CURRENT EXPERIENCE WITH RENEWABLE SUPPORT SCHEMES IN EUROPE

Prepared by the Council of European Energy Regulators (CEER)

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1 Executive Summary

1.1 Framework

The need to reduce the dependence of the European economy on imported primary energy and fossil fuel impact on the environment has encouraged countries to increase the share of renewable energy sources (RES) for electricity supply.

Owing to higher production costs, electricity from renewable energy sources is not – except large hydro power - competitive within the electricity market. This leads to the need for subsidies, if the share of electricity produced from renewable energy sources (RES-E) is to increase.

Economic theory states that subsidies in general have the potential to distort the market.

1. Additional costs are allocated differently to end consumers from one Member State to the other.
2. Different support levels create undue competitive advantages for some market participants at the start of competition which will therefore be characterised by market distortions from the beginning.
3. Without harmonised rules regarding the right for a certain support, the increasing RES-E market favours cross-subsidies within large electricity producers, which own both renewable and non-renewable power plants.
4. Guaranteed support levels often lead to artificially high production costs, because power equipment producers align their prices to the support level.

Regulators have to avoid unfair discrimination and promote effective competition along with efficient functioning of the market. And even if granted subsidies are not a “state aid” in the meaning of Article 87 of the EC Treaty, parts of the electricity market, that may reach a share of approximately 16 %, receive some kind of support.

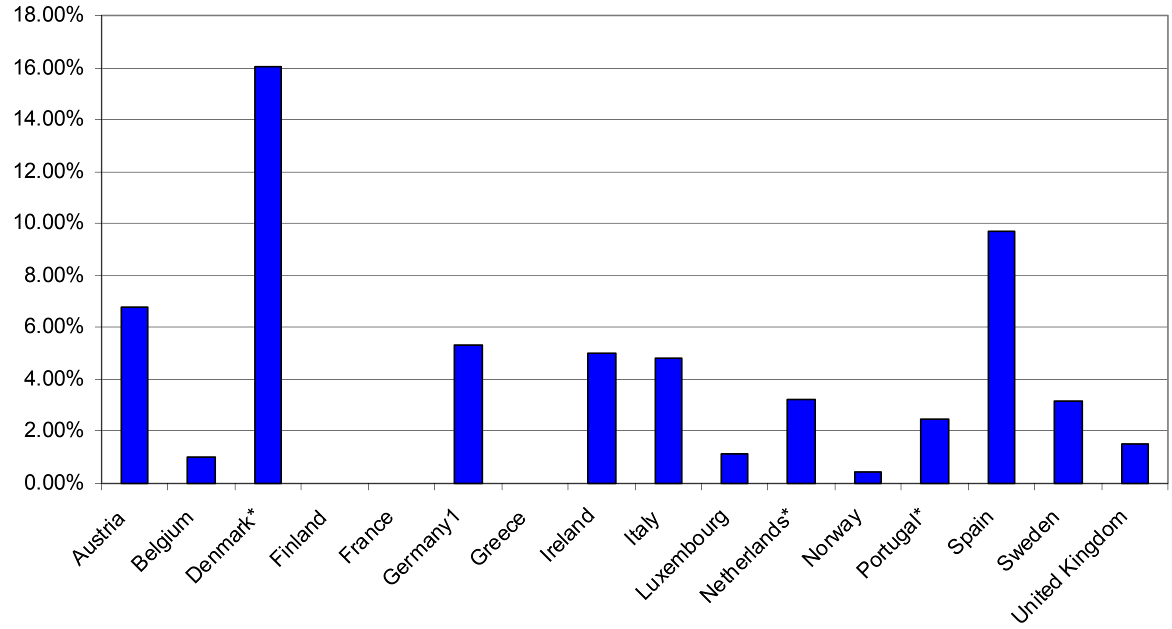

Figure 1: Comparison between supported RES-E and indigenous production

Against the background of each regulator's focus - to ensure the functioning of the electricity market - the purpose of this report is to identify market distortions, to offer solutions for removing them and to provide comparative information on the current systems for support of RES-generation.

The implementation of the RES-E Directive considerably boosted development in the field of sustainable electricity production.

The EU set down indicative targets for the production of electricity from renewable energy sources for all Member States, assuming the following advantages[1]

- environmental protection,
- sustainable development,
- increase in local employment,
- positive impact on social cohesion,
- contribution to security of supply and
- meeting the Kyoto targets more quickly.

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[1] Reason 1, Directive 2001/77EC of the European Parliament and of the Council of 27 September 2001 on the promotion of electricity produced from renewable energy sources in the internal electricity market.

However, the achievement of the indicative targets is related to the following challenges:

- high production costs and therefore the need for support schemes,
- lower degrees of efficiency due to different technology-levels,
- additional (hidden) costs, such as balancing energy, regulatory costs and grid extension,
- the fact, that the production of RES-E, is a rather expensive means to reach the Kyoto target and
- (potential) market distortions.

The present report shows the current experiences with RES-E support schemes and uncovers various problems. In order to design a CEER strategy in connection with RES-E the following recommendations are given:

I. EU-Level

A) Conflicts between targets of different Directives

There is an obvious conflict between the targets of the RES-E Directive and Directive 2000/60/EC (Framework for water policy). On the one hand electricity production in hydro power plants is supported; on the other hand it is limited because of ecological considerations.

In general it seems that the Union tries to achieve a target, e.g. the Kyoto target, by different means, but without optimally synchronising these means with each other.

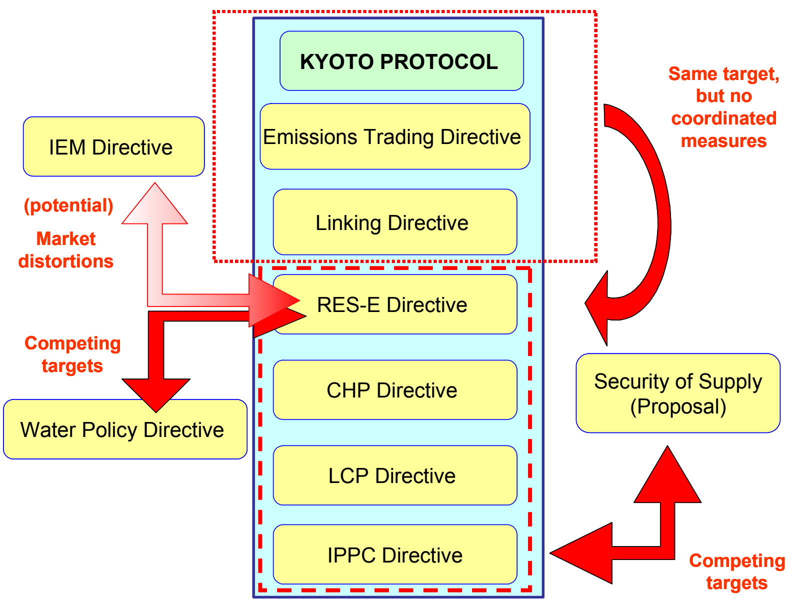


Figure 2: Conflicts between different EU Directives

A harmonisation of various Directives that have impacts on the internal energy market by designing an integrated "master plan" that merge economic, technical and environmental targets, is recommended.

B) Harmonisation of RES-E support scheme

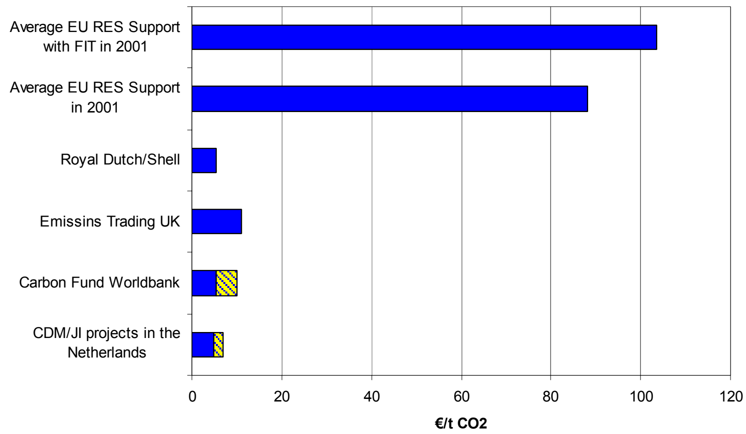
One of the intentions of the RES-E Directive was to provide the legislative framework for a European wide harmonised support scheme for RES-E.[2] The implementation of a harmonised support scheme is the key factor for guaranteeing a level playing field in the electricity market and maximising the efficiency of financial support. It is important to stress that this process does not necessarily have to end in the same support scheme for all Member States but in harmonised rules for supporting RES-E.

CEER underlines and supports the original intention of the Commission to really harmonise the rules for support scheme for RES-E.

C) Reduction costs for greenhouse gas emissions

RES-E is one means to reduce greenhouse gas emission, but the following aspects have to be considered:

i. The costs for the reduction of greenhouse gas emissions through RES-E are very high



Source: Eurelectric, own investigations

Figure 3: Reduction cost for CO_2

ii. The actual generation system in general and balancing capacities in particular have to be considered. If the balancing energy for wind power comes from fossil power plants (Germany and Spain) the contribution of RES-E (especially of wind power) to the Kyoto target is

[2] Article 1, RES-E Directive.

questionable, because the efficiency is lowered by starting up and turning down the power plants and more greenhouse gases are emitted.

A cost-efficient package of measures, taking into account total system costs, to reach the Kyoto target should be created. RES-E is only a (small) part of this package.

II. National Level

A) Market distortion through different support levels

Based on various potentials for RES-E within the EU and the high dependency of production costs of RES-E on climatic conditions, the focus on the national indicative target leads to different support levels for the same RES- E within Europe. [3]

The hydro power example: In most EU Member States only electricity produced in small hydro power plants (<10 MW) is supported. The support level ranges from 2.4 Cent/kWh up to 11.3 Cent/kWh; the support period ranges from 7 years to the lifetime of the investment. Germany supports in addition the refurbishment of hydro power plant up to 150 MW, Spain supports hydro power up to 50 MW[4].

[3] Denmark points out, that the average wind turbine installed to day has been put into service fore some years and therefore does not represent the state of the art to day. The stock of these old wind-turbines therefore requires subsidies to secure recovery of investment costs.

[4] All used data concerning Germany in this report was given by E.On (TSO) and VDN (association of network operators).

	Indigenous Production 2003[2] TWh	Supported RES - E in 2003 [TWh]	Supported RES-E electricity [in %]	Total Costs for RES in 2003 Mio. Euro	Average Additional Costs excl. Market price [Cent/kWh]
Austria	58,20	3,942	6,77%	133,30	3,38
Belgium	80,50	0,806	1,00%	n.a.	n.a.
Denmark*	43,80	7,034	16,06%	n.a.	n.a.
Finland	79,90	n.a.	n.a.	n.a.	n.a.
France	537,80	n.a.	n.a.	n.a.	n.a.
Germany[1]	538,90	28,700	5,33%	1.700,00	5,92
Greece	54,40	n.a.	n.a.	61,00	n.a.
Ireland	20,60	0,550	2,67%	6,60	1,20
Italy	278,20	13,391	4,81%	1.000,00	7,47
Luxembourg	4,10	0,048	1,17%	2,70	5,63
Netherlands*	89,10	2,900	3,25%	n.a.	n.a.
Norway	106,20	0,450	0,42%	48,60	10,80
Portugal*	36,30	0,900	2,48%	20,64	2,29
Spain	230,60	22,430	9,73%	n.a.	n.a.
Sweden	132,50	4,200	3,17%	118,70	2,83
United Kingdom**	365,30	5,562	1,52%	580,00	10,43

1: Source: VDN, E-ON
2: Source: IEA
*2002
** Data based on total ROC issue for April 2002 to March 2003

Table 1: Supported RES-E and total cost for RES-E support

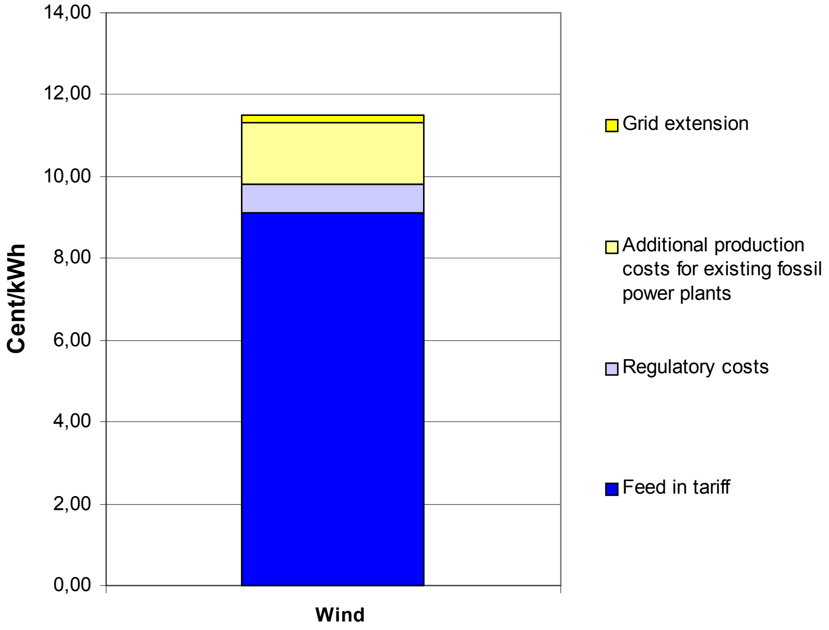
Against the background of minimizing support costs, the strategy should also enhance competition between generators using different RES as well as between manufactures. In this respect the support scheme must be “technology neutral” and should not favour any special type of technology. This would also lead to improvements regarding operation performance and technology efficiency.

In order to avoid further cost-inefficiencies the focus of the next generation of support mechanisms should be market based and technology neutral. RES ought to be used where the production costs are at the lowest level.

B) Market distortion through additional costs

Within the Member States different costs are covered by the support schemes. In Germany the costs for balancing are not included into the national support scheme and must be paid by those consumers who happen to be connected to those grid-companies which also have a lot of wind power[5]. As another example, in Austria balancing costs are included into the support scheme and are paid by all Austrian end consumers.

[5] On 08/01/2004 the Renewable Energy Sources Act in Germany came into force. § 14 rules a nationwide compensation of costs.



Source: Christian Schneller, E.ON

Figure 4: Additional cost for wind power in Germany

To give correct price signals additional costs, such as balancing energy or grid extensions, must be transparent and must be paid by all end consumers within a support system. In order to maximise the efficiency of the support system, the handling of these costs should be the same within Europe.

C) Technical challenges

Both fossil and renewable power plants have impacts on the grid. RES-E has a high dependency on climatic conditions and thus leads to further challenges for the transmission system operator or the distribution system operator. To handle the occurring problems "heavy handed" organisational and technical rules are needed. The conditions for grid access must be clearly defined both for fossil and renewable plants. In order to maintain the high power quality and quality of supply there must be contracts involving all parties (power plant owner, TSO and DSO) that clarify the actions to be taken if there are problems regarding power quality and quality of supply. The TSO must have the possibility to react on grid problems arising and this must also be the case if decentralised power plants are connected to the distribution network.

The problems with RES-E production decrease with full load hours. This also leads to the conclusion, that a uniform distribution of all technologies across the Union is absolutely not desirable.

To ensure the maintenance of the high power quality and security of supply adequate mechanisms both on the organisational and the technical side must be defined to minimize the impacts of new power plant on the grid. The individual characteristics of the national grid and of the national RES-E potentials must be taken into consideration.

1.2 Conclusion

The purpose of this report is to inform the debate on RES-E in general and more specifically to quantify some technical and economic consequences of the dynamic development of RES-E within Europe.

It was found that the majority of discovered problems arise from the fact that there is no harmonised support system within Europe. In order to reach cost-effectiveness and at the same time not to disturb competition within the market the main message of this report is to implement a European wide harmonised RES-E support system, respecting both existing resources and characteristics of the grid. This system should fulfil the following standards:

- reflecting the existing potentials of different energy sources within Europe,
- enhancing competition between generators,
- encouraging renewable electricity suppliers to improve operation performance and technological efficiency,
- offering objective information to end consumers,
- including additional costs and making them transparent and
- introducing market based mechanisms.

2 Introduction

2.1 Objective

On 23rd and 24th March 2004 the members of the CEER "**Single Energy Market" Working Group/Task Force "Regional Energy Markets"** declared that *"The issue of renewables is of high importance and is politically very sensitive. A specific renewables report will be issued by the TF asap and will include a country benchmark (capacities, technologies), present the main identified difficulties (impact on grid, subsidies) as well as suggested solutions".*[6]

The aim of this report is to analyse the current development in the field of renewable energy sources (RES) including the possible market distortions in the internal energy market caused by the increasing volumes of subsidised renewable energy in the European Union.

2.2 Methodology

The report has been drawn up by the **CEER Task Force Regional Energy Markets** starting with the preparation of a questionnaire which was distributed to the **CEER Task Force Members** in April. Both the questionnaire and the received answers can be found in the annex.

Besides the information gathered through the questionnaire different other sources were used. If the information was not given by the **CEER Task Force - Members,** the reference is indicated.

The present report focuses on an analysis of the development of electricity produced out of renewable energy sources the EU-15 Member States. The EU's ten new Member States will be subject of a follow up report in autumn 2004. An overview regarding new Member States is given by an ERRA-report attached in the annex.

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[6] Minutes Single Energy Market (SEM) Working Group, 1st Meeting, CEER Secretariat, 23rd March 2004, 10.30 - 17.00.

2.3 Structure

The report is structured as follows: First, the legislative background is outlined, then, common issues of regulatory duties and the latest Directive on RES-E are discussed. Third, the status quo of the current supply and demand of RES-E in the EU-15, the support schemes and the share of technologies in 2010 are given. In chapter 7 the latest experiences regarding the RES-E are shown, including recommendations how regulators can react on these developments. Finally, concrete actions are outlined.

Chapter 3 - 8 of the report gives a general qualitative analysis; the detailed data is shown in the annexes.

3 Legislative Framework

3.1 The EU Directives

After the first steps of liberalising the internal European electricity market, with no or few focus on RES-E, the European Union started increasingly to support generating electricity from RES.

The "*White Paper on Renewable Sources of Energy"* was one of the first contributions to stable the market for RES; the RES-E Directive was one of the most important.

With the adoption of the RES-E Directive the European Union set the fundamental legislative basis for the actual support schemes in Europe and set indicative targets for each Member State (see Figure 5).

