.

Natural circumstances for operation of some DER technologies greatly differ between countries, and this is especially the case for wind energy and solar energy. This is the reason why the return on investments for wind energy greatly differs between countries and this leads to situations that support provided for wind energy is lower in Denmark (located at the coast) than in e.g. the Czech Republic (a landlocked country). Denmark has better natural conditions for wind energy and therefore tariffs for operation of wind power can be lower.

TGC versus FIT/premiums

Comparing support level between feed-in tariff systems and TGC shows that on average they are comparable. Some countries have lower average TGC prices, others higher.

According to the information in chapters 3 and 4 the lowest TGC prices are in Sweden (slightly above € 20/MWh). In Romania they are already twice as high (around €40/MWh) and support through TGC is comparable to that in countries with FIT when taking TGC prices plus electricity prices into account. TGC prices in Poland are even higher (around € 55/MWh). In the UK they are comparable, at least for the year 2007 (€ 58/MWh), but they have been much higher between 2004 and 2006 (in the range of € 65 – 78/MWh).

Based on this information it is not possible to say that a TGC system is more cost-effective ("cheaper") than a feed-in tariff/premium scheme. TGC prices are based on market prices and in case of the UK, they have been often higher than the average feed-in premiums in other countries. TGC prices are usually depending on market developments, its demand (quota obligation) and supply (investments realised).

Duration of support

In countries with feed-in tariffs/premiums the duration of support usually varies between 10 to 15, with some exceptions to support given for 20 years (e.g. Denmark, Germany, Spain). Duration of support is very country specific and depends very much on return on investments per technology per country.

In countries with TGC, there is a demand for these certificates as long as there is a target that is equal or higher as the amount of renewable energy (or CHP energy) produced. This means that in countries with TGC, the scheme is in place as long as a national target exists (e.g. in Sweden up to 2016 and in the UK up to 2027).

Recommendations:
The tariff level of feed-in tariffs / premiums is usually based on an IRR calculation. The result is a tariff that is provided for a number of years (with a certain indexation). Some general recommendations for tariff levels can be made:

- Provide stabilised support for fixed number of years
- Consider lower tariffs after certain period of time. Especially for wind power plants, stepped tariffs
- Recalculate tariffs every year for new projects (keeping into account changes in price of technology)

5.1.4 Differentiation of support

Support can be differentiated by a number of aspects. The following can be considered:

- The choice between feed-in premium or fixed price
- Differentiation by technology
- Differentiation by time of day (peak and off-peak hours)
- Stepped tariffs based on annual operation (e.g. lower tariff after no. of full load hours for wind energy) or different (usually lower) tariffs after a certain no. of years.
- Mandatory reporting of production level in advance – if not meeting expected production sanctions in the form of lower tariffs can be provided
- Other differentiations, such as based on network level of connection or location.

Differentiation of support is interesting to study as it may influence the way increasing DER shares integrate in the electricity market and interact with the electricity network.

Feed-in premium or fixed price
Of the EU 15 Member States, Denmark and the Netherlands have introduced a feed-in premium, Spain gives investors the choice to opt for fixed feed-in tariffs or for premiums.
Of the new Member States, the Czech Republic and Slovenia have introduced feed-in premiums next to the fixed feed-in tariffs. The other countries only have fixed tariffs

Differentiation by technology
All countries that have introduced feed-in tariffs or premiums have differentiated per technology, usually meaning different tariffs per technology. Only Hungary has chosen a different form. Tariffs are the same for each technology only the duration differs, based on different return on investments (calculated by the regulatory authority according to a standardised methodology).

Differentiation per time of day
This is another differentiation that can be applied. Spain has introduced different time of day tariffs for RES based CHP, the Czech Republic and Hungary have done this for controllable DER (CHP and small hydro). Austria is considering differentiating tariffs per time of day.

Stepped tariffs
Stepped tariffs have been introduced in a few countries, meaning different levels of tariffs during the duration of support. Examples are:

- Slovenia has a regressive tariff system, meaning that after 5 years support is reduced by a few percent and after 10 years again.
- Bulgaria has stepped tariffs for wind energy, meaning that tariffs are lower after 2150 hours of utilisation.

The main reason for including stepped tariffs is to prevent overcompensation for DER.

Mandatory reporting of production

Mandatory reporting has been introduced for (controllable) DER in a no of countries. These are the Czech Republic, Hungary, Romania, Denmark, the Netherlands and Spain.
Mandatory reporting is only effective from a network point of view when it is combined with financial incentives, e.g. lowering feed-in prices / premiums for the given period with x% in the case of significant deviation.

Such sanctions may bring an extra burden to DER operators, but with increasing shares of DER, they might become necessary. Therefore, stepwise introduction is recommended that could take place in the following way:

- Introduce mandatory reporting for controllable DER
- Introduce mandatory reporting for intermittent DER (with lower sanctions than for controllable)
- Introduce mandatory reporting for all DER (with sanctions being the same).

Other (additional) ways to cope with this reporting / balancing task is the following:

- State that all DER operators should become member of a balancing group (e.g. example Hungary). Hereby balancing responsibility is split into a large group of operators
- Sell the balancing responsibility (e.g. NL → programme responsibility) to third parties. This could mean that DER operators sell their electricity at slightly lower prices, covering the risk of unbalance.

Recommendations for a new feed-in premium scheme
Feed-in premiums provide incentives to produce electricity at times that it is most wanted. Therefore, taking into account the integration with the market, a price premium should be recommended instead of a fixed price.

Another alternative, with keeping fixed prices in place, but attempting to improve the integration of DER to the electricity market could be the option to have fixed-feed-in prices with:

- Time of day tariffs (e.g. separated in peak and off-peak)
- Stepped tariffs (e.g. for wind energy – when more operational hours as the average in the country, tariff can be x% lower)
- Mandatory reporting of expected production

In case a feed-in premium is used, time of day and stepped tariffs may not be needed as the market environment usually determines the most optimal time of production. Mandatory reporting should be included, however.

Feed-in premiums do have one disadvantage over fixed feed-in prices, the risk of creating over subsidisation may be higher. When electricity prices increase DER operators receive higher revenues, as the premium is usually fixed for a certain time. Premiums are usually fixed for single projects to guarantee a certain certainty for investors (e.g. in cases with lower electricity prices). In times of higher electricity prices this may (temporary) create a situation that DER operators can cover their (marginal) costs by selling electricity only, and receive a subsidy on top of that.

Nevertheless, an important reason for having premiums instead of fixed tariffs is that, in the latter case, DER remains separated from the electricity market, even when higher shares of DER are realised. Introducing premiums has the main advantage that DER is taking part in the electricity market and is less considered as power generation having a special treatment.

Other differentiation
To improve network integration, other ways to differentiate feed-in tariffs are also (theoretically) possible. Examples could be to differentiate tariffs per voltage level or location, taking into account the burden for the network. This is not applied in any of the countries and is not recommended for the following reasons:

- It would make calculation of feed-in tariffs/premiums very complex, probably creating too much of an administrative burden
- Within Deliverable 1.1, recommendations are given related to Use of System (UoS) charges for DER operators. These charges could be differentiated by location or voltage level. The advantage of this system is also that revenues from these charges are directly transferred to the stakeholder (the network operator) in need for these revenues.

5.1.5 Additional support provided

Most of the countries in the overview provide additional subsidies through investment subsidies or tax reductions.

The new member states have introduced so-called operational programmes, where investment subsidies can be gained for renewable energy paid out of European structural funds. In the EU15 Member States support is usually given through tax exemptions or tax deductions.

Table 5.3 – overview of additional support provided

Country	Support scheme	Recommendations
Czech Republic, Hungary, Lithuania, Poland	Investment support (paid out of operational programmes)	Provide only temporary support for specific technologies
Netherlands	Tax deduction (from investments)	Provide only temporary support for specific technologies
United Kingdom, Netherlands	Tax exemption for renewable energy	Provide tax exemption only for consumption

A no. of countries provide investment support in combination with the dominant form of support, this is feed-in tariff/premium or green certificates. These additional forms of support have usually been included to support investments in a certain form of technology.

Having more types of support in place for renewable energy brings a certain threat of inefficiency of the different support schemes. For an investor it is attractive to be able to receive both investment support as well as operational support. It is questionable, however, if this support is cost-effective in the long-term. Therefore, the following recommendations are made:

- Provide only temporary (additional) support to promote a specific technology
- Return to only providing operational support.

A different case is for tax exemption for energy produced from renewable energy sources. In the case of the UK (and other countries as the NL) tax exemption is provided for end-users, consuming electricity from renewable energy sources. It remains a production incentive, but provided to consumers, not producers. Therefore, it does not provide a double incentive to producers, it only creates demand on the market.

5.2 Support scheme schematic overview

Tables 5.4 gives a schematic overview of support provided in each of the EU Member countries studied. Tables 5.5 and 5.6 look in more detail to feed-in tariff schemes and tradable green certificates.