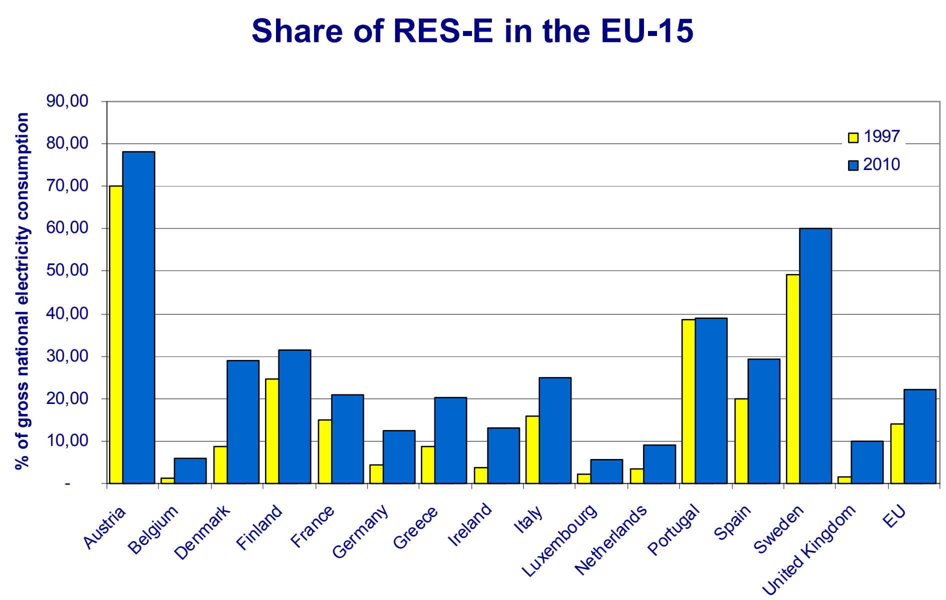


Figure 5: Indicative targets of the RES-E Directive

Besides the RES-E Directive there are other legislative documents which influence the RES-E market or rather the Internal Energy Market (IEM):

- ***Directive 2000/60/EC** of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy*
- ***Directive 2003/87/EC** of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC (Text with EEA relevance)*
- ***Directive 2004/8/EC** of the European Parliament and of the Council of 11 February 2004 on the promotion of cogeneration based on a useful heat demand in the internal energy market and amending Directive 92/42/EEC*
- ***COM (2003) 739(01);** Proposal for a Directive of the European Parliament and of the Council on energy end-use efficiency and energy services*
- ***Directive 2003/54/EC** of the European Parliament and of the Council of 26 June 2003 concerning common rules for the internal market in electricity and repealing Directive 96/92/EC*
- ***Directive 2001/80/EC** of the European Parliament and of the Council of 23 October 2001 on the limitation of emissions of certain pollutants into the air from large combustion plants*
- ***Directive 2001/81/EC** of the European Parliament and of the Council of 23 October 2001 on national emission ceilings for certain atmospheric pollutants*

3.2 The environmental versus the regulatory focus

One of the main conclusions uncovered in the report of the **CEER Working Group on Taxation and Environment** of 13 June 2003 was that Energy Regulators have no direct competences or powers regarding tax and environmental regulations. In the field of Combined Heat and Power (CHP) and RES-E regulators have some competences, e.g. monitoring of the RES-E market.

However, the support and the increasing extension of RES-E have impacts on other regulatory tasks. Table 2 shows a comparison between the targets of the RES-E Directive and the responsibilities of regulatory authorities based on Article 23 of Directive 2003/54/EC.

Regulator's Responsibilities (excerpt) Directive 2003/54/EC Article 23	Targets Directive 2001/77/EC Various Articles
• Responsible for ensuring non discrimination, **effective competition and efficient functioning of the market**	• Promote an **increase in the contribution of renewable energy sources** (Art. 1)
• mechanisms to deal with **congested capacity** within the national electricity system	• (...) encourage greater consumption of electricity produced from renewable energy sources (...) These steps must be **in proportion to the objective to be attained.** (Art. 3)
• Publication of appropiate **information** by transmission and distribution system operators concerning interconnectors, **grid usage** and **capacity allocation** to interested parties	• (...) **Reducing** the regulatory and non-regulatory **barriers (Art. 6)**
• effective **unbundling**	• Promotion of RES-E for reasons of **security and diversification of energy supply**, of **environmental protection** and of social and economic cohesion (reason 2)
• **terms, conditions and tariffs** for **connecting** new producers of electricity to guarantee objectiveness, transparency and non-discrimination, in particular taking full account of the **costs and benefits of the various renewable energy sources technologies**, distributed generation and combined heat and power	• (...) adapt support schemes to the developing internal electricity market. (...) be **compatible with the principles of the internal electricity market** and take into account the characteristics of the different RES, together with the **different technologies** and **geographical differences.** It should (...) promote in an **effective way**, be simple and at the same time as **efficient as possible, particularly in terms of costs (...) (Reason 16)**
• Member States shall create appropiate and efficient mechanisms for regulation, control and transparency so as to avoid any abuse of a dominant position in particular to the detriment of customers and any predatory behavior.	• (...) and **limit the cost to the consumer**, while, in the medium term, **reduce the need of public support**

Table 2: Comparison Directive 2001/77/EC - Directive 2003/54/EC

The main duty of regulatory authorities - to ensuring an effective and efficient IEM - is influenced by the developments in the RES-E market, especially regarding transparency, non-discrimination and security of supply. The development of RES-E supports in some areas the IEM, e.g. by offering additional installed capacity and thus reducing the dependency of imports, but on the other hand the RES-E support causes market distortions because of non-harmonised support schemes and different additional cost, e.g. costs for grid extension, within the EU. This area of (potential) conflicts is discussed in detail in chapter 7.

4 Current supply and demand

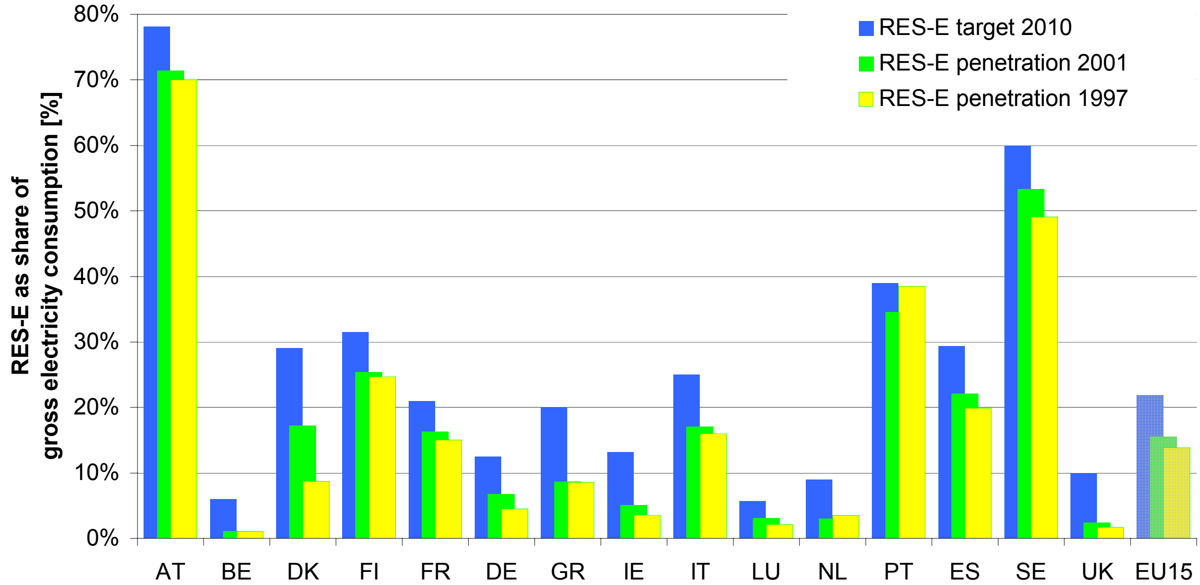
4.1 Country Specific Targets

> "*Member States shall take appropriate steps to encourage greater consumption of electricity produced from renewable energy sources in conformity with the national indicative targets (…)*"

Article 2 of the RES-E Directive defines in connection with Annex 1 the national indicative targets. The targets are calculated as follows:

$$\text{national target} = \frac{\text{total national RES} - \text{E}}{\text{gross national electricity consumption}}$$

The achievement in 2001 of the national indicative targets is shown in Figure 6. At the moment there are a lot of national initiatives for increasing the share of RES-E but the European Commission stated in the report "The share of renewable energy in the EU" that only Germany, Spain, Denmark and Finland "are on the track" regarding the indicative targets in 2010.



Source: Expansion

Figure 6: Achievement of the indicative targets in 2001

All respective targets set by the RES-E Directive are depending on more or less uncertain factors. **Austria, Denmark, Greece, Italy, the Netherlands** and **Spain** simply note that their targets can be met if gross electricity consumption of 2010 stays within certain limits or follow projected growth rate. **Portugal** and **Luxembourg** state that targets are realistic if planed investments/improvements can be realized and result in expected production volumes. **Luxembourg** and **Italy** also mention that waste included as a renewable fuel is a condition included in their prognosis. **Sweden's** standpoint is that the target set by the directive is based on a too thin basis concerning yearly fluctuations in the Swedish hydro production. A long-range calculation of average hydro production (30 years) gives an adjusted target level at 52%. The Swedish national goal is in line with a long-range based calculation and implemented in Act on Electricity Certificates (May 2003). Since **Norway** has not yet implemented the EC-Directive no target is set. **Finland** simply denotes the target "challenging". Both Norway and Finland are in the process of developing new policy instruments and are therefore reluctant to provide comment on targets. **Ireland** has established a Renewable Energy Development Group to ascertain progress and to facilitate achievement of the 2010 target.

4.2 Responsibilities and Financing

	Obligation				Financed by and via:			
	Customers	Producers	Traders/Supplier	Government	Customers	Producers	Traders/Supplier	Goverment
Austria				✓	Tariffs			
Belgium (Brussels)			✓				Certificates	
Belgium (Flanders)			✓				Certificates	
Belgium (Walloon)			✓				Certificates	
Denmark				✓				
Finland[1]				✓				State budget; energy taxation
France[1]	✓				Tariffs			
Great Britain			✓				Certificates	
Greece				✓	RES Levy			
Iceland								
Ireland	✓				PSO Levy			
Italy		✓			Tariffs	Certificates		
Luxenbourg				✓	tariff < 65kV			State budget
Netherlands				✓	Tariffs	(Adm. Costs)		
Norway					Tariffs			State budget
Portugal				✓	Tariffs			State budget
Spain				✓	Tariffs			
Sweden	✓				Certificates			State budget

Table 3: Obligation and financing

The general statement is that the government is obligated to fulfil the national targets and in practice means that the government decides respective tariff/support levels. Out of the states (regions) that have answered the questionnaire seven use a system with some kind of environmental surcharge on network tariffs. Three countries base their financing on a tax or levy and another four use green certificates. Among those having a certificate system **Italy** stands out with the obligation put on producers of electricity.

In some cases support systems (or part of them) are financed via state budget. This is the case for **Luxembourg**, **Norway**, and **Portugal** and if it is needed the build in guarantee price on certificates in **Sweden**. The **Austrian** system is financed by both traders and consumers. The Belgian system is financed by traders. But Austria along with **Greece** and **Belgium** notes that the surcharge for RES-E eventually ends up on the customer's bill. Both countries have a limit on the additional charge for the customer prescribed in the law. **Sweden** and **Belgium** relies on specific mechanisms in the certificate system to protect the end consumer. Example in Belgium for large electricity consumers, the corresponding quota obligation for their suppliers can be reduced under conditions. Again **Norway** has blanks since final policy decision is not yet taken.

5 Description of Support Systems

5.1 Overview

Having outlined the legal framework regarding obligations and financing, an overview of the options of supporting scheme is given in this chapter. The schemes vary in their regulatory intensity from one country to another and are also partly combined.

		Direct		Indirect
		Price-driven	**Capacity-driven**	
Mandatory	Investment focussed	Rebates		Environmental taxes
		Tax Incentives	Quotas/TGC	
	Generation based	Feed-in tariffs	Bidding	
		Rate-based incentives		
Voluntary	Investment focussed	Shareholder Programs		Voluntary agreements
		Contribution Programs		
	Generation based	Green tariffs		

Source: Rexpansion

Table 4: Support schemes

The advantages of the two main supports schemes in Europe – feed in tariffs (FIT) and tradable green certificates (TGC) – are specified in Table 5.

	Advantages	Disadvantages
TGC	• flexible and market-oriented, • initiate technological developments, • increase of economic efficiency is possible, • often higher political acceptance and • easy to enlarge it to other countries.	• higher insecurity for investors • volatile certificate prices • high transaction costs and • high monitoring costs.
FIT	• very effective regarding the extension of RES-E • few regulatory and administrative costs, • stable basic conditions and • high planning reliability	• non cost-efficient • non market-oriented

Table 5: Advantages and disadvantages of support schemes

The most frequent support framework is a FIT scheme. In six out of eight cases the FIT system is complemented by an investment grant system. Five countries use a certificate system, and as in the case of feed-in tariffs, it is often combined with a system for investment grant. **Ireland** makes an exception with a tendering scheme through bidding for produced electricity. As today **Finland** and **Norway** relies on fiscal policies and investment subsidies. Both countries await new policy proposals in the course of this summer.

	Feed in Tariffs	Certificates	Investment grant	Tax Reduction	Tendering	Others
Austria	Electricity fed into the public grid		(Building of plants)			
Belgium		Produced Electricity	(Building of plants)	part of federal levy	counstruction of new plants	For Flandern: exemp. of distr.cost for sold electr.
Denmark						
Finland			Building of plants	end users		
France[1]	Electricity fed into the public grid (up to 12 MW)				counstruction of new plants of more than 12 MW	
Great Britain		Electricity fed into the public grid	Building of plants	CLL exemption	NFFO/SRO contracts	
Greece	Electricity fed into the public grid		Building of plants			
Iceland						
Ireland					Bidding process for AER contracts with ESB-Public Electricity Supply	
Italy	Electricity fed into the public grid	Produced Electricity	For PV			
Luxembourg	Electricity fed into the public grid		Building of plants			
Netherlands	Electricity fed into the public grid	Produced Electricity	Building of plants	end users		
Norway			Building of plants			
Portugal	Electricity fed into the public grid		Building of plants	individual tax payer		
Spain	Electricity fed into the public grid		For PV			
Sweden		Produced Electricity				Subsidy wind power

[1]: Source: Eurelectric, 2004

Table 6: Type of support system and what is supported

More details on the national support mechanisms are given below.

Austria: The support via feed-in tariffs based on the Green Electricity Act is the main support scheme. There are some other supports from other institutions (mainly investment grants; Österreichische Kommunalkredit, Ministry of Environment).

Belgium (Flanders): Sold RES-electricity injected in a Belgian distribution grid ≤ 70kV is exempted from distribution costs.

Belgium (Brussels): Electricity suppliers have to turn in each year a certain number of green certificates. The number of certificates to turn is a percentage of the amount of electricity supplied to liberalised end customers in the previous year. This percentage is 2 % in 2004, 2.25 % in 2005 and 2.5% in 2006. The penalty is fixed to 75 Euro per missing GC.

Belgium (Walloon): Every quarter, electricity suppliers have to redeem a certain number of green certificates (GC) to meet their quota obligation. The quota obligation was 3% in 2003 and increase to 7% in 2007. The penalty is fixed to 100 Euro per missing GC.

Denmark: Support grid reinforcement, balancing of production covered by purchase obligation (FIT) and administration.

Great Britain: Renewable obligation certificates (ROCs) have current a value of 72-75 €/MWh and represent the main support. NFFO/SRO (Non-Fossils Fuel Obligation and Scottish Renewables Obligation) contracts still exist but no new ones are planned. Investment grants under capital grant schemes but not under RO. Qualifying renewable electricity has to be sold by a licensed supplier to a customer in Great Britain. On-site use by a generator can qualify less than one of the provisions of the RO.

Greece: The existing support scheme along with the large-scale hydroelectric projects does not suffice to meet the target of 20.1% and additional private funding will be necessary. The lack of measures providing public aid will be offset by further consolidation of the existing investment environment. This is carried out via signals that the fixed feed-in price regime for renewable electricity production will be based on a permanent and stable ground (for further information see Law 2773/1999).

Ireland: The alternative energy requirement scheme (AER) implies that green generators compete for 15 year public purchase agreements contracts with the Public Electricity Supply (PES). The government sets the price caps for different types of technologies (i.e. biomass, hydro and small scale and large scale wind (>3MW)).

Italy: The feed-in tariff system is still operational but authorisation is curtailed (presently some 10TWh).

Luxembourg: Investment grants are financed through state budget. Collected feed-in tariffs are distributed by a fund (FdC) on all customers < 65kV. Additional feed-in subsidy, based on kWh fed into the grid, is paid by the Ministry of environmental affairs (MENV).

The Netherlands: The Feed-in tariffs give producers a subsidy on every single kWh of RES-E fed into the grid. A producer also receives a subsidy for electricity fed n an installation, when this is produced out of RES. The investment grant is an allowed deduction from the fiscal profit (55% of the investments in renewable). There are some extra support possibilities such as free write-off of investments in renewable energy. Consumers also receive a reduction from the energy tax paid when consuming renewable electricity. This tax reduction will however will be discontinued from January 1st 2005.

Norway: Until 2004 half electricity tax on renewable energy production in Norway was granted. As mentioned above future policy directions are expected to be taken later this year.

Sweden: The certificate system is designed to replace the recent support systems, however a special transitional support for wind power was considered as being necessary in order to meet national RE target.

Figure 7 below summarises and categorizes the main support system for the respective countries.

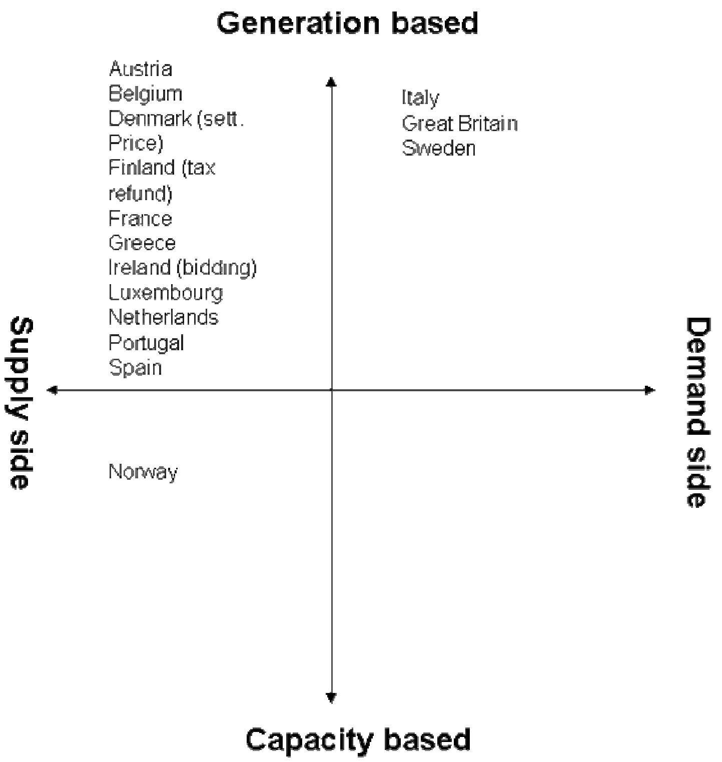


Figure 7: Categorization of policy instruments

It is shown that most countries have chosen a generation based support scheme. The majority of the presented countries use a combination of two or more instruments.

5.2 Political discussion and expected actions

In **Austria** there is an ongoing discussion on changing the Green Electricity Act. The main issues are the extension of wind power and delays of payments of the FIT. The Green Electricity Act furthermore limits the budget for renewable energy but does not provide limit to build plants. The Minister of Economic Affaires has announced that there will be an amending law with focus on energy efficiency.

Belgium (Flanders)**:** The exemption of distribution cost is being discussed. A final discussion is postponed for the next Flemish government (Flemish elections on 13/06/2004).

Denmark: The latest political agreement (29 March 2004) include the construction of new offshore wind farms and replacement of wind turbines in unfavourable locations with new wind turbines build in other places. This agreement calls for increased research and development and demonstration of advanced energy technologies. The objective is above all to ensure that the whole production of electricity from wind turbines and local power-and-heating plants (CHP) will be sold under market conditions. The planed new offshore wind farms will get support after a tendering scheme through bidding for the lowest support.

In **Finland** there is an ongoing review of the recent support system. New proposals are expected to be made in June 2004.

In **Great Britain** a technical review of the RO has just come into effect. It's with the main represents the extension to co-firing. DTI/SE intends to consult on the terms of reference of a wider review of the RO this summer and discussions about the scope are taking place. There will also be consultations on any changes arising as a result of the Energy Bill and on extending the RO targets to 2015.