Table 5.4 - Overview of RES-E support in the new MS

	Support category	Additional support or taxes	Level of support (€/MWh)*	% of market price	Years of support provided
Bulgaria	FIT	-	40 - 85	200 - 300	12 yrs
Czech Republic	FIT (fixed tariff or premium)	Investment subsidies	60 - 100	200 - 300	15 yrs
Hungary	FIT + tendering for wind energy considered	Investment subsidies	100	200	Until return on investments is yielded
Lithuania	FIT	Soft loans, exemptions from pollution tax	58 - 70		Until 2020
Poland	TGC	RES exempted from excise tax	53 (average TGC price)	180-200%	Targets until 2014
Romania	TGC	-	41 (average TGC price)	± 175%	In place until 2012 (soon until 2020)
Slovakia	FIT	Investment subsidies	60 - 90	110 – 364%	Should be 12 yrs, but no guarantee
Slovenia	FIT	CO2 taxation non RES	50 - 70	140 - 200	10 yrs
Austria	FIT		55 - 140	130 – 300	10 – 13 yrs
Denmark	FIT (premium)		16 – 70 (wind) 54 – 80 (biomass)	115 – 160 140 – 180	20 yrs
Germany	FIT		52 - 130		20 yrs
Netherlands	FIT (premium)	Investment subsidies	36 - 62		12- 15 yrs
Spain	FIT (fixed tariff or premium)		70 - 120		15 – 20 yrs
Sweden	TGC	Feed-in premium for wind	21 (average TGC price)		Targets until 2016
United Kingdom	TGC	Investment subsidies, tax exemptions	58 (average TGC price)		Targets until 2027

*tariff for PV excluded in this range as it is significantly higher than tariffs for other DER sources

Table 5.5 - Overview of RES-E support characteristics in selected EU MS – Feed-in tariffs

	Support category	Differentiation by technology	Differentiation per time of day	Other differentiation	Remarks
Bulgaria	Fixed tariff	Yes	No	Installed capacity, stepped tariffs for wind power	
Czech Republic	fixed tariff or premium	Yes	Only for small-hydro and CHP	Possible to choose between green bonus and premium every year	Mandatory reporting of expected production for DER – except wind and solar)
Hungary	Fixed tariff	Duration of support is dependent on IRR	Yes, expect wind and solar	Longer duration of support for sources < 500 kW	Tendering for wind energy considered (above the 330 MW limit)
Lithuania	Fixed tariff	Yes	No	No	
Slovakia	FIT	Yes	No		
Slovenia	fixed tariff or premium	Yes	no		
Austria	Fixed tariff	Yes	No, but considered		
Denmark	Premium (tendering for off-shore wind)		No, but considered	Fixed tariff for old wind turbines	Compensation to wind turbines for their balancing costs
Germany	Fixed tariff	Yes	No		Fixed decrease of FIT rates for new RES each year in the range of 1- 5 %
Netherlands	Premium	Yes	No		All producers responsible for day-ahead projections
Spain	fixed tariff or premium (with cap and floor mechanism)	Yes	Yes, only RES-based CHP	Possible to choose between FIT and premium every year Depending on technology, level of support changes after a no. of years	DER units above 10 MW to be part of generation control centre + incentive for keeping power factor between limits

Table 5.6 - Overview of RES-E support characteristics in selected EU MS – Green certificate schemes

	Support category	Additional form of support	Average TGC price	% of market price[26]	Remarks
Poland	TGC	RES exempted from excise tax	53	180 – 200	
Romania	TGC	-	41	175	Mandatory reporting of expected production for controllable DER
Sweden	TGC	Feed-in premium for wind	21		Sanctions for not meeting obligation (150% of average TGC price)
United Kingdom	TGC	Investment subsidies, tax exemptions	58	140 - 220	Penalty revenues recycled back to suppliers

[26] Percentage gives electricity market price plus TGC price

5.3 Interaction between support schemes and network regulation

DER operators receive financial support for their production, but also have to face certain regulation, addressing connection to the network (connection charges) as well as use of the network (Use-of system charges). Deliverable 1.2a of SOLID-DER (Cossent, et al, 2008) provides for a detailed description of network regulation in all the SOLID-DER countries.

From a policy and regulatory point of view it is optimal to make a clear division between regulation and support. Financial mechanisms are provided to grant support to DER generation, network regulation is meant to streamline connections to networks and to regulate other issues related to network management.

From this point of view, both instruments can be treated completely separated as they have different objectives. It should, however, not happen, that support policy and regulation works against each other. Examples of such a situation are the following:

- DER is financially supported, but due to complicated and expensive network regulation (deep connection charges), procedures are lengthy and the costs of connection make projects not economically attractive.
- DER receives support and due to the obligation to connect DER under any circumstances, network companies face high costs they cannot earn back by calculating them in their network charges (regulation does not allow that).

For these reasons, a certain level of coordination is needed between support and regulation for DER. This coordinating role of streamlining support and regulation is an important task for the national energy regulator.

At the moment, DER operators pay for (network) connection charges and in some countries also for use of the network, i.e. so-called Use-of-System charges. It is clear that DER should pay network charges to provide them with economic signals that promote efficient operation (differentiation per voltage level, peak and off-peak production, etc.) and efficient location (network reinforcements needed).

To assess the adequacy of these charges, it is necessary to take into account what kind of support mechanism is in force in each country.

In Deliverable 1.2a (Cossent, et al, 2008) it has been recommended to implement UoS charges for DER in order to promote efficiency. However, where feed-in tariffs or premiums are used to remunerate DER, these can be used as a complement or a substitute to obtain the same results. Moreover, it is needed to charge or remunerate differently according to the voltage level of the period of time. For instance, those DER connected at low voltage level are better positioned to reduce energy losses and improve quality of service; especially where a more active management of the network is used.

Therefore, the following is suggested:

- DER should pay cost-reflective UoS charges, especially in those countries where flat FIT or quota obligations and TGC are applied.
- In case Feed-in premiums are applied, DER operators tend to produce electricity at times demand is high and mean less of a burden to the network. Nevertheless, also here UoS charges should be considered, but they can remain fixed (no differentiation per voltage level, time of day etc.).

Differentiation of feed-in tariffs based on network connection level

To improve network integration, other ways to differentiate feed-in tariffs are also (theoretically) possible and have been considered within SOLID-DER. Examples could be to differentiate tariffs per voltage level or location, taking into account the burden for the network. This means that the feed-in tariff the DER operator receives is dependent on the voltage level or location he/she is connecting to.

At the moment, this is not applied in any of the SOLID-DER countries and is not recommended for the following reasons:

- It would make calculation of feed-in tariffs/premiums very complex, probably creating too much of an administrative burden
- It is much easier to differentiate UoS charges by location or voltage level than feed-in tariffs. The advantage of this system is also that revenues from these charges are directly transferred to the stakeholder (the network operator) in need for these revenues.
- In a country with quota obligations and green certificates, such a system is not possible anyway. Therefore, this proposed system would be limited to certain countries only.

5.4 Conclusions

From the overview provided in this chapter, we can learn the following regarding feed-in tariff schemes:

- Feed-in tariff schemes remain the major support schemes in both old and new Member States
- Member states with longer experience have moved from fixed feed-in tariffs to feed-in premiums making the system more market based.
- Apart from differentiation in technologies, a differentiation per time of day is often included (both in countries with fixed tariffs as those with feed-in premiums.

The following can be concluded in countries with Tradable Green Certificates in place:

- Four countries have introduced TGC schemes. Costs for the TGC vary enormously, caused by the difference in low-cost RES potential in the countries (e.g. when comparing Sweden and the UK).

Both in countries with feed-in tariffs as in countries with TGC, additional investment support forms part of the DER policy.

Support schemes and network regulation serve different goals. Therefore, setting up / formulating both policy instruments is in principle a separate task, but coordination remains needed to prevent counteracting policy instruments.

6. CONCLUSIONS AND RECOMMENDATIONS

The overview from chapter 5 shows that a number of member states with increasing DER shares have already started to include economic efficiency signals in their support schemes for investment in DER based power production. Examples are the EU15 Member States Spain and Denmark and new Member States like Hungary and the Czech Republic. The following mechanisms can be observed:

- Differentiated time-of-day tariffs. Tariffs are higher in peak periods so that DER operators tend to produce in times that demand for electricity is higher (example Hungary).
- Providing feed-in premiums instead of fixed-feed-in tariffs, which also gives a market signal that leads to shift of production to periods of higher demand.
- Granting of support is combined with mandatory reporting of expected DER-E production. Not meeting these production volumes can lead to reduction of tariffs for a limited period of time (e.g. in the Czech Republic or Hungary for small hydro and CHP).