In **Ireland** the responsible government department (Department for Communications, Marine and Natural Resources) has recently published a paper for consultation on future targets for renewables and potential support schemes. Decision is not expected until autumn 2004.

In **Luxembourg** a change towards a more market based support system are proposed and in preliminary discussion.

In order to deal with the problematic out flow of tax-advantages from **the Netherlands** the Dutch support system has a new design focusing on support of producers rather than tax exceptions for consumers.

In **Norway** a white paper of the Minister of Petroleum and Energy is expected to be published in June. It will announce whether or not a certificate market, in connection to the Swedish one, will be introduced. If the answer is affirmative the system will at the earliest be implemented in 2006 at the earliest.

In **Portugal** the current discussion is about the increasing surplus costs for consumers versus the stability of remuneration to producers.

Spain has recently updated the support systems through "the Royal Decree" (approved in March 2004). The main changes are done in purpose to increase security and predictability of economic incentives. After several discussions the actor has the choice between two mechanisms to choose between: FIT or market participation incentives.

In **Sweden** the certificate system has been in place for more than one year (since May 2003) and a first evaluation is in progress. The first phase that was completed in May 2004 analyzed *the addition of peat, role of electric intense industry* and *design of quota obligation fee*. The second and final section (expected in November) will contain a general overview and may propose changes to the system. Possible changes (increased level of ambition, new quota requirements) may come into force in 2005 at the earliest.

5.3 Supported electricity and levels of support

In 2003 the support level within the European Member States was very heterogeneous. It is worth mentioning that the lowest average additional costs are found in countries, which have chosen a certificate or tendering system.

	Indigenous Production 2003[2] TWh	Supported RES - E in 2003 [TWh]	Supported RES-E electricity [in %]	Total Costs for RES in 2003 Mio. Euro	Average Additional Costs excl. Market price [Cent/kWh]
Austria	58,20	3,942	6,77%	133,30	3,38
Belgium	80,50	0,806	1,00%	n.a.	n.a.
Denmark*	43,80	7,034	16,06%	n.a.	n.a.
Finland	79,90	n.a.	n.a.	n.a.	n.a.
France	537,80	n.a.	n.a.	n.a.	n.a.
Germany[1]	538,90	28,700	5,33%	1.700,00	5,92
Greece	54,40	n.a.	n.a.	61,00	n.a.
Ireland	20,60	0,550	2,67%	6,60	1,20
Italy	278,20	13,391	4,81%	1.000,00	7,47
Luxembourg	4,10	0,048	1,17%	2,70	5,63
Netherlands*	89,10	2,900	3,25%	n.a.	n.a.
Norway	106,20	0,450	0,42%	48,60	10,80
Portugal*	36,30	0,900	2,48%	20,64	2,29
Spain	230,60	22,430	9,73%	n.a.	n.a.
Sweden	132,50	4,200	3,17%	118,70	2,83
United Kingdom**	365,30	5,562	1,52%	580,00	10,43

1: Source: VDN, E-ON
2: Source: IEA
*2002
** Data based on total ROC issue for April 2002 to March 2003

Table 7: Supported RES-E and support levels

In most of the countries large hydro power is not supported. But the definition of large hydro power plants differs within the EU. Spain supports hydro power up to an installed capacity of 50 MW, in Germany, e.g., modernised hydro power plants up to 150 MW are supported. In most of the other countries the capacity limit for small hydro power plants is 10 MW.

Also the supported RES-E in relation to the indigenous production (that is not equal to the gross national electricity consumption, which is the reference value for the indicative targets) is an indicator for the evaluation of the support system. The given date reflects the situation in 2003, but due to the heat wave the RES-E production was suboptimal. In **Austria** the share of supported RES-E had normally reached 9 – 10 %.

In **Denmark**, the share of the supported electricity is converging 16 % of the total electricity produced. Taking into account that in most countries also combined heat and power (CHP) is supported this values could reach shares above 30 %.

Due to the fact that also for regulators a lot of data are not available and the costs are not transparent for end consumers it is recommended to improve the information quality in this respect.

The detailed information for each Member State and each RES is attached in the annex.

5.4 Conclusion: Political discussions and expected actions

The implementation of the RES-E Directive is still rather fresh and in most countries there are ongoing political processes about possible changes in RES-policy. In **Finland**, **Ireland**, **Norway** and **Sweden** there are ongoing reviews of the different support systems and expected changes may take effect in the course of the year to follow. **Great Britain**, **the Netherlands** and **Spain** have recently updated their national support schemes. In **Austria**, **Belgium** (Flanders), **Luxembourg** and **Portugal** there are preliminary discussions that may lead to a change in respective policies.

6 Technologies

The following section describes current and forecasted development of installed capacity for different technologies. The data is given for each member state along with a brief analyze of development and policy strategy. More detailed information can be found in the Commission Staff Working Document "*The share of renewable energy in the EU", {Com (2004) 366 final}* or in the report from the ECN policy studies *"Renewable electricity policies in Europe – country fact sheets 2003"*.

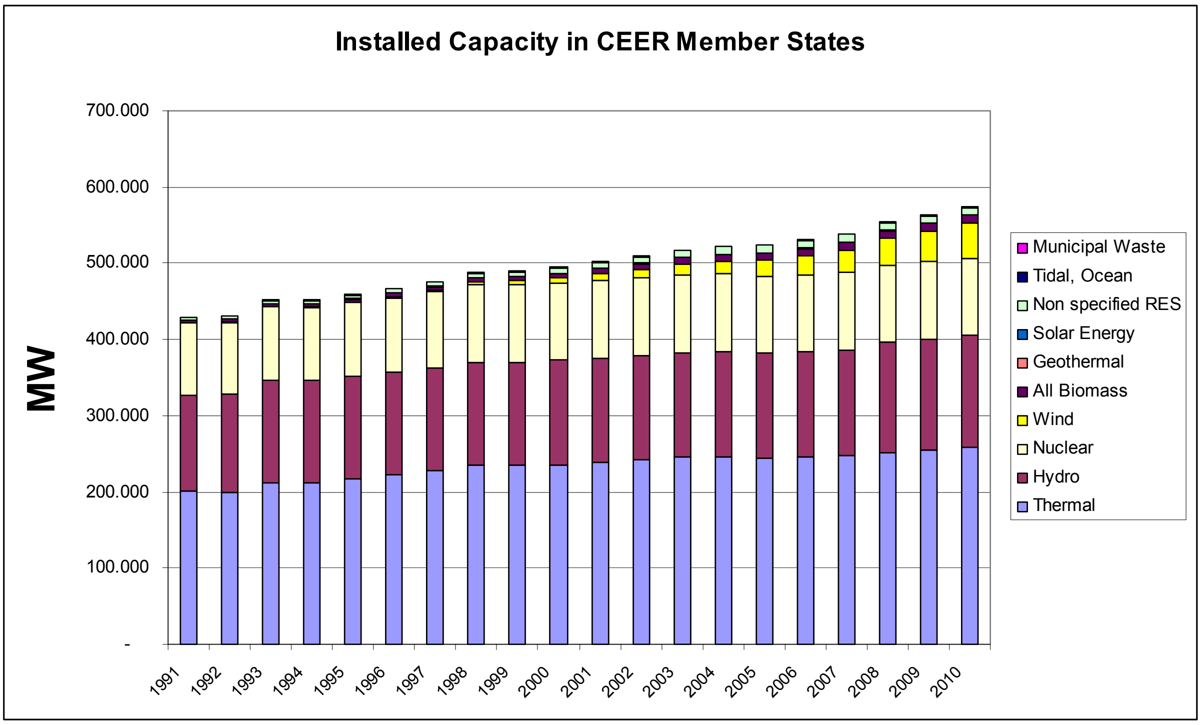


Figure 31: Installed capacity in CEER-Member States 1991 – 2010

Total installed capacity is projected to grow at 9.4 % between 2003 and 2010. The three major technologies (thermal, hydro and nuclear) are expected to grow slightly in capacity while percentage shares decline with 1-2 %.

CEER

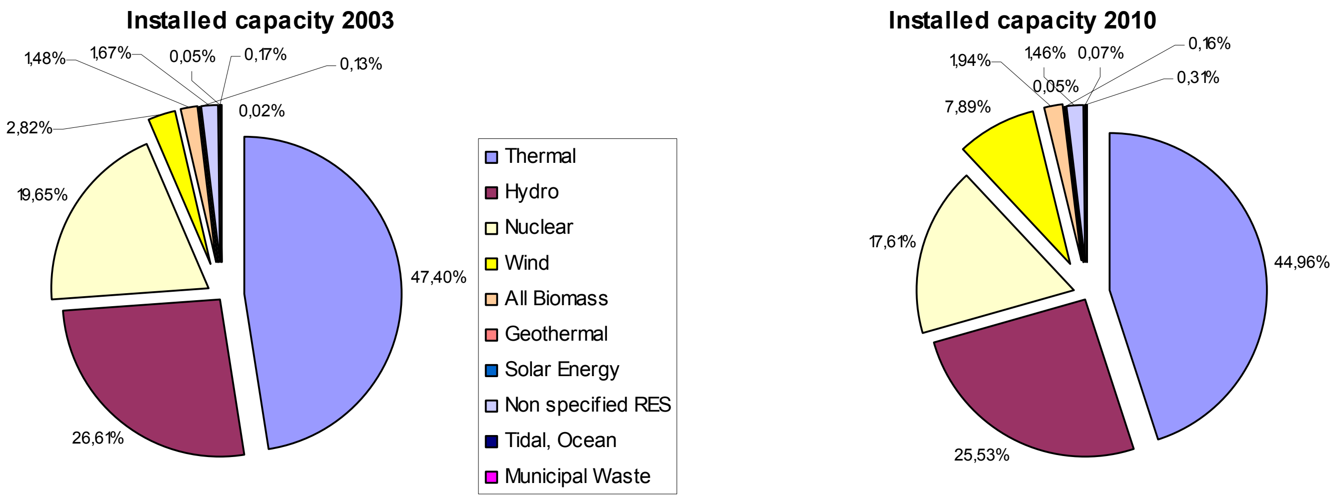


Figure 32: Comparison of the technology shares in CEER-states 2003/2010

The major changes expected in technology composition over the period can be found in wind power. The forecasted share of wind power in 2010 is 7.4 % which is equivalent to a 265% percentage increase compared to the capacity in 2003. The forecasted increase in wind power capacity range from 46 % increase (Denmark) to 14 folded increase (Norway). A run-through of the member states respective forecasts shows a majority relies on wind power as the main contribution of RE-capacity towards 2010. The cost of wind power has decreased by 50 % over the last 15 years and wind power as a technology is ready to cover a significant share of Europe's electricity production.

Note that current production still is very concentrated to the three big wind nations, Germany, Spain and Denmark. Several countries give positive signals with new "wind friendly" policy systems and pioneer off-shore projects. The positive examples may induce an increased focus on wind power development in countries that still move slowly.

	1991		2003		2010		Growth rate	
	MW	%	MW	%	MW	%	1991 - 2010	2003 - 2010
Thermal	200,241.40	46.70%	245,385.79	47.40%	258,544.93	44.96%	29.12%	5.36%
Hydro	127,152.40	29.65%	137,773.82	26.61%	146,800.00	25.53%	15.45%	6.55%
Nuclear	94,336.70	22.00%	101,711.00	19.65%	101,268.00	17.61%	7.35%	-0.44%
Wind	533.00	0.12%	14,618.70	2.82%	45,399.00	7.89%	8417.64%	210.55%
All Biomass	2,911.80	0.68%	7,671.24	1.48%	11,149.00	1.94%	282.89%	45.34%
Geothermal	569.00	0.13%	661.43	0.13%	941.21	0.16%	65.41%	42.30%
Solar Energy	5.00	0.00%	115.20	0.02%	311.00	0.05%	6120.00%	169.96%
Non specified RES	2,657.00	0.62%	8,645.00	1.67%	8,424.00	1.46%	217.05%	-2.56%
Tidal, Ocean	240.00	0.06%	241.00	0.05%	415.00	0.07%	72.92%	72.20%
Municipal Waste	179.00	0.04%	859.00	0.17%	1,811.00	0.31%	911.73%	110.83%
Total	**428,825.30**	**100.00%**	**517,682.17**	**100.00%**	**575,063.14**	**100.00%**	**34.10%**	**11.08%**

Table 8: Installed capacity 1991/2003/2010 and technology shares in CEER

The category biomass as presented here is projected to grow with 32 % and have a total share of 2 % in 2010. The current growth rate for biomass is significantly lower than earlier expectations. In 1997 the European Commission expected that biomass would stand for 68 % of increased RE capacity while wind power covered 24 % and hydro, geothermal and solar the remaining 8 %. The situation today is that wind power is expected to stand for 50 % and hydro geothermal and solar together for 10%. In order to cover the remaining 40 % biomass requires a yearly growth of 18 % (compared the former 7%). There may be a need for future policy efforts to focus on biomass rather than wind power.

As shown in the lower section of Table 9, the minor technologies (denoted “others”) are forecasted to hold their positions with a share around 2 %, even though respective percentage increase is large. Solar PV technology give the same signals of development that wind power gave some 10-12 years ago and may consequently give a significant contribution in 10-20 years.

7 Regulation versus RES-E support

Despite the fact that regulatory authorities have no or few competences in the field of RES-E, there are some key factors regulators can influence to support RES-E.

7.1 Customer information

The opening up of the electricity market in the European Union will gradually give all consumers a choice of supplier. This choice can be based on price, quality and reliability of service, but can also relate to the generation characteristics of the electricity supplied.

In 2001 the RES-E Directive introduced the concept of a Guarantee of Origin (GoO) for RES-E, mutually recognised by Member States. By 27th October 2003, Member States are required to have set in place legislation which establishes a system that will enable renewable energy generators to obtain a GoO on request for electricity produced from the plant. Whilst Member States are required to recognise GoO from other EU countries, it is not necessary established systems are identical.

Article 5 (6) of Directive 2003/54/EC establishes a mandatory disclosure system for all electricity suppliers, which have to inform the end consumer on the contribution of each energy source to the overall fuel mix of the supplier over the preceding year.

DG TREN published an explanatory note[7] regarding this topic. The objectives of this specification are fourfold:

- *increase market transparency by providing open and easy access to relevant information,*
- *comply with the consumers right to information regarding purchased products,*
- *enable consumers to make informed choices about suppliers based on the generation characteristics of the electricity they supply,*
- *educate consumers and stimulate electricity generation that contributes to a secure and sustainable electricity system.*

[7] Note of DG Energy & Transport on Directives 2003/54, and 2003/55 on the internal market in electricity and natural gas.

In order to the customer's supplier choice it is important, that systems for GoO and disclosure are reliable, transparent and minimize the potential fraud risks (double issuing, double selling, and double counting).

Challenge	Recommendation
For developing the internal energy market the correct **information** is of high importance. The field of RES-E is very sensible and sometimes only the benefits are communicated. But as for every alternative, there are also counter arguments such as cost and energy inefficiencies. Customers, which are financing the system, need **reliable and objective information** on this topic in order to optimize their decisions. In most of the EU-Member States RES-E is supported by law and customers have to pay for it. In order to proof the customer that he hasn't paid extra adequate means have to be installed.	In order to avoid suboptimal future decisions the **objective information** should be communicated. To strengthen the reliability of the support system and to give the **customer the possibility to control** it, a harmonised system for guarantees of origin and disclosure both and on the national and the European level should be supported by • Standardising definitions (energy sources, minimum information set for GoO, etc.); • Helping to install an electronic database, which is the only means to avoid double issuing; • Inform national governments on possibilities to harmonise national GoO and disclosure system (defining interfaces, etc.); and • Offering the customer access to the relevant information on used energy sources and their impact on the environment.

7.2 Permissions

Article 6 RES-E Directive points out that, Member States shall evaluate the existing legislative and regulatory framework with a view to:

- reducing the regulatory and non-regulatory barriers to the increase RES-E,
- streamlining and expediting procedures at the appropriate administrative level, and
- ensuring that the rules are objective, transparent and non-discriminatory, and take fully into account the particularities of the various RES technologies.

Investors in RES-E encounter various administrative steps to be taken previously to the actual construction of a plant; planned power plant must be approved by a government agency and requires at least two types of permissions:

- Construction permits
- Connection to the grid

The problem for investors is that lead times can vary a lot from one country to the other, but also within a country from one region to the other and even more often from one project to the other.

A comparison between the occurred lead times for wind power within Europe is shown in Table 9.

Lead times for the planning phase in wind power (in years)				
Wind power	Min	Max	Average	Ratio Max/Average
Austria	0,6	5,0	2,0	2,5
Belgium	1,0	10,0	2,5	4,0
Denmark	1,0	5,0	2,5	2,0
France	3,0	6,0	3,5	1,7
Germany	0,5	4,0	2,0	2,0
Greece	2,5	7,0	4,5	1,6
Ireland	1,0	4,0	1,5	2,7
Italy	2,0	6,0	3,5	1,7
Luxembourg	1,5	4,5	2,5	1,8
Netherlands	0,5	3,5	2,5	1,4
Spain	1,0	8,0	3,0	2,7
UK	0,5	5,5	2,0	2,8

Quelle: ECN

Table 9: Lead times for the planning phase in wind power

Two kinds of lead times can be discerned:

- Techno-economic lead times
- Administrative lead times

The techno-economic lead time can hardly be influenced by regulators but regarding the administrative lead time some permits also affect the duties of regulators:

- Grid connection
- Contracts with local electricity companies or grid companies (in the case of feed in tariffs)

Usually there are also other permissions (land law, environmental law) and most of these regulations are supervised by different authorities, with different procedures, forms and attachments. In addition, there can be differences between lead times experienced in the different regions of the same country. That is the case in the UK: in Wales, the planning phase goes up to 3 years, while in Scotland it is 1.5 years. England lies somewhere between the two. This is also the case in Spain, as authorisations for construction are given by regional governments and no single uniform criteria exist across the country (therefore, 17 different approval procedures).

Challenge	Recommendation
On one hand, grid extension and the building of power plants are often delayed due to long lead times or non-transparent methodologies for connection to the network. This is the case for both fossil and renewable plants. Adequate procedures can help to develop the internal market. On the other hand also small RES-E owners are part of the (technical) system and have therefore to respect the characteristics of the existing grid and the possible impacts of small units on the grid. In general, the rules for network access applying to RES-E producers should be the same as for other types of energy sources.	One should support the national authorities to shorten the lead time by • designing guidelines on which permissions are needed • creating lighter procedures for small projects and • streamlining and expediting procedures at the **appropriate administrative** level. **Regulators** should assure that DSO fully comply with Article 7 RES-E Directive but should also protect and support the high level regarding security of supply, which can be negatively influenced by uncoordinated extension of power plants.

7.3 Stimulating demand-side management

The main approach to achieve the targets of the RES-E Directive is to increase the share of RES-E. Although there are many benefits from a growing share of renewable electricity, such as

- reduction of greenhouse gas emissions,
- reduction of acidification gas,
- a more diversified resource basis,

- avoided risk of disruption in fossil fuel supply,
- contribution towards sustainability and
- increased local employment and income

the costs are also very significant.

Another possibility to reach the target is to reduce the electricity demand by demand side management measures.

With the proposal for a Directive regarding energy efficiency (COM (2003) 739(01); *Proposal for a Directive of the European Parliament and of the Council on energy end-use efficiency and energy services)* the European Commission offers an overall framework, completing the already existing Directives:

- 2002/91/EC on energy performance of buildings,
- 2000/55/EC – OJ L 279/33 on energy efficiency requirements for ballasts for fluorescent lighting,
- 2002/40/EC OJ L283/45 on labelling of electric ovens,
- 2002/31/EC OJ L86/26 on labelling of airconditioners,
- 2003/66/EC OJ L170/10 on labelling of refrigerators

as well as

- the regulation on Energy Star labelling for office equipment 2001/2422/EC OJ L332/1.