6.1 Policy recommendations

Recommendations regarding the support of DER in the power system should keep into account the following developments:

- Support for RES-E/DER, either in the form of feed-in tariffs or quota obligations have led to an increasing share of DER in almost all MS. To meet renewable energy targets for 2020, renewable energy support has to be continued in some form.
- Increasing RES-E/DER shares interact with the electricity network. Adequate changes in support schemes may improve the integration of new DER in the distribution (and transmission) networks.
- A further increase of RES-E/DER shares may become increasingly expensive for the overall system under some support schemes due to increasing system costs. To prevent this rise of costs to the consumer RES-E/DER, support schemes must become more market based and cost oriented.
- RES-E/DER will gradually have to be treated as conventional power production as regards its access to markets and networks. Priority access to networks and markets is a market distortion that is not desirable with high levels of RES-E/DER.
- With increasing shares, DER should gradually be exposed to market risk like every generator (but keep subsidies in form of feed-in market premium). Exposing DER to market risks is better for the electricity system than exposing DER to an artificial feed-in tariff system that does not have any relation with the system needs.
- With regards to financial support, this should be limited to an externality-corrective support. With increasing RES-E/DER, the external costs of fossil fuel based and nuclear energy will gradually decrease due to their decreasing shares. The marginal costs of power production will therefore gradually move towards the level of RES-E/DER, making lower support levels possible.

No specific recommendation for feed-in premiums or quota obligations are provided, as both systems can function in a market environment. Therefore, recommendations have been formulated for both Feed-in Tariff systems as Quota Obligations (with Green Certificates):

1. What is a cost-effective FIT?
2. What is a cost effective Quota obligation system?

6.1.1 Feed-in tariff system

Traditional forms of power production based on fossil fuels or nuclear energy come with some additional external costs (costs of pollution, costs of coal mining, storage of nuclear waste) that are not integrated into the market price of electricity. Without integrating these externalities, these forms of power production are cheaper than production based on renewable energies. Full integration of externalities is a complex task, although the introduction of the EU Emission Trading Scheme is first step in this direction. Emissions in the energy sector depend on the type of fuel used and the way this fuel is produced (e.g. oil, natural gas, coal, lignite or uranium). Consequently energy producers are more motivated to look for power production having the lowest CO2 emissions per kWh power produced. In this report we have, however, focused at (financial) support for DER only.

Many European countries have therefore chosen to create an *externality-corrective* distortion of the conventional power market by supporting DER, having no CO2 emissions per kWh produced (renewable energy) or provide at least a reduction through a better conversion efficiency (CHP). The result is that the share of renewable energy is increasing in most EU Member States (as shown in this report).

When the share of renewable energy is increasing, however, the traditional form of fixed feed-in tariffs (setting a fixed price for each RES kWh produced) is becoming less efficient from the point of view of market efficiency, network management and in the end also not from the point of (consumer) society. Therefore the introduction of the following elements of an optimal feed-in tariff scheme is proposed:

- Limit the distortion of the market by providing incentives to DER production mainly at peak hours, through:
    - Introduce feed-in premiums instead of fixed tariffs as the better match between supply and demand in the market, or
    - Introduce tariffs that differ per time of day (peak or off-peak hours)
- Support is a costly option, so *overcompensation* should be avoided. Consequently the following actions should be taken:
    - Due to a constant learning process experienced with different generation technologies (wind turbines, PV panels), production costs are decreasing over the years with a certain percentage, which means that feed-in tariffs can gradually be reduced.
    - Consider the introduction of stepped tariffs. .For instance for wind power– lower tariffs after a certain number of hours (e.g. 2000 full load hours per year) or
    - Lowering of the tariffs after 5/10 years of production for all DER categories.
- From the point of view of the network – as little interference as possible or support conflicting with an optimal network management is needed. This can be realised through:
    - Differentiate feed-in tariffs by time of use, avoiding production at times that power is not needed and has to be transported over large distances
    - Receiving support should be combined with mandatory reporting of expected power output by DER and some form of sanctioning if there is a variance with the actual production data with (let say) more than 10-20%.
- Last but not least, one still has to keep the interest of the DER operator in mind by creating stable investment environment with :
    - Support being stable for a number of years (either fixed tariff or premium) or using a fixed regression rate (a certain percentage) per technology for new projects (example Germany).
    - Making investments attractive (e.g. return period 10-15 years) to start investments in new DER sources.

6.1.2 Quota obligation systems

Quota obligations are a market based system that leads to investments in the cheapest form of renewable energy and is, at least theoretically, more efficient than feed-in tariff systems. However, quota systems are often viewed as being unreliable due to the large variability in the green certificate price experienced. Cost effective quota systems should include therefore some elements of banking and other restrictions that limit the variations in certificate prices. However these limitations must allow the certificate price to increase in order to give the necessary investment incentive to produce enough certificates to fulfil the quota obligations over the long term.

Also a significant penalty for not meeting the renewable energy quota has to be introduced. A too low penalty for not acquiring enough certificates will undermine the certificate market, both by removing liquidity and by excluding the financial transfers to renewable producers and thereby the main idea of the scheme.

An efficient quota obligation system would induce competition among certificate producing technologies. The result is that some technologies will dominate others in the supply of certificates. In some cases the experience of having biomass related technologies especially co-firing contribute a major part to the certificate market which has been seen as problematic. Technologies that require high upfront investments will not be supported as long as there exist low cost fuel-switch options. So first as the low cost options are fully exploited next the investment and capital intensive technologies as wind and later PV will be supported. If such an outcome is not wanted a certificate scheme system might not be the right solution and premium-FIT should be considered instead.

However it is possible to combine certificate schemes, as is demonstrated in Sweden, with the add-on premium to wind additional to the revenue from the certificates. This is a solution if this specific technology is seen as providing some additional value compared to other (e.g. biomass co-firing) technologies than just the renewable characteristics. The argument of higher costs of this technology should not be the only reason of providing this support.

An efficient system is also dependent on the independence of certificate producers from each other. If there are a few players supplying a major part of certificates the risk of exercising market power in this segment is important. Power markets integrated with other countries will limit the risk of market power in wholesale electricity, but as certificate markets are most often limited to individual countries there is a risk that consumers will be influenced by higher electricity prices from lack of competition in certificate markets even though wholesale electricity markets are competitive.

To have efficiently functioning certificate markets, a relative high degree of market liquidity is needed and therefore a considerable share of certificates (>25%) should be traded on the market. This could be a reason to enable trade of certificates between countries with such a system, increasing the certificate market.

Finally a cost effective certificate system should ensure that the renewable producers receive a major share of the additional costs that the final consumers are exposed to from the quota obligation. The transaction costs of the system, which for example energy suppliers receive, must be minimised. To achieve this, the volume of the certificate market and the amount transferred must reach considerable levels. In the Swedish system it is mentioned that 70% of the charged amounts from consumers is passed to the producers as incentive for investment, which is regarded as relatively successful due to the observation that only 8% is transaction costs and the remaining costs consists of mainly value added tax.

6.2 Conclusions

As both feed-in tariff schemes as well as tradable green certificates schemes are established in a number of European countries, no specific choice has been made for one of the schemes. Therefore, policy recommendations are split into specific recommendations for feed-in tariff schemes and tradable green certificates schemes.

The following policy recommendations are proposed:

- Countries with fixed feed-in tariff schemes should gradually move towards more market oriented systems such as feed-in premiums, providing a bonus for DER operators on top of the market price
- To ensure network integration, supported DER generation should meet other obligations of power system. This is mainly mandatory reporting of expected production.
- In countries having green certificate systems in place it is important to create a liquid market where not only low-cost options are realised → gradually increasing targets should lead to shift to other DER options
- DER should gradually be exposed to market risk like every generator (but keep subsidies in form of feed-in market premium or green certificates). Exposing DER to market risks is better for the electricity system than exposing DER to an artificial feed-in tariff system that does not have any relation with the system needs. Both feed-in premiums as quota obligation systems can provide this.

Harmonisation of support schemes

Given the increasingly ambitious renewable energy targets proposed by the European Commission (Energy & Climate Package 2008) a certain harmonisation of support schemes in Europe should be considered. For some EU MS it will be easier to reach this target than for others. The new directive will therefore provide the possibility to buy RES power abroad. To do this, a certain harmonisation of support schemes will be needed to reach more efficient exploitation of DER potentials EU wide. A specific choice for feed-in tariff schemes or green certificates is not recommended, however. Moreover, the proposed new RES-Directive does not give clear recommendations for the harmonisation of support schemes either.

Nevertheless, in the medium to long-term future, up to 2020 and beyond, a certain form of harmonisation may be preferable. Harmonisation of support scheme among the EU Member States should therefore mainly include the recommended items above:

- Introduce feed-in premiums in countries with fixed tariffs in place, so that basically one form of DER production support remains.
- Quota obligation systems theoretically provide the opportunity to trade green certificates between countries with such a system. This would be preferable in the long-term as to achieve a larger, more liquid market for green certificates. To achieve this, administrative procedures of each of the systems have to be streamlined to create equal conditions in each of the countries.
- Harmonise grid related issues, like the mandatory reporting of expected production. This should lead to streamlined conditions for DER generation in all EU Member States. This should prevent that DER investments only take place in those countries with the best subsidy scheme and without taking regard of the available potential in the separate countries.