The measures to reduce the energy demand must be designed in an appropriate way to meet the need of the market (for example: there must be an adequate incentive to reduce electricity otherwise the actions are inconsistent with the decision structure of a benefit maximising agent).

Challenge	Recommendation
One of the main targets of RES-E support is to reduce greenhouse gas emissions and customers pay huge amounts of money to support RES-E in order to achieve this target. The focus of this instrument is on the production side. But there are also other alternatives to succeed. One of the cheapest options is to save energy on the demand side.	One should support demand side management measures by • offering adequate information about energy saving for end-consumers and • supporting the national and European authorities in designing the measures and incorporating them into the existing market model All actions shall only be taken, if the costs of the measures are not outweighing their benefits.

7.4 Technology and Grid Aspects of Distributed Generation

As part of its monitoring work, CEER has decided to issue a questionnaire (see annex) addressing the regulator's viewpoint regarding RES-E and the current developments in this sector, which was prepared by the Task Force Regional Energy Markets.

A main part of the circulated questionnaire was an analysis of difficulties that may occur in connection with RES-E. It is important to stress that the outcome of this report is not assigned to inhibit further expansion of RES-E, but to show an overall picture of the RES-E market including consequences of the support of RES-E.

The main share of the additional RES-E within the European Union will be delivered by wind power plants.

> *"In 1997, the Commission expected that 68% of the growth in electricity from renewable energy sources would come from biomass. 24% could come from wind power and 8% form a mixture of hydro, geothermal and photovoltaic power.*
> *Now, the strong growth of wind power means that it can be expected to contribute 50% of the increased need to achieve the targets set in the Directive."*[8]

[8] European Commission, The share of renewable energy in Europe, p. 20.

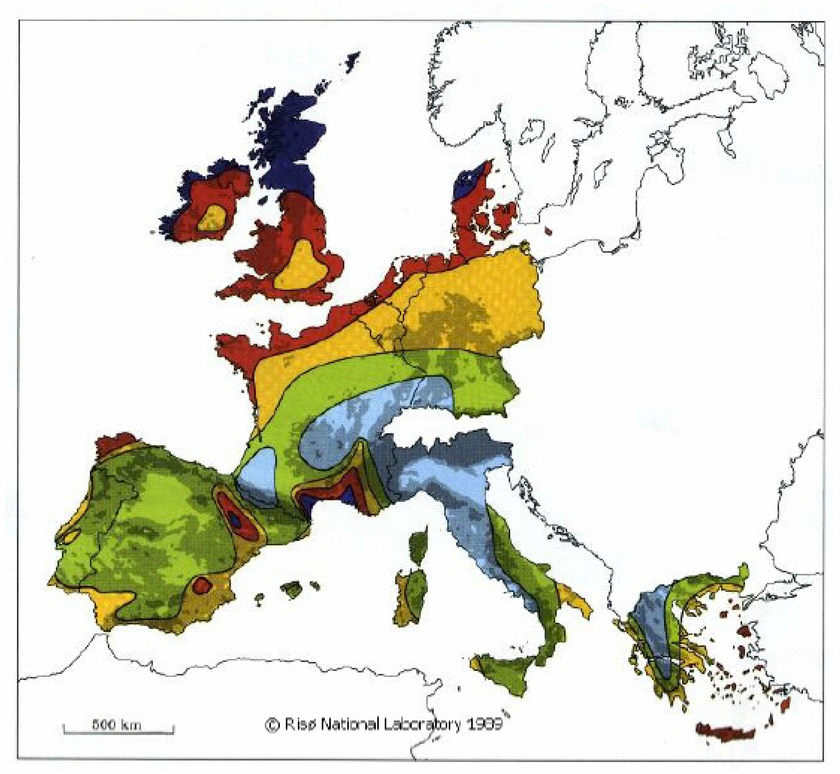
The installed wind power capacity in Europe covers 66,5% of the worldwide installed capacity in 2003. Within Europe mainly Germany, Denmark and Spain had an enormous development in the wind power sector.

Maximum Net Generating Capacity (MW)			Installed Wind Power [MW]		Share of Wind [%]	
Country	2002	2003	2002	2003	2002	2003
Denmark	13.316	13.253	2.880	3.080	21,63%	22,79%
Germany	125.557	127.744	12.037	13.500	9,59%	10,63%
Spain	63.898	65.366	5.043	6.000	7,89%	9,25%
Greece	11.730	12.108	462	550	3,94%	4,65%
Netherlands	19.525	20.010	727	800	3,72%	4,08%
Ireland	5.003	5.207	137	140	2,74%	2,80%
Austria	18.605	18.817	139	450	0,75%	2,38%
Sweden	33.453	33.576	328	450	0,98%	1,34%
Italy	79.934	80.479	806	1.000	1,01%	1,25%
Luxembourg	1.164	1.524	16	16	1,37%	1,37%
United Kingdom	79.880	82.212	552	1.000	0,69%	1,24%
Belgium	15.436	15.272	44	60	0,29%	0,39%
Finland	18.469	18.558	41	80	0,22%	0,43%
France	115.754	116.800	145	240	0,13%	0,21%
Portugal	9.478	-	174	-	1,84%	-
Norway	28.059	28.214	97	200	0,35%	0,71%

Source: ABS Energy Research

Table 10: Installed wind capacity

It is worth mentioning, that the countries with the highest installed capacity are not equal to the countries with the highest wind potential. More details on the wind potential in Europe are attached in the annex.



Source: Risoe

Figure 8: Wind potential in Europe

In connection with RES-E power plant the following technical problems could occur.

Distributed generation in the European electric power supply has increased strongly over the past decade, a trend likely to continue in the years to come for many reasons, as mentioned already. With benefits in terms of reduction of losses, primary sources diversification and certain aspects of security of supply, distributed generation imposes some specific requirements on the transmission and distribution grids and is likely to impact the future balancing needs and systems. The key aspects relating to the grid connection of distributed generation are summarized. Since the large portion of the non-conventional generation in Europe is and will be realized as wind power, experiences with the wind power in the countries with the strongest wind power growth are presented.

7.4.1 Distributed Generation Impacts on the Grid

When discussing the grid impacts of distributed generation, one needs to explain the concept of "distributed capacity" - the following example can be used: one aim of installing distributed generation is to reduce the peak demand. However, distributed generation does not include any reserve capacity. Therefore the transmission/distribution grid must be able to cover at least some of the generation usually supplied by distributed generation. Hence, transmission/distribution lines will be overdimensioned and the load factor will be worse than without distributed generation. Since transmission/distribution grids are monopolies, the TSO/DSO will usually be able to recover the costs for the overdimensioned system and the poor load factor via higher transmission tariffs. Distributed capacity refers hence to all aspects of distributed generation and distributed resources adding on reserve capacity, e.g. stand-by generators or load management, to minimize the requirements for overdimensioning of transmission/distribution grid.[9]

The connection of distributed generation leads to changes in the electric power flows direction, fault-currents, and other aspects, requiring a redesign of certain components of the distribution grid like e.g. local fault protection systems. Furthermore, distribution grids have usually a radial or loop design, and not a meshed design like transmission grids. Electric power flows in distribution grids without distributed generation are usually one-directional and no or little redundancy exists. Without starting an in-depth discussion it is fair so say that the distribution grids with high integration of distributed generation would need to be re-shaped and adapted to the changed conditions. These changes will be reflected in the grid access and connection conditions. Moreover, because of the need to provide balancing and reserve on a global level, the need for reliable and sufficient transmission grid capacity will remain even with the intensive distributed generation in the future.

The key impacts of the distributed generation and the grid are explained below. A large variety of these impacts makes the analysis of grid integration issues very complex. Furthermore, local grid conditions have an important influence on the grid connection, as explained later. Hence, each grid will require a detailed analysis.

Power Quality - the somewhat vague term “power quality” is used to describe a wide set of parameters and impacts characterising the interaction between generators and consumers over the electric power grid. Both for conventional and for distributed generation, the respective power quality standards must be complied with in planning and in operation of the sys-

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[9] Achermann,T.; Andersson, G.; Söder, L.: Distributed Generation: A Definition, Electric Power Systems Research 57 (2001), p. 195 – 204.

tem. Power quality is characterized by several key phenomena related to a given point in the electric power system value chain.

Voltage drop – Electric power flows cause voltage drop and losses over the transmission and distribution lines. The connection of distributed generation close to consumption can reduce the power flows and therefore significantly impact local voltage levels and losses[10].

Voltage variation - The steady state voltage tolerances are normally -10 % to +6 % of nominal voltage at a given level. However, dynamic (fast) voltage variations become a nuisance at distributed grid penetration as low as 0,3 % in the weak grids[11]. These variations are often found in remote areas where for example the wind conditions are best. This can be the limiting factor of for a permitted installed distributed (wind) generation power in such areas.

Flicker - One specific kind of fast and small voltage variations. It is manifested through "flickering" of the electric light beyond a specific threshold based on the capability of human eye.

Harmonics - are a phenomenon associated with the distortion of the fundamental sine-wave of the grid voltage, which is purely sinusoidal in the ideal situation. Harmonic disturbances are produced by many types of electrical equipment including also the type of generators used e.g. for some distributed generation (asynchronous generators). Depending on their harmonic order (i.e. the multiple of the basic grid frequency of 50 Hz), harmonics may cause different types of damage to different types of electrical equipment.

Transients - Connection and disconnection of electricity equipment in general and generators / motors especially, gives rise to so called transients - short, very high, inrush currents to the generator in the primary circuit, and one with zero or low rating in a secondary circuit of an induction generator.

Stability - The electric power systems used worldwide today are based on alternating current (AC systems). That is, the voltage constantly changes between positive a negative polarity and the current changes its direction. The number of changes per second is the frequency of the system with the unit Hertz (Hz).The frequency of the system is proportional to

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[10] Achermann,T.; Andersson, G.; Söder, L.: Distributed Generation: A Definition, Electric Power Systems Research 57 (2001), p. 195 – 204.

[11] Sustelnet, Review of Technical Options and Constraints for Integration of Distributed Generation in the Electricity Network, Final Version 1.1.

the rotating speed of the synchronous generators operating in the system and they are – apart from an integer even factor depending on machine design – essentially running ant the same speed. One says that the generators run in synchronous operation. Increasing the load in the system tends to slow down the generators and if that is not controlled and balanced the frequency falls. Eventually, without control and balancing the overloaded synchronous system will fall out of synchronisation, the generators will split from the grid and the supply will be interrupted.

Reactive power is a concept associated with oscillating exchange of energy stored in capacitive and inductive components in a power system. Reactive power is for example produced in capacitive components (e.g. capacitors, cables) and consumed in inductive components (e.g. transformers, motors). The synchronous generator is special in this context as it can either produce reactive power when over-excited[12], or consume reactive power when under-excited.

Asynchronous generators - Medium-sized and small generators are often not synchronous but asynchronous machines (also known as induction generators), since they are significantly cheaper than synchronous generators. Asynchronous generators, however, have different operational characteristics than synchronous generators. For example, a directly grid-connected asynchronous generator is not capable (if not equipped with additional control gear) of providing reactive power. It actually takes reactive power from the grid during the start-up process and operation. Different technical options exist to overcome the disadvantages of grid-connected asynchronous generators. Manufactures of generator technologies have used a large range of options, such as capacitors and power electronic converters. The consumption of reactive power in some asynchronous generators is in the order of e.g. 35 % of the rated active power. To minimise losses an to increase voltage stability, the asynchronous generators are compensated to a level between their idling reactive demand and their full load demand, depending on the requirements to the local Grid (System) Operator. In Europe a number of grid and distribution codices exist, specifying among others also different reactive power (var[13]) compensation.

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[12] Excitation is the direct-current voltage induced at the primary circuit (rotor) of the synchronous generator. While the rotor rotates, this excitation induces the secondary voltage at the stator of the generator connected to the grid.

[13] An abbreviation from VAr, Voltage-Ampere-Reactive.

Line losses are quadratically proportional with the current. Since the active and reactive currents are perpendicular to each other, the total resulting current is the root of the squared sum of the two currents and the reactive current hence contribute as much to the system losses as does the active current. To minimise the losses it is necessary to keep the reactive current as low as possible. This is accomplished by compensating reactive consumption by installing capacitors at or close to the consuming inductive loads. Furthermore, large reactive currents flowing to inductive loads, are one of the major causes of voltage instability in the grid due to the associated voltage drops in the transmission/distribution lines**.**

7.4.2 Connecting Distributed Generation to the Grid

As described in previous section, numerous aspects can impact the connection of distributed generation to the grid and eventually limit the permitted installed power in certain cases.

Distribution networks have usually a radial or loop design, and not a meshed design like transmission networks. Therefore, the power flow in distribution networks usually is one-directional and no or little redundancy exists. Connection of distributed generators is compromised by the affect it has on the local distribution system. Among the impacts mentioned earlier and related to the power quality in general, especially the steady-state voltage rise is a common delimiting factor for permitted installed power of distributed generation. A number of techniques can be applied to limit steady-state voltage rise, some of which are static in time (e.g. network reinforcement) and some dynamic.

A general characteristic of non-dispatchable generators to which a large part of distributed generation belongs, is a fluctuating power output which is usually not directly correlated with the electrical load. The resulting network voltage fluctuations superimpose themselves on existing fluctuations caused by changes in load and may lead to a widening of voltage bands. This widening of the voltage bands uses up grid reserves which are then not available for other grid users. Increase of generator reactive import or export (inductive or capacitive) can to a certain degree also increase the voltage bands. This could however be desirable from the point of view of optimising the reactive power flow in higher voltage levels. Therefore the power factor of a distributed generator should not generally be set to a fixed value (often 0,9 or 1) but should be regarded as a degree of freedom of the connection which is set in every individual case in order to meet the local grid requirements.

The grid connection of distributed generation will be limited by the allowed voltage bands or by the current of the grid. Therefore it is sometimes necessary to build new grid capacity. The costs for grid connection can be split up in two: the costs for the local electrical installation (e.g. own local grid) and the cost for connecting the generator to the grid (e.g. distribution grid). The costs for connection to the grid ranges from virtually zero for a small generator connected to an adjacent voltage line and can on the other hand require e.g. a complete new transformer station (LV/MV) or additional lines to the next possible grid connecting point. Finally, the actual costs for reinforcing the grid because of the distributed generation connection would also depend on whether deep or shallow tariffs apply.

There exist two general approaches in planning of the grid connection of distributed generation:

1. Only the customer requirements are relevant for the decision whether or not a distributed generator may be connected and how the grid connection has to be designed. The grid operator checks a possible interference in every single case. This procedure is applied e.g. in the UK, with the respective quality standards defined in grid and distribution codices[14].

2. In order to make the handling of a large number of distributed (including renewable) generation grid-connections easier, special grid-connection rules are set up and must be met as a pre-condition before a decision is made on whether or not a distributed generator is connected. The German and Austrian market arrangements, grid and distribution codices define such connection rules and customer requirements.

7.4.3 Wind Power Experiences

As already explained, a large part of present and future non-conventional generation in Europe is and will be realised as wind power. Some experiences and lessons learned from the countries with the high installed wind power and high percentages of wind power in terms of total installed power are presented shortly.

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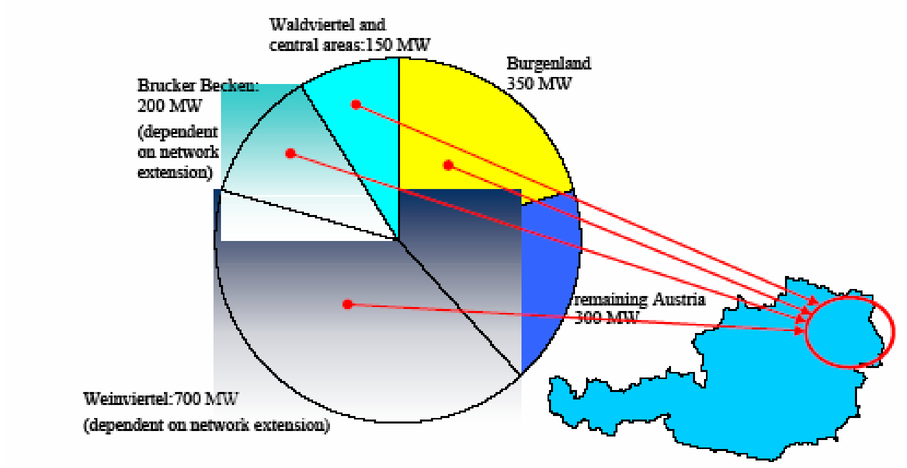
[14] [14] Sustelnet, Review of Technical Options and Constraints for Integration of Distributed Generation in the Electricity Network, Final Version 1.1.

- Austria

  Goals - In the Green Electricity Act of 01. January 2003, the Austrian Government set the goal to achieve in 2010 the national target of 78,1% electricity produced from renewables (Austria has approximately 70% hydro-generation). The increase from 1,5% to 4% would be achieved in wind and biomass. The intermediate goal to have 500-800 MW installed wind power in 2008, has already been reached in 2004 (>500 MW).

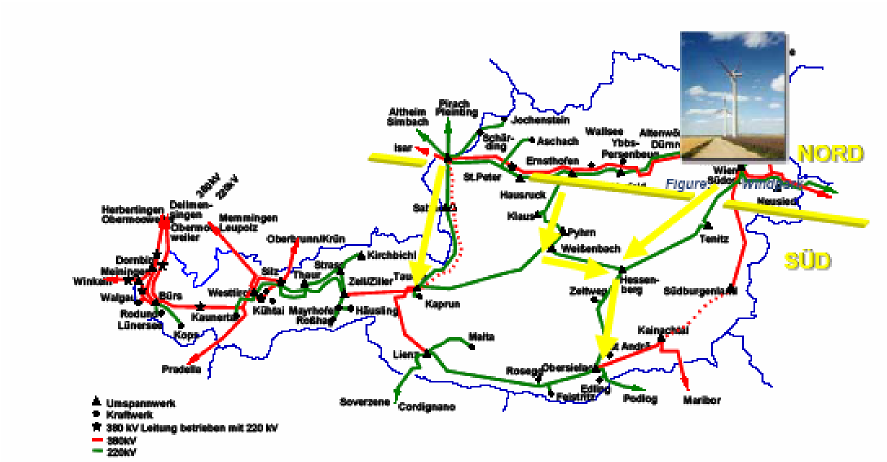
  Wind situation – due to the wind availability (1,600 – 2,200 full operating hours/year), virtually all the newly installed wind generation in Austria is concentrated in the north-east of the country. This increases the already existing unbalance between the large generation surplus in the north and deficit with high consumption in the south of the country.



Source: E-Control/Consentec

Figure 9: Wind power in Austria

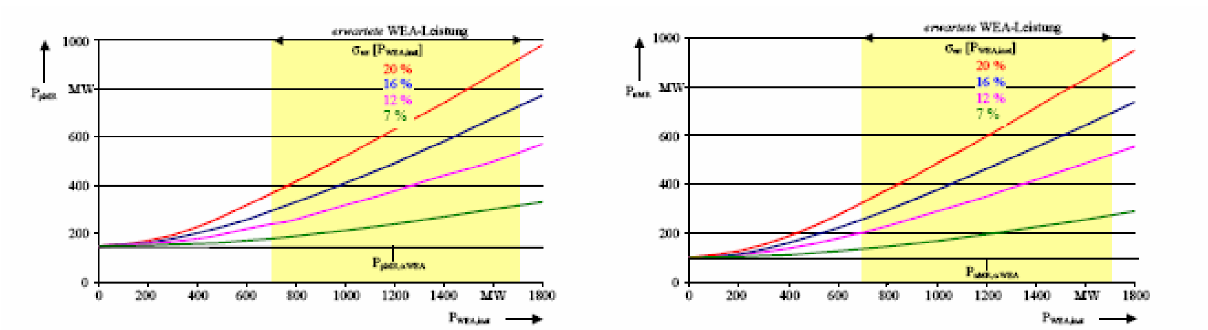
Grid situation – grid reinforcements with new lines and substations are required for wind generation connection to the grid in all the four areas with highest wind potential. The missing part of the Austrian 380 kV ring is the most important factor impacting the grid connection of the wind generation. In combination with the already mentioned unbalance between the high generation in the north and deficit in the south, the new wind power generation contributes to the overload of the weak 220 kV north-south lines, requires additional congestion management measures (redispatch) and eventually leads to the deteriorated operational security of the system in certain (n-1-unsecure) situations.