Due to the different history of support schemes in the EU Member States, harmonisation is something that should be carefully planned, trying to achieve a certain streamlining of basic conditions of support but not endangering strong points of the single support schemes of Member States.

7. REFERENCES

Country questionnaires filled in by SOLID-DER partners for the following countries:

Bulgaria (BSREC), Czech Republic (Enviros), Hungary (MAKK), Lithuania (LEI), Poland (KAPE), Romania (BSREC), Slovakia (EGU), Slovenia (University of Ljubljana), Austria (Verbund), Denmark (Risoe), Germany (ISET), Netherlands (ECN), Spain (Comillas).

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Annex A: Definition of DER etc

What are Distributed Energy Resources?
Distributed Energy Resources are generally connected to the distribution network and therefore can be considered as an alternative notion to Distributed Generation, so both terms are interchangeable. According to the EU Electricity Directive distributed generation are all power plants connected to the distribution system. Each different type of distributed generation has, however, its own technical and commercial characteristics. Table 7.1 makes a distinction between large and medium/small-scale RES and CHP supply technologies. The medium and small scale-units of both RES and CHP sources are considered as distributed generation. There are three typical characteristics that distinguish DG from centralised large-scale generation:

- Distributed generation is connected to the distribution network (usually at voltage levels of 110 kV and lower) and is often operated by independent power producers, often consuming a significant share of power themselves. The large-scale units are connected to high voltage grid levels and operated by incumbent utilities (sometimes a joint venture with a large industrial consumer). DG has, as it is connected to lower voltage networks, to cope with a number of specific network issues that are of less relevance to centralised generation capacity.
- A second distinction is the location of the electricity supply. DG is usually generated close to the source and not so close to the demand site. Especially wind power is usually generated remote from the more populated regions. The consequence is that wind power plants are connected to weak (low voltage) electricity grids, i.e. grids with low consumption, having all kinds of impacts on the functionality of the distribution grid. Combined heat and power (CHP) is usually connected closer to the customer but often primarily sized to local heat demand and not to local electricity demand.
- A third aspect is the intermittent nature of electricity supply from RES and CHP. In contrast with electricity supply from conventional large power plants the electricity supply from wind and PV installations is far less controllable due to influence on weather conditions. But also the controllability of power supply from CHP and small hydro-power might be poor, because of the dependency on heat demand or water flow respectively.

Table 7.1 Categorisation of Sustainable Electricity Supply Technologies

	Combined Heat and Power (CHP)	Renewable Energy Sources (RES)
Large-scale generation	• Large district heating* • Large industrial CHP*	• Large hydro** • Off-shore wind • Co-firing biomass in coal power plants • Geothermal energy
Medium/small-scale generation (Distributed Generation)	• Medium district heating • Medium industrial CHP • Commercial CHP • Micro CHP	• Medium and small hydro • On-shore wind • Tidal energy • Biomass and waste incineration/gasification • Solar energy (PV)

* > 50 MW_e
** > 10 MW_e

Annex B: Feed-in tariffs in the Czech Republic and Hungary

Czech Republic

Feed-in tariffs are based on the Price Decision of the Energy Regulatory Authority 7/2007 of November 20, 2007.