Source: E-Control / Consentec

Figure 10: Congested lines within Austria

Balancing power demand has not increased so far due to the relatively good forecasting of wind (approx. only 14% deviation) and the present installed power that is still below 700-800 MW. According to the results of the study commissioned by E-Control in 2003[15], the significant increase of the demand for positive (P_{pMR}) and negative (P_{nMR}) balancing power, especially tertiary reserve, could be expected by the end of 2004/2005, presuming the installed power of around 700 MW is reached, as indicated in the figures below.



Source: E-Control / Consentec

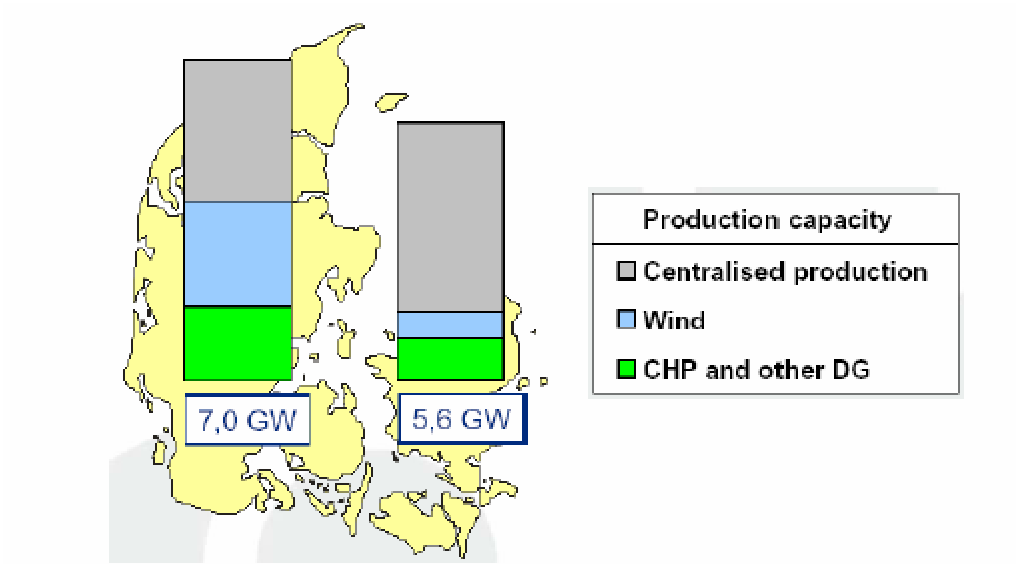
Figure 11: Balancing costs in Austria

- Denmark
  Goals – The aim of the government of Denmark set in 1996 was to have 1,500 MW wind power installed by 2005, corresponding to 10% of the electricity production. This goal was reached already in early 1999. In the long run, the aim is to have 5,500 MW wind

[15] Constentec, Windkraftstudie im Auftrag der Energie-Control GmbH, 2003.

power installed by 2030. The intention is that the main part, about 4,000 MW is installed offshore.

Wind situation – wind availability (offshore) in Denmark has a comparably high value of 3,200 – 3,800 full operating hours / year. This is significantly higher than many other European countries and has therefore led to the highest percentage of wind power in terms of total installed power of all European countries so far. Of all European countries, Denmark has so far successfully integrated the highest rate of distributed generation, the present situation being shown in the following figure.



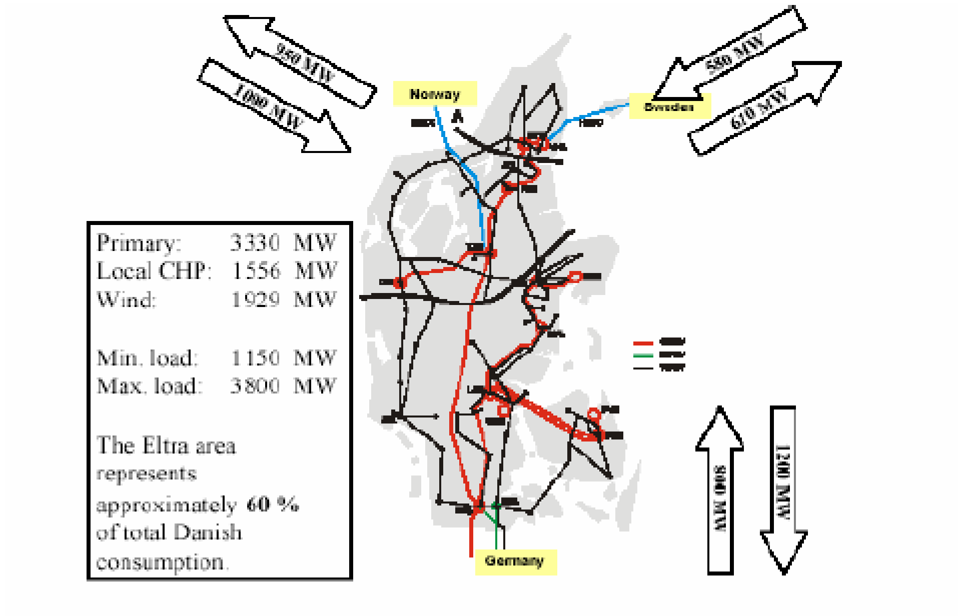
Source: EU Project Sustelnet/Eltra

Figure 12: Installed capacity in Denmark

The 90% of distributed generation capacity (of which a large portion is wind power) has been built over the past 10 - 15 years. However, recently increasing costs of wind power have raised many discussions on how to proceed with the ambitious goals to further increase the distributed generation, notably wind. Especially wind power system costs are increasing non-proportionally for each incremental unit of wind power, affecting thus transmission / distribution, balancing and ancilliary (system) services.

Grid situation – The (Eltra, West Denmark) electric power system includes transmission and distribution grids. Eltra is co-operating with regional transmission and distribution grid operators to provide transport services. The rules for this co-operation are defined by law.

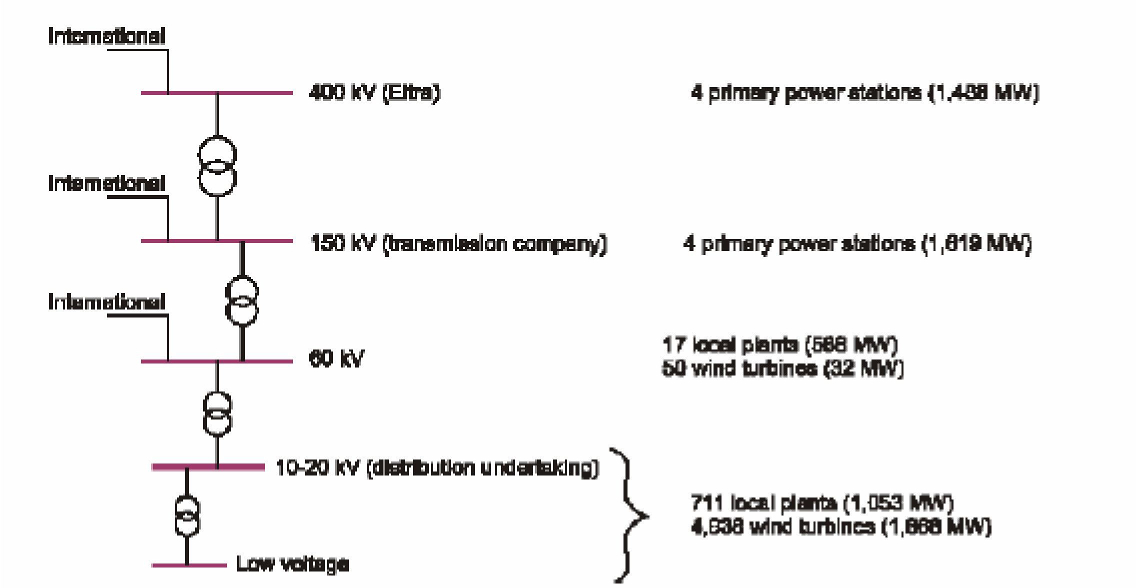
The Eltra grid and the underlying concept for massive integration of the distributed generation (including wind) into the electric power system are shown in the figures below.



Source: Eltra

Figure 13: Grid situation in Denmark

Balancing power – With more than 20% of total installed power in wind generation, a special attention is paid to the reserve requirements in general and balancing in particular. Eltra has developed a well proven concept of massive integration of distributed generation at different voltage levels that is accordingly complemented in the distributed balancing and ancilliary services provisioning, mainly concerning local issues like voltage and reactive power management. Still, some analyses show (and discussions are ongoing with the stakeholders and decision makers) that at least 40% of each newly installed wind power MW should be covered through the (new, thermal) conventional generation.



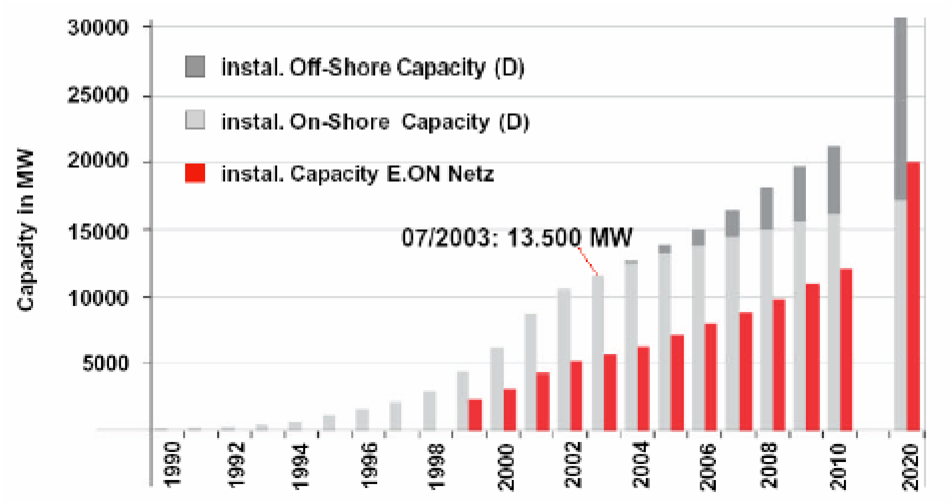
Source: EU-Project Sustelnet / Eltra

Figure 14: Generation structure in Denmark

The distributed mini/micro thermal generation has also increased significantly in Denmark over the past decade. This may also be a sound basis to compensate for the above mentioned "40%". A prerequisite for that would be an even more advanced distributed energy and balancing management.

- Germany

  Goals - With already the worldwide-highest total installed wind power of more than 12,000 MW in 2003, Germany is set to reach 20,000 MW until 2020. The earlier set goal to reach 12,500 MW wind power in 2010 has already been surpassed 7 years in advance. For Germany, this rapid growth in wind power is considered central to reaching the country goal of reducing carbon emissions 405 by 2020.

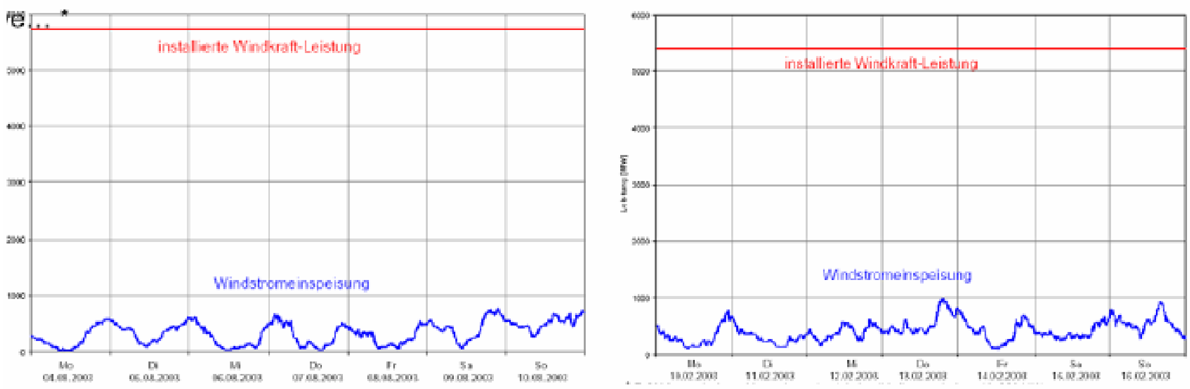


Source: E.On

Figure 15: Installed wind capacity in Germany

Wind situation – The wind availability in Germany varies from modest 1,600 up to 3,000 and even higher total operating hours per year for the best off-shore locations. The diversity of "quality" of wind locations in Germany is illustrated in Figure 8 that shows wind availability throughout Europe.

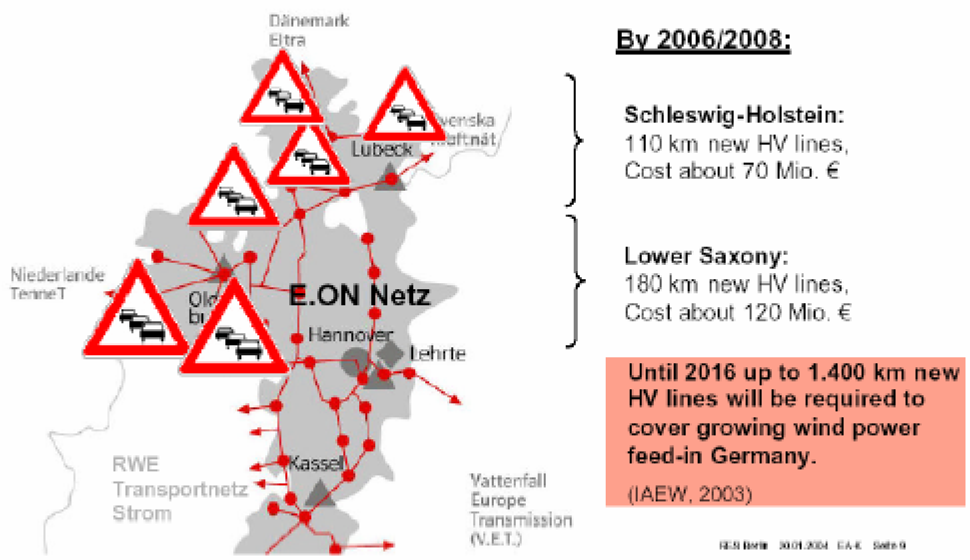
Moreover, the high installed wind power in the German system, increases dependency on wind availability in times of peak load. However, it is often so that just in such times, the wind availability is low and the (much needed) wind power generation remains well below the installed capacity as illustrated in the following figures for the 2003 summer hot-wave and the 2003 winter.



Source: E.On

Figure 16: Contribution of wind power in Germany

Grid situation – In general, the German transmission and distribution grids have been traditionally strong and capable of providing high quality and reliability of supply (distribution) as well as operational security (transmission). Nevertheless, because of the wind power boom and especially following the large offshore installations, numerous new bottlenecks and congestions have appeared in German medium and high voltage grids that will require massive reinforcements and cause significant costs, as illustrated for the E.On grid in the following figure.



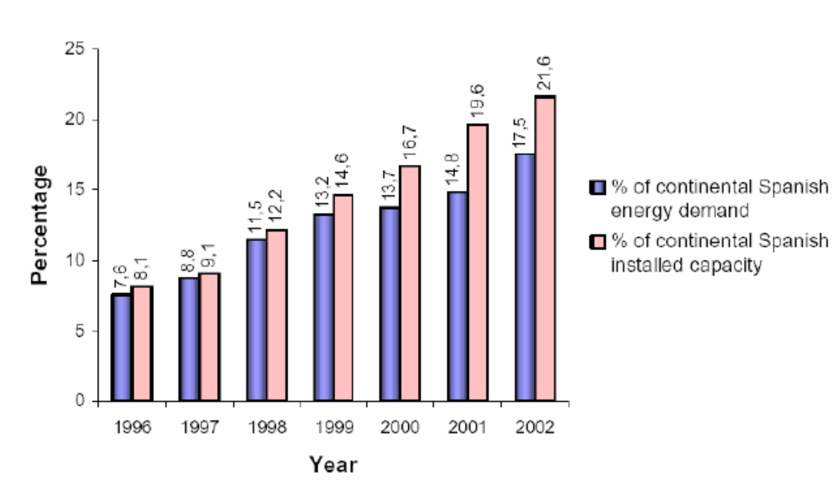
Source: E.On

Figure 17: Congested lines in Germany

Balancing power – As indicated already above, one of the key problems with the wind power is wind availability in times of peak load, often not compatible with the actual load /demand situation. Therefore, whereas in theory the total installed wind power of almost 13,000 MW in Germany, would correspond to some 26 large coal fired plants, the electricity generated by wind power is much lower. This accounts according to some studies (source Uwe Boehmer-Beuth, Warburg & Co KgaA) to only 17% on average in Germany or 1,500 full operating hours / year. In order to compensate for (naturally conditioned) unpredictability of wind power, conventional (in Germany thermal) generation is mandatory in order to preserve electric power system integrity and security of operation. In a very simple calculation based on the above rough figures, it could be said that some 83% of installed wind power should be secured in conventional generation. Without a detailed discussion, an important question is in this case the total effect on carbon emissions.

- Spain

  Goals – In the Spanish electric power system with 40,000 MW peak load, 220.000 TWh annual consumption and some 20 mio. customers, the distributed generation from renewable sources – notably wind – is mainly needed for reduction of carbon emissions and reaching (or at least coming close to) the defined Kyoto goals for the country. Presently Spain has some 5,800 MW CHP and 6,000 MW installed wind power, being thus the second European country in terms of absolute installed wind power. The following figures illustrate the development of distributed ("special") generation in Spain over the past decade.



Source: EU Project Sustelnet / Comilas University Madrid

Figure 18: Distributed generation in Spain

	Installed capacity (MW) 1998	2003
CHP	3.700	5.800
Wind	770	6.000
Solar	1,1	8,5
Mini-hydro	1.200	1.560
Biomass	60	360
Waste	200	820
Total	**7.929**	**16.552**

Source: EU Project Sustelnet/Comilas University Madrid

Figure 19: Distributed generation in Spain

Wind and grid situation – Due to its geographic position and characteristics, Spain has relatively high wind availability between 1,800 – 2,600 total operating hours / year. An important aspect of wind power integration is the grid connection arrangements that must be approved by all the three parties involved: distribution and transmission grid operator and the wind generator. With respect to the technical aspects, an additional important aspect has been newly solved by the new Spanish regulation RD 436/2004, concerning the reactive power, as indicated in the following figure.

	Power factor	Incentive (% of average electricity tariff)		
		Peak	Intermediate	Off-peak
Inductive	<0,95	-4	-4	8
	1	0	4	0
Capacitive	<0,95	8	-4	-4

Source: EU Project Sustelnet/Comilas University Madrid

Figure 20: Wind and grid situation in Spain

Balancing power – The aspects of balancing mentioned for the previous countries apply in Spain too. Nevertheless, an important advantage with regards to congestion management, redispacth and balancing services in Spain is in the fact that all the generators scheduled to run day ahead are due to offer their remaining capacity to the peak to the market for redispatch, with the prices for this additional services derived based on the actual market situation. This relatively robust market design ensures that the technical aspects of balancing wind power will be easily met than in other market designs. Nevertheless, here too the question of actual real cost of wind and effect on carbon emissions (in light of additional thermal generation needed for balancing & compensation) remains.

Challenge	Recommendation
Both fossil and renewable power plants have impacts on the grid. RES-E has a high dependency on climatic conditions and thus leads to further challenges for the transmission system operator or the distribution system operator. To handle the occurring problems “heavy handed” organisational and technical rules are needed. The conditions for grid access must be clearly defined both for fossil and renewable plants. In order to maintain the high power quality and quality of supply there must be contracts involving all parties (power plant owner, TSO and DSO) that clarify the actions to be taken if there are problems regarding power quality and quality of supply. The TSO must have the possibility to react on arising grid problems and this must also be the case if decentralised power plants are connected to the distribution network.	To ensure the maintenance of the high power quality and security of supply adequate mechanisms both on the organisational and the technical side must be defined to minimize the impacts of new power plant on the grid. The individual characteristics of the national grid and of the national RES-E potentials must be taken into consideration. The problems with RES-E production decrease with full load hours. This also leads to the conclusion, that a uniform distribution of all technologies across the Union is absolutely not desirable.

7.5 Design aspects of RES-E support systems

Notwithstanding the European Commission supports RES-E with both a wide range of legislative framework and financial means, at the same time other Directives exist, that may hinder the extension of the most cost efficient RES – large hydro power – in the future.

The targets of Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy, that in some cases may run contrary to those of the RES-E Directive.

Challenge	Recommendation
The targets of various European Directives often compete with each other. The implementation of Directive 2000/60/EC will reduce the production of hydro power within Europe. This legislation is contradictory to the targets in Directive 2001/77/EC.	**At European level**: A harmonisation of various Directives that have impacts on the internal energy market by designing an integrated "master plan" that merge economic, technical and environmental targets, is recommended.

Besides the impact of different legislative framework the embodiment of a national support scheme determines heavily the success of the system or the disappointment.

Occured Problems Excerpt of "The share of renewable energy in Europe"		
Austria	•	In December 2003 the **contracting** of RES-E plants was **stopped**
	•	The processing of the "Einspeisetarifverordnung" was set out
	•	The **possible refusal** of the provincial governors to increase the cap on the surcharge for RES-E create potentially great **uncertainity**
Belgium[1]	•	**Three different** green certificate **markets** have started
	•	Because of the possibility of banking of certificates and increasing penalty rates and a shortage on certificates, not much of trading has taken place, **it is more favourable of paying penalties** in the first year
	•	The three regional different systems complicate the implementation of RES-E market
Denmark[2]	•	The introduction of a green certificate market has been announced but has not been implemented
	•	**Instability** of political environment
France	•	For RES-E installations up to 12 MW a feed in tariff system is foreseen
	•	Uncertainty in winning a bid for projects larger than 12 MW due to the tender process
	•	**Administrative and grid barriers persit**
Germany	•	Partially exploited potentials and **limited grid capacity** in the northern parts of Germany presently slow down growth of onshore wind energy on a high level of the market
	•	Most of low-cost potentials have already been exploited
	•	Offshore wind energy develops slowlier than expected due to **high costs** and **unsolved technichel problems**
Greece	•	**Administrative barriers** represent the most crucial constraint to further growth.
	•	The big danger is that the construction and reinforcement of the grid will be delayed, postponing as a consequence the development of RES.
Ireland	•	The tender is a stop-start programme where the future of target setting is unknown
	•	Projects eligible may not exceed certain capacity levels which may lead to a certain **inefficiency of the project design**
Italy	•	Grid connections/planning procedures/for > 50 MWh only
	•	Lot of red tape to apply (PV)
Netherlands	•	The political instability caused **uncertainty** on future energy support programmes with the consequent withholding of new renewable energy investments
Portugal	•	**Complex and slow licensing procedures** have resulted in long lead times for renewable installations

1: The EC report mentioned: "The year 2004 is crucial for completing the analysis of this country". The indicated problems mainly occurred in the starting periode. An indicator for the successful operating of the system is the 75 % growth rate for wind power in 2003.

2: Denmark points out that the reason for the postponement of the green certificate system was not "instability of the political environment" as mentioned in the EU-Report.

Table 11: Occurred problems in the field of RES-E support

The following examples show possible inefficiencies in detail:

7.5.1 Balancing Energy (Austria)

Most of the RES used for electricity generation is subsidized via guaranteed feed-in tariffs. In order to receive those payments renewable generators have to feed in their electricity into the public grid and they have to be a member of a so called “renewable balance group” (ÖKO-BG). Since Austria is divided into 3 control areas there are 3 ÖKO-BGs. The financial responsibility for the energy balance within the balance groups is borne by the “renewable balance group manager” (ÖKO-BGV).

According to the provisions of the Renewable Energy Act the respective TSOs of the control areas are responsible for the management of the ÖKO-BGs. They are obliged to buy the electricity produced by the generators, schedule it and allocate it to the suppliers. The schedules for the following day are based on generation forecasts. Each supplier that serves end users has to take the allocated electricity proportionately to his market share on the retail market (market for supplying end users). As a result each supplier has the same renewables proportion in his portfolio.

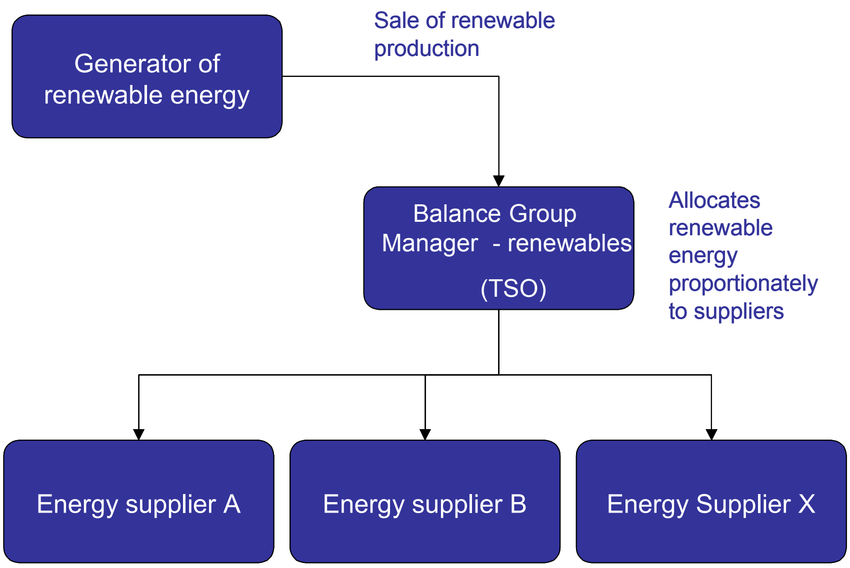


Figure 21: Operational flow - renewable energy support

The required payments to the generators are based on the feed-in tariffs and are financed by two funds. Approximately half of the required amount comes from surcharges to the grid tariffs paid by end users per unit electricity consumed (currently between 1,78 €/MWh and 2,39 €/MWh depending on the voltage level of connection) the other half is founded by the suppliers which have the obligation to pay the fixed amount of 45 €/MWh for the renewable energy allocated to them. The TSOs in their capacity as ÖKO-BGVs keep a separate account of the incurred payments and are compensated for the costs of managing the balance groups.

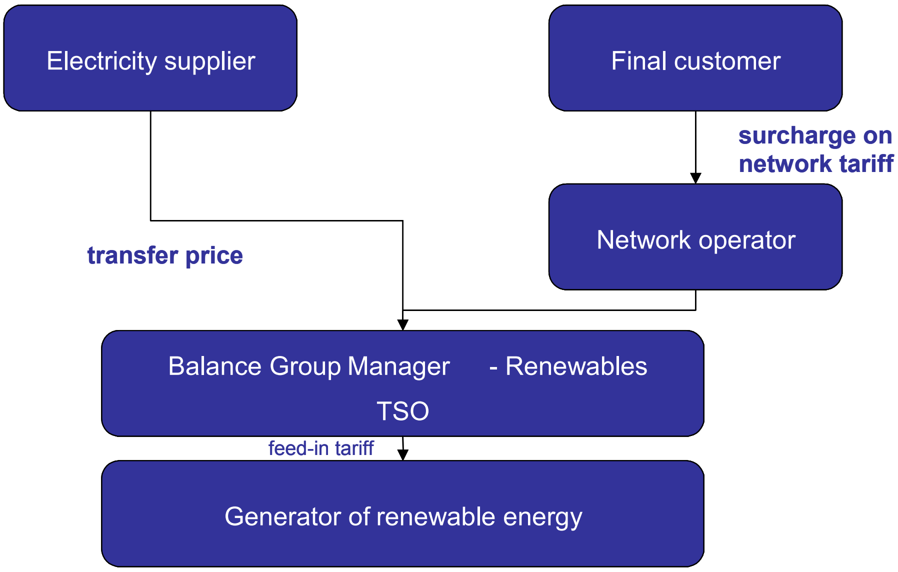


Figure 22: Financial settlement - renewable energy support

Since the ÖKO-BGVs allocate the green electricity according to their generation forecast made one to three days ahead of production there may by some gap between the schedules and the energy actually fed into the grid. To cover the difference the ÖKO-BGs are balanced on the balancing market and cleared against the imbalance price set by the market operator. The clearing itself is mandatory for every balance group.

The balancing market itself is organized in a competitive way and has been working since October 2001 more or less satisfying. Analysing the structure of the ÖKO-BGVs we can identify some characteristics.

Firstly, there are just generation metering points in this balance groups. Therefore no statistical compensation can occur between generation and consumption within the balance group. Furthermore the ÖKO-BGVs have no right to influence the actual amount of renewable electricity fed into the grid. The generation is rather difficult to forecast, because there is much wind and hydro generation and the current capacity depends on the water and wind situation.

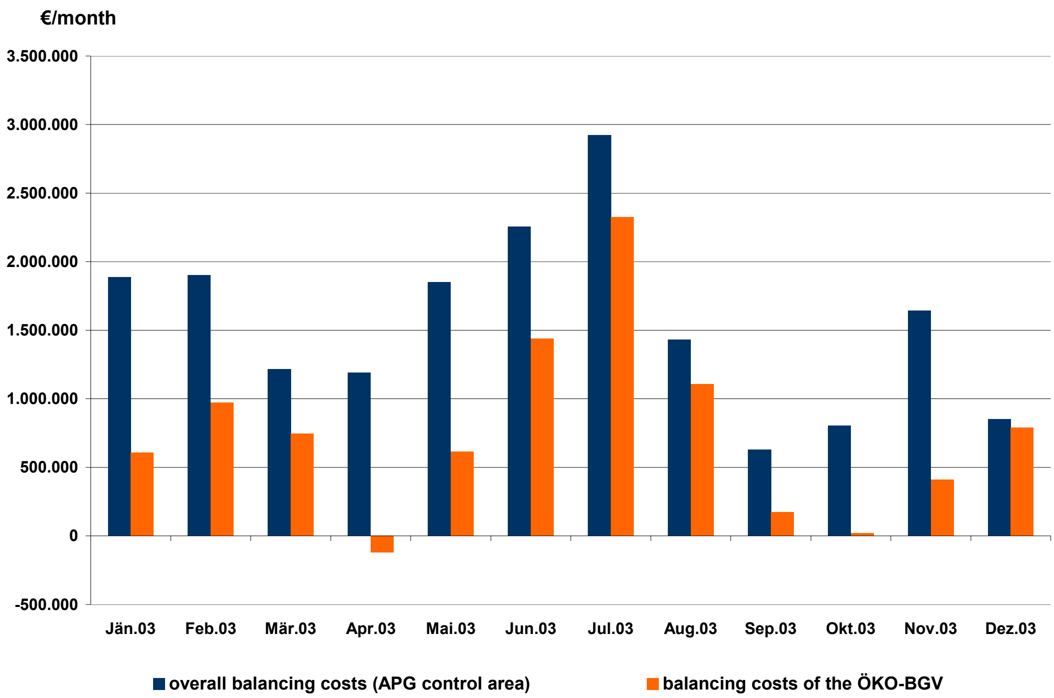


Figure 23: Overall balancing costs compared to the balancing costs of the ÖKO-BGV in the control area of Verbund APG

This initial situation resulted in balancing costs of about 9 million € in 2003 in the control area of Verbund APG, which is handling some 80% of all Austrian renewables production. Figure 23 show that the ÖKO-BGV has a huge share of the total balancing costs. This is mainly a result of the lack of control possibilities and some inflexibility in the energy allocation procedure to the suppliers. The allocation procedure takes place in advance (day ahead or even 3 days ahead for weekends) to give other balance groups (suppliers) the possibility to consider these quantities in their internal forecasting process.

Related to the energy generated by renewables the balancing costs are up to about 3 € per MWh (differs between control areas).

	cost (+) / revenue (-)	balancing costs 2003 in €	balancing costs per unit of fed-in renewable energy (€/MWh)
APG	imbalance cost ÖKO-BGV	**9.079.015,00**	3,19
TIRAG	imbalance revenue ÖKO-BGV	**-71.947,38**	-0,08
VKW-ÜNB	imbalance cost ÖKO-BGV	**675.095,96**	3,22

Figure 24: Balancing cost of ÖKO-BGVs in the Austrian control areas 2003

It has to be examined whether the Öko-BGV experiences some disadvantages in the balancing process that can be attributed to its special characteristics. Potential handicaps are obviously the above-mentioned difficult forecasting conditions of the generation and additionally the size of the balance group. A possible forecast error of the ÖKO-BGV has significant impact on the deviation of whole control area and on the price situation in the balancing market. From Figure 25 we can learn that there is a clear relationship between the deviation of the ÖKO-BGV and the deviation of the whole control area.

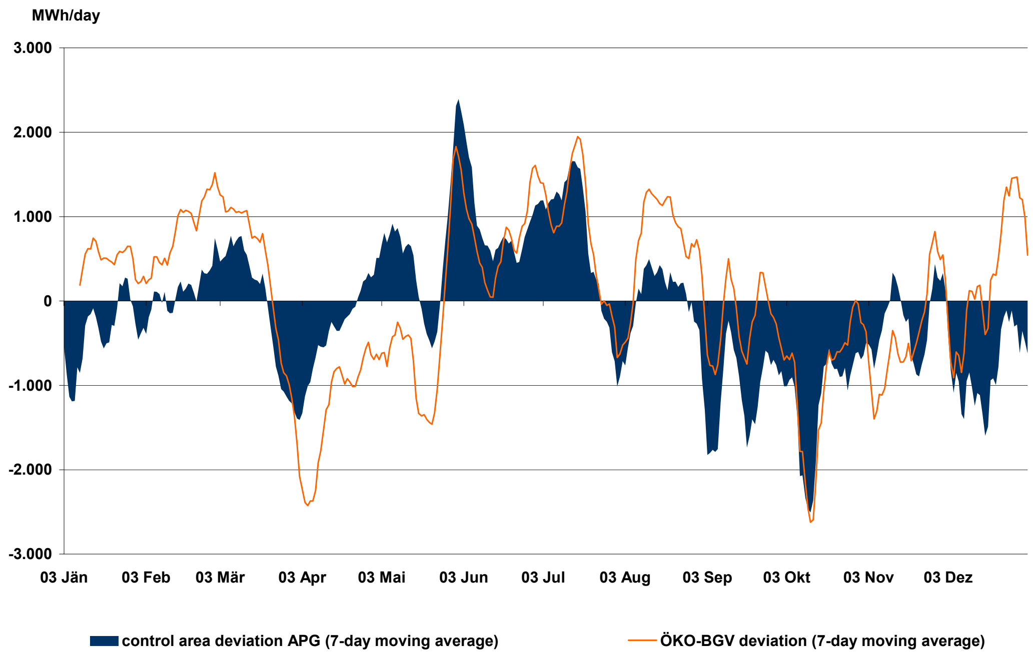


Figure 25: Deviation of the control area Verbund APG and the ÖKO-BGV

In order to create an efficient scheme for the promotion of renewables balancing costs should certainly be as low as possible. Nevertheless they have to be calculated correctly and made transparent. Beside various possibilities to reduce the total balancing costs in control areas it would be of special importance for renewables balancing groups as they exist in the Austrian scheme to initiate a higher level of short-term flexibility. If ÖKO-BGVs could e.g. trade on an intra-day market depending on the actual renewables generation, the balancing costs could be reduced. However, at the moment there is on the one hand a clear lack of liquidity in these short-term markets and on the other hand the legal framework does not facilitate such processes.

7.5.2 The FIT system for RES-E plants in 2002

The main argument against the FIT scheme is that it is not conforming to traditional market principals and that favourable tariffs are not being reduced in step with the technological development.

In some cases, like Austria, the very complex legislative basis led to some further discussion about this model:

> *"In some federal countries like Belgium and Austria, the political promoting system is very complex; some authors speak about a 'chaos'. In the nine different Länder of Austria there are nine different decrees concerning the payment for renewables, leading to about 100 different tariffs for only a tiny portion of the total electricity production. All these prices vary greatly, with highest and lowest prices showing relations of 32:1 for photovoltaics and 8:1 for biomass."*[16]

In addition there were different surcharges for end consumers, which are financing the system, and approximately 140 grid operators, who had the obligation to buy the offered electricity from RES based on § 32 Electricity Act 2000, what led to high administrative costs and was contradictory to the unbundling-principle.

Each of the nine *Länder* had to fulfil the targets based on the Electricity Act, but due to climatic reasons it was very difficult for some to achieve the aim; others, like *Burgenland*, excelled in reaching the targets, because of the high wind potential in this region.

[16] Reiche D., Bechberger M.; Policy differences in the promotion of renewable energies in the EU member states. Energy Policy 32 (2004) 843 – 849.

In 2002 the Austrian Parliament decided to introduce a uniform nationwide system for RES-E. The main arguments were:

- higher cost efficiency,
- higher energy efficiency,
- less complexity regarding the legislative basis and
- less costs for the end consumer.

7.5.2 Additional costs

In most CEER-Member States not all costs caused by RES-E are covered by the support scheme. In Germany, e.g., the following indirect costs have to be added to the wind power tariff:

- regulatory costs: 0,7 cent/kWh
- additional production costs of the existing conventional power plant of about 1,5 Cent/kWh and
- for necessary grid extension 1,5 Cent/kWh.[17]

Additionally, and especially in connection with wind power, there are balancing costs which are not covered by the German feed in tariff system and are not passed on to all German electricity consumers. These costs have to be paid by end-users in areas with high wind potentials and distort therefore both the internal and the regional market.

E.ON, one transmission system operator in Germany, pointed out that approximately 50 % of balancing costs of wind power in Germany where covered by E.ON Netz GmbH. But E.ON Netz GmbH has only a share of 30 % regarding gross electricity consumption in Germany, so E.ON customers have to cover more of the costs in relative terms.

[17] Ch. Schneller, “Renewable Energies: between Desire and Reality; An Appeal for National Wind Energy Concept”; in: Eurelectric; “A Quantitative Assesment of Direct Support Schemes for Renewables”.

Challenge	Recommendation
RES support schemes are affecting the Internal Energy Market. The design of the schemes is often not embedded the existing market model but exist parallel to it. Thus leads to additional cost and suboptimal production allocation of RES-E within the national and the European market.	**Regulators** shall support the appropriate authorities in designing the support scheme by offering information on the (potential) costs, such as balancing energy, and possible impacts on the gird and the market model. In order to reach a harmonised support system, **regulatory authorities** shall also report existing problems in connection with the support scheme to the European Commission. The main target should be to minimize the overall cost of the support system.

7.6 Financial aspects

7.6.1 Different support schemes

As outlined in Chapter 4 the existing support schemes vary a lot within the European Union. Besides the main support scheme, like a feed in tariff or a tradable green certificate system, in most countries other support mechanisms also exist (see Table 12).