Technology	Start of operation / category	2008			
		feed-in tariff		green bonus	
		CZK/kWh	c€/kWh	CZK/kWh	c€/kWh
Wind energy	before 2004	3,28	11,80	2,69	9,68
	2004	2,96	10,65	1,93	6,94
	2005	2,82	10,14	1,98	7,12
	2006	2,57	9,24	2,23	8,02
	2007	2,52	9,06	2,37	8,53
	2008 and later	2,46	8,85	2,69	9,68
Small hydro (< 10 MWe)	before 2005	1,73	6,22	0,53	1,91
	2005 and reconstructions	2,22	7,99	1,02	3,67
	2006 and 2007	2,45	8,81	1,25	4,50
	2008 and later	2,6	9,35	1,4	5,04
Biomass combustion (new locations)	category O1 (energy crops)	4,21	15,14	2,93	10,54
	category O2 (straw, forestry / gardening waste, etc.)	3,27	11,76	1,99	7,16
	category O3 (wood processing waste, shawings, sawdust etc..)	2,52	9,06	1,24	4,46
Biomass combustion (locations before 2008)	category O1 (energy crops)	3,54	12,73	2,26	8,13
	category O2 (straw, forestry / gardening waste, etc.)	2,94	10,58	1,66	5,97
	category O3 (wood processing waste, shawings, sawdust etc..)	2,43	8,74	1,15	4,14
Biomass co-firing with fossil fuels	category S1 (energy crops)	-	-	1,39	5,00
	category S2 (forestry / gardening waste, straw, etc..)	-	-	0,79	2,84
	category S3 (wood processing waste, shawings, sawdust etc..)	-	-	0,24	0,86
Sewage and landfill gas combustion	All categories	2,33	8,38	1,05	3,78
Biogas combustion	before 2004	2,74	9,86	1,46	5,25
	2004 - 2005	2,63	9,46	1,35	4,86
	2006 - 2007	3,3	11,87	2,02	7,27
	2008 and later	3,3	11,87	2,02	7,27
	2008 and later (agric. waste)	3,9	14,03	2,62	9,42
Geothermal electricity	All categories	4,5	16,19	3,37	12,12
Solar electricity	before 2006	6,57	23,63	5,76	20,72
	2006 and 2007	13,8	49,64	12,99	46,73
	2008 and later	13,46	48,42	12,65	45,50
Exchange rate CZK/EUR		27,8		27,8	

Hungary

Feed-in tariffs and indexation rules are based on Governmental Decree 389/2007
1 EUR = 255 HUF

Note: Here the level of *tariffs* is given, not the level of support (in economics terms, support is the reward on top of market price, either fix price FIT or fixed premium on top of market price is the support system))

RES-E categories	Feed-in tariffs (eurocent/kWh, without VAT)		
	peak	Off-peak	Deep-off-peak
Licence and resolution (quantity and duration) or licence-application before the force of the new governmental decree (except hydro power plants larger than 5 MW)	11,6 but for solar and wind: 10.4	10.4	4.2 but for solar and wind: 10.4
Licence and resolution after the force of the new decree AND capacity is not larger than 20 MW (in the case of hydro 5 MW)	11.6 but for solar**: 10.4	10.4	4.2 but for solar 10.4
a) Licence and resolution after the force of the new decree AND capacity is larger than 20 MW, but does not exceed 50 MW b) Non-RES part of co-fired electricity if the ratio of non-RES fuel is below 10 % (monthly and yearly)	9.3	8.3	3.4
a) Licence and resolution after the force of the new decree AND capacity is larger than 50 MW (in case of hydro 5 MW) b) Licence and resolution after the force of the new decree and generation equipments are used	7.2	4.6	4.6
Electricity from waste	10.9	7.5	3.9
CHP categories			
a) Licence or generation before the force of the new decree AND heat is for district-heating AND capacity is not larger than 50 Mwe b) Licence or generation before the force of the new decree AND heat is not for district-heating AND capacity is not larger than 6 MWe	12.8	8.2	1.2
a) Licence after the force of the new decree AND heat is for district-heating AND capacity is not larger than 50 MWe b) Licence after the force of the new decree AND heat is for special institutions* AND capacity is not larger than 6 MWe	10.7	7.3	1.2
a) Heat for district-heating or for special institutions AND capacity is between 50 and 100 Mwe b) Heat is not for district-heating or for special institutions AND capacity is not larger than 20 Mwe c) Licence after the force of the new decree and generation equipments are used	7.3	4.6	1.2
Electricity generated during the heating season AND commercial operation started before the force of the new decree AND heat is for district-heating or for special institutions AND capacity is between 50 and 140 MWe	11.2	7.0	1.2

*Special institutions (classified by the Governmental Decree): central administration bodies, local governments and their institutions, state-financed non-profit institutions carrying out public tasks.

** Newly permitted wind is not possible for an unspecified time, because of the 330MW quota has been already distributed (but not all is built yet).

Yearly indexation rules for RES-E tariffs are the following:

- Licence and resolution before coming into force of the new decree: quantity-weighted average tariff * CPI (Consumer price index).
- All others: quantity-weighted average tariff * (CPI-1 %). CPI published by Statistical Office.

Yearly indexation rules for CHP peak and off-peak tariffs:

- Gas-fired units: T0*(1+((NG*0,6 +(INF-1) *0,4)/100)), where T0 is the basic tariff, NG is the regulated price increase of natural gas, INF is the CPI-forecast of the Hungarian National Bank.
- Non gas-fired units: T0*(1+((INF-1)/100)), where T0 is the basic tariff, INF is the CPI-forecast of the Hungarian National Bank.

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