	Feed-in tariffs	Certificates	Investment grants	Tax reduction	Tendering	Others
Austria	✓		✓			
Belgium (Brussels)*		✓	✓	✓	✓	
Belgium (Flandern)*		✓	✓	✓	✓	✓
Belgium (Walloon)*	✓ (minimum price)	✓	✓	✓	✓	
Denmark	✓					
Finland			✓	✓		
France[1]	✓				✓	
Great Britain		✓	✓	✓	✓	
Greece	✓		✓			
Iceland						
Ireland					✓	
Italy	✓	✓	✓			
Luxembourg	✓		✓			
Netherlands	✓	✓	✓	✓		
Norway			✓			
Portugal	✓		✓	✓		
Spain	✓		✓			
Sweden		✓				✓

[1]: Source: European Commission Report, 2004

*: Actually the support systems are identical in all regions of Belgium

Table 12: Support schemes within Member States

Most of the support schemes are not coordinated within a country what leads to the situation that RES-E producers often earn higher profits due to different support schemes that can be combined with each other. An investigation of E-Control in Austria uncovered that the annual rate of return is between 8 – 14 %.

A comparison between different EU-Member States regarding hydro power plants above 10 MW results in the following analysis: In Germany and Spain also hydro power plants above 10 MW are supported. In Germany, which has in some parts similar climatic conditions as Austria, the refurbishment of plants up to 150 MW is supported (not at the same level as small hydro power plants). This leads to a competitive disadvantage for Austrian hydro power plants. In Spain all hydro power plants up to 50 MW are supported with the same tariffs.

In connection with the implementation of Directive 2000/60/EC (a framework in the field of water policy) it would be rather counterproductive if as a result a large hydro power plant has to reduce its production (or has to be taken off the grid) while other less competitive hydro power plants receive further support.

Challenge	Recommendation
Due to higher production costs RES-E production must be supported in order to achieve the targets of the RES-E Directive. Various initiatives on the regional, national and European level are taken and are often not harmonised with each other. These subsidies can be combined in some cases, so that windfall-profits can be created. Different support schemes within European Member States lead also to potential competitive disadvantages of some market participants.	To design a cost-efficient support scheme, one should inform both appropriate authorities and customers on double subsidies regarding RES. For a guaranteed income (in the case of feed in tariffs) the annual rate of return should be on an appropriate level. Support schemes both at the European and the national level should be harmonised in order to spend the capital in the most effective and efficient way and to guarantee a sustainable growth of RES that complies with the rules of the internal market.

7.6.2 Production costs and potentials

The competitive position of large scale hydro power is manifest. The production costs of biomass based electricity and wind power are still at a level which leads to the need of subsidies to secure recovery of investments costs. However progress of wind power technologies has diminished the need for support given to new wind turbines for a shorter number of years.

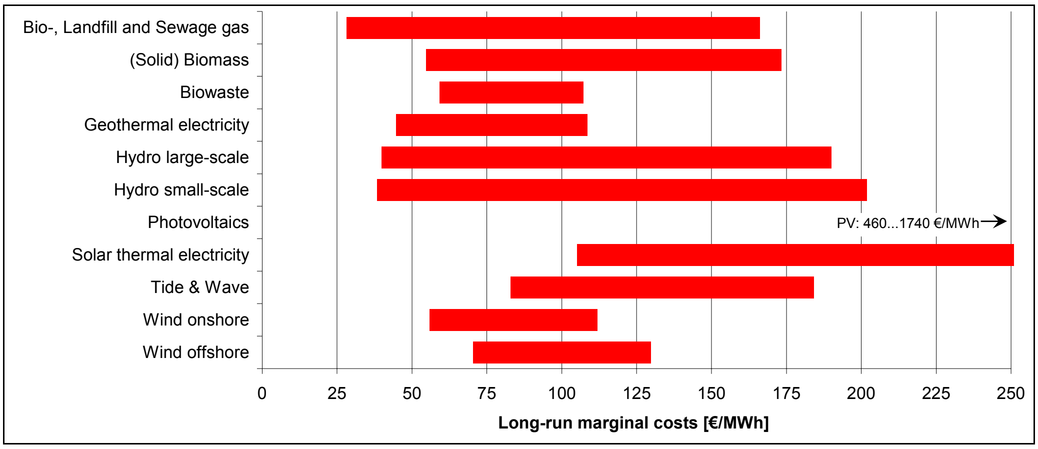
In general the average wind turbine installed to day does not represent the state of the art. The costs of production here require subsidies in a period of transition.

In general biomass plants have a capacity value in the electricity supply system. If look at in isolation, wind power need a back-up capacity to safeguard supply. However, apart from supply systems without connections to broader systems, the balancing power or capacity can be bought on the market to some extent. Progress of integration European regional markets into a single market contributes to relieve the balancing problem, but the question of costs still remains.

Due to the fact that the targets of the RES-E Directive are set on a national level and not on the European level different potentials and cost structures influence the decision on the support scheme and support level.

The production costs differ a lot between different RES-E technologies. High capital investment costs are an impediment for market penetration and being competitive within the electricity market.

In addition to high investment costs the operating cost for biomass plant are very high, due to high fuel costs.



Source: Rexpansion

Figure 26: Costs of RES-E in EU-15

One of the cheapest, but at least the most dominant, RES-E, large hydro power, is already the most exploited RES in Europe; but there are still potentials.[18] In Austria with it is large amount of hydro there are still project to be realised. But the impacts of ***Directive 2000/60/EC*** *of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy* could inhibit these projects.

The RES with the highest potential within the "new" RES (wind power, biomass, and solar energy) is wind power. In annex vii and viii an overview on the wind power potentials is given. The best areas for wind power are in the north of Europe and in some costal areas in the south.

[18] The European Commission pointed out "In fact, the development of small hydro lagged far behind the potentials that are seen for this source in Austria".

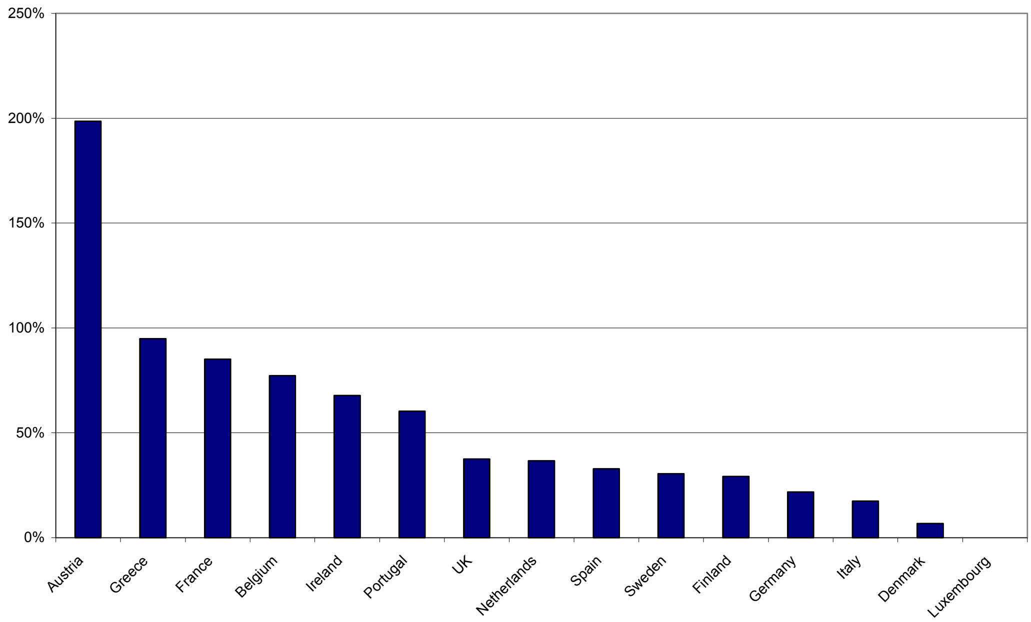
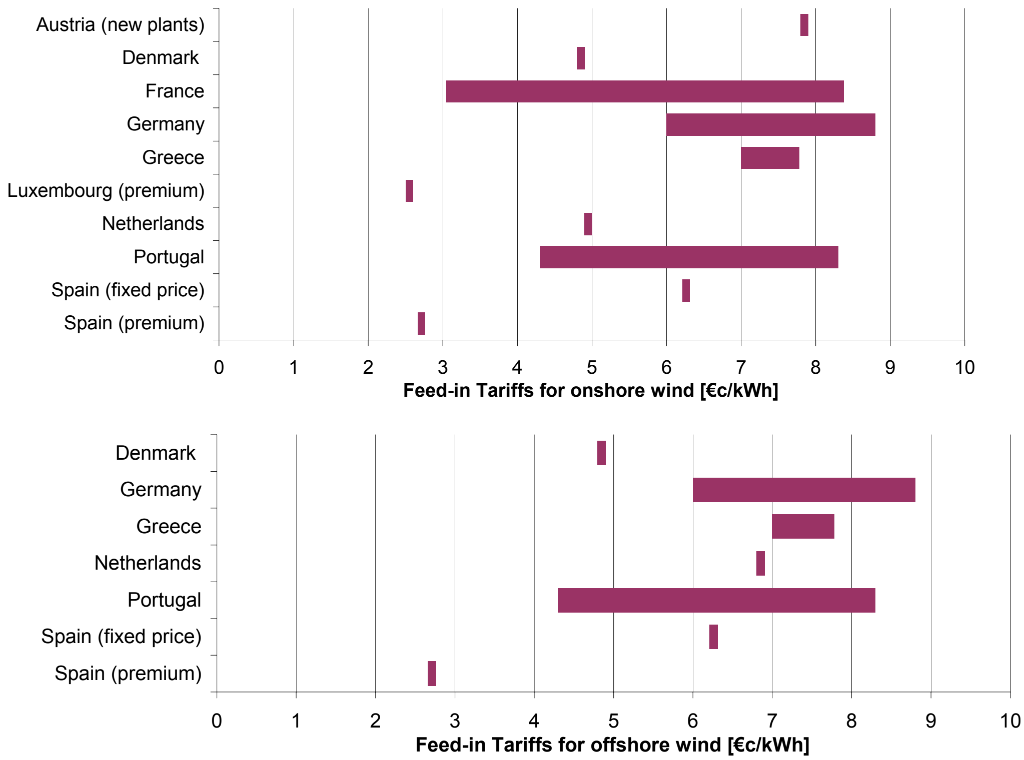


Figure 27: Growth rates wind power 2003

The support of wind power through feed in tariffs is shown in Figure 28, but they are hardly comparable because of the different support periods, support schemes and support levels.



Source: Rexpansion

Figure 28: Feed in tariffs for wind power

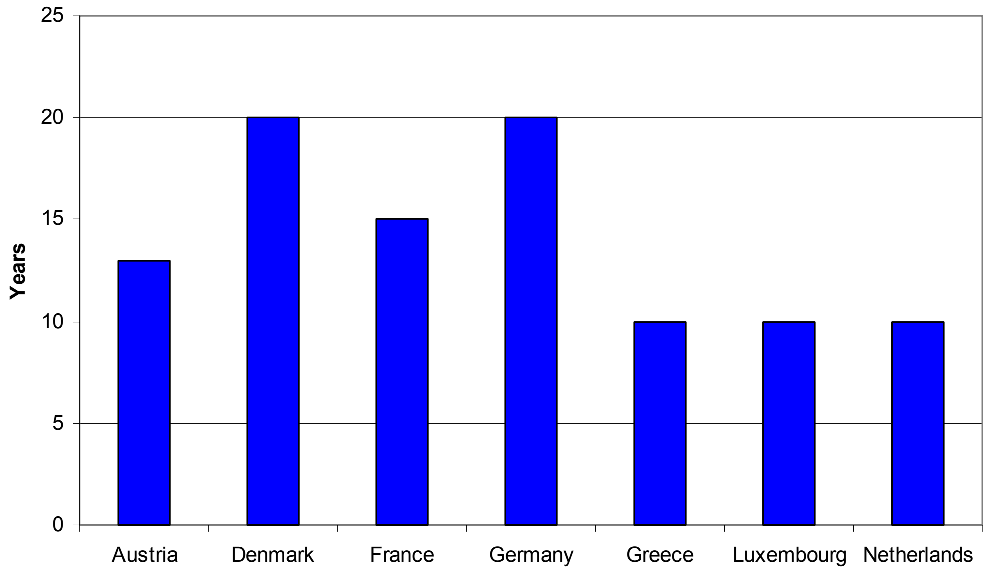


Figure 29: Support periods

Challenge	Recommendation
The most uses support scheme within the first period of RES-E in Europe was the feed in tariff model on a national basis. This model was a good starting point to make RES-E more competitive. The great disadvantage of this model is, that it is non cost-efficient and does not complies with market principles. The next period of RES-E support should be characterised by a more market based approach reflecting the need of cost and energy-efficiency and prevention of market distortions.	The feed- in tariff model was a good means to stimulate the contribution of RES-E to the overall electricity production. In order to avoid further cost – inefficiencies the focus of the next generation of support mechanisms shall be more market based. Potentials shall be used where the production costs are at the lowest level. To achieve this target a harmonised European support system is necessary.

7.6.3 Costs of emissions reduction

The overall target of the environmental legislation is to avoid greenhouse gas emissions. Also the RES-E Directives points out:

> *"The increased use of electricity produced from renewable energy sources constitutes an important part of the package of measures needed to comply with the Kyoto Protocol to the United Nations Framework Convention on Climate Change, and of any policy package to meet further commitments."*[19]

The cost of reducing one ton of CO_2 differs a lot between the different measures. Figure 30 shows that the production of RES-E is a very costly measure to reduce greenhouse gases.

[19] RES-E Directive, Reason 3.

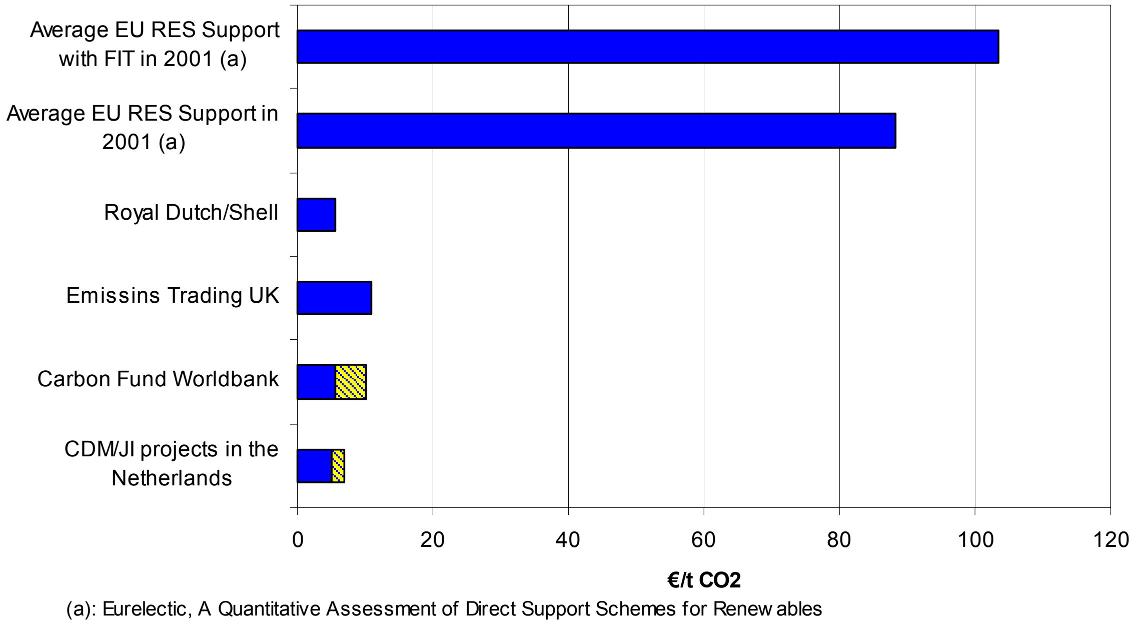


Figure 30: CO2 reduction costs

Of course do RES have other advantages than the reduction of CO_2, as stated in the RES-E Directive (Reason 1):

- Creation of local employment,
- Positive impact on social cohesion and
- Contribution to security of supply

The balance between these advantages and the increasing costs must be found in order to minimise the financial burden of each energy end consumer.

Challenge	Recommendation
RES-E is one means to reduce greenhouse gas emissions, but it is a rather expensive one. Besides the reduction of emissions, there are other advantages of RES-E. An adequate balance between high costs and reachable advantages must be found.	A cost-efficient package of measures, taking into account total system costs, to reach the Kyoto target should be created. RES-E is only a (small) part of this package.

7.7 Administrative aspects

Despite the clear statement from the European Commission

> *"The European Union needs affordable renewable energy to contribute solving its own security of supply problems and meeting its targets for reducing greenhouse gas emissions. Recognising the wide benefits of renewable energy, Europe is pushing the development of technological and institutional solutions that can also be applied on a global scale."*[20]

there are increasing resistance against new RES-E power plants. In the field of wind energy the main counter-arguments brought into the discussion are:

- negative influences on animals, especially birds
- negative impacts on tourism
- destruction of the landscape and
- potential radar distortions.

Challenge	Recommendation
In the field of RES-E there are a lot of pros and cons and often the delivered data is not reliable. This causes insecurity of market participants, mainly end consumers.	One shall offer objective information on the impacts of RES on national level.

[20] European Commission, The share of renewable energy in Europe, 2.05.2004.

8 Conclusions

For many years, RES technologies have received financial and political support within the European Union and its Member States. The reasons have differed, ranging from security of supply and local employment to emission reduction.

The initial target of the RES-E Directive was to facilitate a significant increase in the generation of RES-E by providing the framework for a harmonised European RES-E support system.

The current RES-E market is far from being harmonised and the long-term perspective of the RES-E Directive is only of limited importance in many Member States.

The main outcome is that a harmonised system with tradable green certificates would solve a lot of problems occurred in the first phase of RES-E support. Member States with high-cost potentials could cover parts of their targets by purchasing certificates in Member States with low-cost potentials. All Member States benefit from this approach. On one hand, in one Member State additional incomes from exports are generated, on the other hand, the targets could be reached at a significant lower cost level (see Table 7).

Additional costs, such as balancing energy, could be internalised in the certificate price and thus could also lead to more transparency for end consumers.

9 Annex

i. National targets according to Directive 2001/77/EC

	in GWh 2010	in % 2010	Implementation in national law
Austria	43,814	78.10%	Green Electricity Act, came into force on 1st January 2003
Belgium (Brussels)		not yet fixed	
Belgium (Flanders)	2,914	6%	Electricity Decree, 17/07/2002
Belgium (Walloon)	2,000	8%	Royal Decree 12th April 2001 (regional energy markets)
Denmark	10,000	29%	Electricity Supply Act, into force on 1st January 2003
Finland	29,300	31.5 %	Act came into force on 1st January 2004
France			
Great Britain	33,600	10%	
Greece	14,472	20.1%	Electricity Law 2773/1999, Law 3017/2002 "Ratification of the Kyoto Protocol"
Iceland			
Ireland	4,060	13.2%	Not yet been trasnposed into domestic law
Italy	95,000	25%	Law n.387 of december 2003
Luxembourg		5.7%	Came into force on 22nd February 2004
Netherlands	6,000	9%	Electricity law 1998
Norway			
Portugal		39%	Not yet transposed
Spain	80,406	29%	Law 54/97, Royal Decree 436/04
Sweden	96,120	60%	

Table 13: National indicative targets

Austria: Target is realistic if gross electricity consumption by 2010 amounts to 56.1 TWh.

Belgium (Flanders)**:** Electricity supply in 2003 on the public grid in Flanders was 48,558 GWh. 6% of this amount is 2,913 GWh.

Belgium (Brussels): The national objective is 6% but it is no distributed between de three regions. The quotas fixed except the incineration are 2% in 2004; 2.25% in 2005 and 2.5% in 2006 Laws: ordannance electricity of 19 July 2001 modified by the ordonnance gas of April 1, 2004. And the decree green certificates adopted on May 6, 2004

Belgium (Walloon Region): indicative target is 8%, Implementation law : electricity decree 12th April 2001 : obligation set to 7% in 2007 for RES and CHP but not yet set for 2010.

Denmark: The target can be achieved with the measures already decided and the national consumption around 35 TWh in 2010.

Great Britain: Information is taken from DTI's (Department of Trade and Industry) statutory consultation on the RO (Renewables Obligation) and based on estimated sales by licensed suppliers of 324.3TWh. The RO has a target of 10.4%.

Greece: Target based on 72 TWh in gross electricity consumption in 2010.

Ireland: Using the 2003 – 2009 Generation Adequacy Report based on the median demand forecast 4,060 GWh of renewable generation would be needed to achieve the target.

Italy: Italy states that 22% is a realistic figure given that national gross consumption will not exceed 340 TWh and electricity produced with waste as fuel will be fully included as renewable.

Luxembourg: Target set for 2010 can be achieved if:

- Total electricity consumption in 2010 does not exceed the one of 1997.
- Wind power production is multiplied by a factor of 15.
- Biogas production is multiplied by a factor of 208
- Electricity produced from the only municipal waste incinerator in Luxembourg (accounted for half of the RE-E production in 1997) can be taken into account in its entirety.
- Photovoltaic production can be raised to 80 GWh.

Netherlands: Target based on a 2% annual growth of electricity consumption (105 TWh in 2003)

Portugal: Target assumes that it will be possible to continue the national electricity plan with investments in new hydro capacity higher than 10 MW, and that increased renewable capacity made possible with financial state aid can increase at an annual rate eight times higher than has occurred recently.

Spain: The target based on the assumption of gross electricity consumption in 2010 at 277 TWh.

ii. Obligation and Financing

	Obligation				Financed by and via:			
	Customers	Producers	Traders/Supplier	Government	Customers	Producers	Traders/Supplier	Goverment
Austria				✓	Tariffs			
Belgium (Brussels)			✓				Certificates	
Belgium (Flanders)			✓				Certificates	
Belgium (Walloon)			✓				Certificates	
Denmark				✓				
Finland[1]				✓				State budget; energy taxation
France[1]				✓				State budget
Great Britain			✓				Certificates	
Greece				✓	RES Levy			
Iceland								
Ireland	✓				PSO Levy			
Italy		✓			Tariffs	Certificates		
Luxenbourg				✓	tariff < 65kV			State budget
Netherlands				✓	Tariffs	(Adm. Costs)		
Norway					Tariffs			State budget
Portugal				✓	Tariffs			State budget
Spain				✓	Tariffs			
Sweden	✓				Certificates			State budget

[1]: Source: Eurelectric, 2004

Table 14: Obligation and financing

Belgium (Flanders) electricity suppliers are obligated to redeem certain number of green certificates each year. The obligated number of certificates is a percentage of the amount of electricity supplied in the previous year. This percentage rises every year to 6% in 2010.

Belgium (Walloon Region): Every quarter, electricity suppliers have to redeem a certain number of green certificates (GC) to meet their quota obligation. The quota obligation was 3% in 2003 and increase to 7% in 2007. The penalty is fixed to 100 Euro per missing

Ireland: The Alternative Energy Requirement (AER) programme was launched in 1995. A competitive tender system awards a 15-year contract with ESB-PES to renewable energy generators. The AEA is funded through a Public Service Obligation (PSO), which is placed on all final customers of electricity. Six AER competitions have been held to date. From 2003 to 2005 the AER component of the PSO increased by 66 % from € 7.44m to €12.356m.

In **Great Britain** the RO buy-out price is intended to act as a cap on the price paid as suppliers may choose to buy-out depending on the price of ROCs. The redistribution of buy-out affects this, however. Suppliers may choose to pass on the RO costs to customers.

The **Swedish** certificate system works with a mandatory demand (and thus financing) put on consumers. The system was implemented in May 2003.

The **Spanish** network tariff includes an item for special regime (“new” RES + waste + CHP), which implies a cost of 7% for the consumers (3% for “new” RES and 4% for waste and CHP).

iii. Supported Electricity

GWh	Small Hydro Power	Wind	Solid Biomass	Biogas	Photovoltaic	Geothermal	Others	Total
Austria	3,364.0	349.0	99.0	40.0	10.0	3.0	77.0	3,942.0
Belgium (Brussels)			110.0					110.0
Belgium (Flanders)	1.8	58.9	96.8	133.9	0.08			291.4
Belgium (Walloon))	315.9	1.4					Biomass: 89.9	404.2
Denmark (2002)	32.0	4,877.0	1,892.0	233.0				7,034.0
Finland								n.a.
France								n.a.
Great Britain	539.0	1,090.0	1,038.0	2,895.0				5,562.0
Greece								1,177.0
Iceland								
Ireland	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	550.0
Italy	5,038.0	4,147.0	3,956.0	(see bio)	n.a.	250.0		13,391.0
Luxembourg	5.15	26.0		15.0	1.37			48.0
Netherlands (2002)	117.0	825.0	1 650	302.0	13.0	45.0	CHP: 51 000	53,952.0
Norway		450.0					Heat: 953	1,403.0
Portugal (2002)	613.0	340.0						953.0
Spain	5,062.0	11,991.0	1,188.0	228.0	9.0		CHP: 19 386 Waste: 2 042 Waste red: 1 910	41,807.0
Sweden	956.0	679.0	4,212.0					4,212.0

Table 15: Supported electricity in 2003

It should be noted that Table 15 shows supported electricity and that does not necessarily imply RE-produced electricity. It should also be considered that definitions (of biomass or small hydro as examples) may differ slightly between the different countries and figures should be treated with the corresponding caution.

Austria: The group "others" includes liquid biomass, dump and sewer gas.

Belgium (Brussels): The incineration of domestic waste is not supported in Brussels-Capital region.

Belgium (Walloon): Biomass specified in "Others" include solid biomass and biogas, and other biomass sources as defined by EC-Directive.

Denmark: Note that figures are from 2002.

Italy: RE-electricity produced within support systems: *Total:* Some 10 TWh through CIP6; 1,4 TWh though green certificates; 2.4 TWh through order n. 62/02 (This includes large hydro and waste energy). *Hydro:* In 2003: 2043 GWh promoted through CIP6 (including large hydro), 600GWh through green certificates and 2395 small hydro (under order n. 62/02). *Wind:* 3847 GWh promoted through CIP6 (includes geothermal) together with some 300 GWh through green certificates. *Biomass:* 3656 GWh promoted through CIP6 (includes waste and biogas) together with some 300 GWh through green certificates (also includes waste and biogas. *Geothermal:* See under wind and in addition some 250 GWh through green certificates.

The Netherlands: In 2003 the support regime for renewable electric production started. All produced renewable electricity is expected to receive the subsidy. Solid biomass includes burned biomass in garbage. CHP receives subsidy per produced kWh. For CHP on July 1st 2004 the support scheme will change so that only support will be given to/over the carbondioxide-neutrally produced kWh (2,6 Cent/kWh for the year 2004).

Sweden: The first year of certificate trade was limited to an 8 month period (May-Dec). The total volume of 452 GWh of wind power received both certificates and the environmental bonus. Small hydro defined as plants with <1500kW in rated output. Biomass defined as bi-products from agriculture and wood industry. Biogas, PV, geothermal and wave energy also supported in the green certificate system, but currently there is no production to support (except for one PV installation).

iv. Levels of support

Cent / kWh	Small Hydro Power	Wind	Solid Biomass	Biogas	Photovoltaic	Geothermal	Others
Austria	3.78 - 5.68	7.8	2.7 - 16	7.72 - 16.5	47 - 60	7	Dump and Sewer Gas: 3 - 6
Belgium (Brussels)		appr. 13.5		appr. 13.5	appr. 13.5		
Belgium (Flanders)	11.3 (or min price)	11.3 (or min price)	11.3 (or min price)	11.3 (or min price)	min price	11.3 (or min price)	
Belgium (Walloon)	6.5 - 10	6.5 - 10	3 - 20 (CHP effect included)	6.5 - 20 (CHP effect included)	15 (federal level)	6.5 - 20 (CHP effect included)	Biomass: 3 - 20 (CHP effect included)
Denmark	8.00	5.7 - 8.0	8.00	8.00			
Finland	4.2	6.9	4.2 - 6.9	4.2			
France[1]	5.57 - 6.19 (+ premium)	3.04 - 8.36	5.00 + premium	4.69	14.77 - 29.55 (+ investment grants: 4,6 - 6,1 €/Wp)	7.61	Landfill gas: 4.57 - 5.81
Great Britain	update in progress	update in progress	update in progress	update in progress	update in progress	update in progress	
Greece	6,449 + Cap. Payment.	6,449 + Cap. Payment.	6,449 + Cap. Payment.	6,449 + Cap. Payment.	6,449 + Cap. Payment.	6,449 + Cap. Payment.	6,449 + Cap. Payment.
Iceland							
Ireland	7.018	5.216 (large onshore) - 8.4 (offshore)	6.412 - 7	6.412 - 7			
Italy	9.7	12.07	17.25	17.25	17.25	12.07	
Luxembourg	7.89 (FdC) + 2.50 (MENV)	8.26-10.35 (FdC)		7.89-8.99 (FdC) + 2.50 (MENV)	10.35 (FdC) + 45 (MENV)		
Netherlands	8.2	6,3 land based 8,2 off-shore	8.2 < 50 MW, 5.5 > 50 MW	0.6	8.2		Mixed stream of waste > 26% heat rate: 2.9; CHP: 0.57
Norway		2.4					Heat: 1.2
Portugal	2002 average price - 7.51	2002 average price - 8.02					
Spain	6.6	6.3	6.4 - 7.1	6.3	18 - 39.7		CHP: 5,94 Waste: 5,06 - 5,80 Waste red: 6,57
Sweden	2.4	4.3 off-shore, 3.7 land based	2.4	2.4	2.4	2.4	

[1]: Source: Eurelectric, 2004

Table 16: Levels of support in 2003

The aim of Table 16 is to provide an overview of the levels of support for different technologies in the different Member States. Table 16 is sorted in order to separate specifications that are easy to interpret from those that are more complex due to the different support schemes and the notations. Information of notations and non-quantified support schemes is given under *details* below. The data for Finland was calculated by STEM.

Support levels vary in the interval from 2 to 14 cent/kWh as an average over all technologies. Solar PV stands out with the widest range differing from a few cents to as much as 60 cent/kWh (note that Austria's support for PV has limit at 15 MW). Biomass and biogas show significantly different support levels, ranging from a couple of cents to 16-17/kWh. Some of the differences can probably be explained with different definitions within the category, which makes the data less comparable. The **Nordic countries** Sweden, Norway and Finland show relatively low levels of support while countries like **Italy** and **Belgium** (Flanders) sometimes have 4-5 times higher support levels. It is interesting to note that support generated from certificate based system varies: **Sweden** 2.4, **Italy** 9.7-17.25, and **Belgium** (Flanders) 11.3, while systems with feed-in tariffs seem to have a narrower interval.

Austria: The extent of the support for wind was: 5.1 Cent/kWh in 2003 (7.8 - 2.7 Cent/kWh). The level of support depends, for most of the plants, on the capacity and in the case of biomass also on the input. Regarding existing small hydro plants the tariffs are only guaranteed up to 2005 and could be cut down if not enough money were available. For PV the total limit of 15 MW supported in Austria has already been reached.

Belgium (Flanders)**:** The VREG (regulatory authority) issues green certificates to producers of RES-E which sell the certificates to electricity suppliers. The value of green certificates on the market approximates the value of the penalty that electricity suppliers have to pay per missing certificate in case they do not turn in enough green certificates at VREG. Market prices of certificates in the past were around 90% of the penalty price. The penalty is now 125 euro per missing certificate (= per MWh). To ensure good prices for green electricity, there are minimum prices to be paid for certificates by the grid operators (minimum price + domestic market price for electricity). Minimum prices: for solar electricity: now 150 euro per certificate, but for PV installed after 01/01/2006: 450 euro per certificate (=1 MWh); hydro power, tidal, wave and geothermic energy : 95 euro per certificate (=1 MWh); wind onshore, organic-biological matter, fermentation and the organic-biological fraction of municipal waste: 80 euro per certificate (=1 MWh); off-shore wind: 90 euro per certificate (=1 MWh); others: 20 euro per certificate (=1 MWh).

Belgium (Brussels) The price of the green certificates should be around approximately 135 Euro/Mwh but the federal state fixes a price of repurchase of minimum: 50 Euro/Mwh for Wind, 20 Euro/Mwh for Biogas and 150 Euro/Mwh for PV.

Belgium (Walloon): The support depends on the price of the green certificate (GC) on the market. The upper limit is fixed by the supplier's penalty (100 EUR per missing green certificate) and a minimum value is guaranteed by the Walloon Region (65 EUR/GC) or by a federal purchase obligation on TSO (Elia, 150 EUR/GC for PV). The number of GC per MWh net produced depends on the CO2 emission saving of the power plant including CHP benefits (from 0,1 GC/MWh to max 2 GC/MWh).

Denmark: The support 5.7 - 8.0 c/kWh for old turbines is for 10 years, after this and for new turbines a premium at 1.5 c/kWh

Great Britain: ROCs (each is 1MWh) are a marketable commodity and are currently being sold at about £48-50 for all qualifying technologies. This is based on anecdotal evidence.

Greece: Capacity payment equals 1.656 Euro/Month/kW Installed - 7,973. A distinction is made between energy produced in the interconnected System from energy produced on the non-interconnected islands. A distinction is also made between self producers selling their surplus to the system from the independent producers (Self Producers: 3,275 - 6,201 c/kWh for the Interconnected System and 6,201 cent/kWh for the non-interconnected islands). The yearly average in 2003 was 6,606 cent/KWh for the Interconnected System and 7,787 cent/KWh for the Non-Interconnected System. The group “others" refer to non RES CHPs using fossil fuels.

Italy: Prices are for feed-in plants only. Green certificate renewables are estimated at an average price of 14 cent/kWh, including the price of green certificate (8,41c€/kWh in 2002; 8,24c€/kWh in 2003). There is also a support scheme for small hydro < 3MW through an average incentive of 6 cent/ kWh inclued in the price of electricity (AEEG order n. 62/02).

Luxembourg: “FdC” denotes support based on collected tariffs “MENV” denotes a feed-in subsidy paid by Ministry of Environmental Affairs.

The Netherlands: CHP also receives a subsidy for produced kWh. Land based wind power receives support up to 18.000 full load hours.

Norway: The support is given as investment support that varies from project to project.

Portugal: Feed-in tariffs depend on the energy fed to the grid and the generation diagram.

Spain: The special economic regime for CHP and renewable energy is limited by installed capacity. The range differs depending on technology, but in general the limit is set at 50 MW.

Sweden: Producers of RE-E receive certificates that provide a second source of income. In 2003 2.4 cent was the average price paid for certificates. The environmental bonus for off-shore installations is 1.9 Cent/kWh in 2004 (gradually decreased to 1.3 Cent in 2009). For land based production: 1.3 Cent in 2004 (decreased to 0.0 Cent in 2009). Support is granted until 25 000 full load hours. Wind power also receives a technical development and market introduction support for off-shore and mountain installations. The support is set to 38 Mio € in 2003-2008.

Support dependent on market price

Austria: The produced RE electricity is sold to an Eco Balancing Group which in turn sells it to obliged traders. The market prices are calculated quarterly; based on base load futures. The average of the four published prices in 2003 is 2.7 Cent/kWh.

Belgium: The value of green certificates on the market approximates the value of the penalty fee that is paid per missing certificate and does not include market price of electricity. Apart from the green certificates the electricity itself can be sold at the market utility price for (grey) electricity.

Great Britain: ROCs can be sold separately to the electricity and two elements of the RO feed-into the price. The buy-out price is set at £30/MWh index linked and any buy-out payments made are redistributed to suppliers who present ROCs. Therefore the additional price depends on how many ROCs are presented against each year's target and how much buy-out is paid by suppliers.

Ireland: Based on the tendering system the following prices were paid for wind (48.1-53 €MW/hr), hydro (64.8€MW/hr) and biomass (59.2€/MWh).

Italy: Yes, reference electricity price for 2003 is around 5,5c€/kWh.

Spain: The average price calculated as market price + premium. The market price in 2003 was 3,726 Cent/kWh.

Sweden: The support level of 2.4 Cent/kWh is weighted average market price on certificates (2003-05 to 2004-04). Market price on certificates depend produced RE-E and consumed electricity and does not include price on electricity.

v. Total costs

Mio. Euro	2003	2005	2010	conditions for calculations	How long is the support granted?
Austria	133.3	235	(289 for 2007)	excl market price	13 years (For new plants)
Belgium (Brussels)	0	6	(10 for 2007)		
Belgium (Flanders)	n.a.	n.a.	n.a.	no figures available (market driven)	Legislation until 2010
Belgium (Walloon))	16,1	n.a.	n.a.		
Denmark	n.a.	n.a.	n.a.		
Finland (2002)	29				(note: stern's adjustment)
France					
Great Britain	580		1500		The RO is scheduled to last until 2027.
Greece	61	91	244	Yearly Average System Marginal Price: 3.5 cent/kWh	10 years
Iceland					
Ireland	6,6	27,4	84,1		15 years
Italy	1000	n.a.	n.a.	(2003, of which 80% prom through CIP6)	8 years
Luxembourg	2,7	2,9	4	excl market price and subsidies from MENV	10 years or more
Netherlands	440	502	577		10 years
Norway	48.6	72.9	n.a.	excl market price, R&D support is additional(Norwegian Research Council)	
Portugal	20,64			excl. market price	Lifetime of investment
Spain	492		1.573		Lifetime of investment. 10 years for CHP
Sweden	118.7	(300)	(500)	based on certificate price 2003 and assumptions on future wind power	7 years (Quotas in certificate system is defined until 2010)

Table 17: Total costs and projected estimated total cost of support systems (Mio Euro)

Note that all underlying calculations for costs 2005-2010 are based on more or less strong assumptions concerning legal basis, market development and future support systems. Long term conditions are crucial for investments in new capacity. The average guarantee time of the support systems listed in table 6 is 11.4 years.

Austria: A total of 200.9 Mio Euro collected via feed-in tariffs and paid to RES-E producers (in this value market price is included). In 2003 25 Mio Euro were paid to the regional governors to support in order to give out investment grants.

Belgium (Flanders)**:** No limit of the issuing of certificates included in legislation. Minimum prices are guaranteed for 10 years after taking in service, for PV installed after 01/01/2006: minimum prices are guaranteed for 20 years

Belgium (Brussels): The quotas after 2006 are not fixed yet by the government and calculations of cost are approximate. 10 Mio. Euro for 2007 based on the recent legal basis.

Belgium (Walloon): Only transaction value of GC from producers to suppliers has been considered as a cost. A significant part of GC issued is not traded because electricity suppliers are also E-SER producers. In 2003, 610 000 GC were issued but only 190 000 were traded. Results for the first quarter of 2004 is a mean value of 92 EUR for 100 000 GC traded. For 2005 about 1 200 000 GC to be issued (amount to be traded and price unknown) and for 2010 about 2 400 000 GC to be issued. The costs could finally be charged to end consumers via higher prices.

Great Britain: The 2003 figure is taken from an estimate by Power UK and the 2010 figure is taken from DTI's consultation. No new analysis has been completed although NAO will be examining the RO costs.

Greece: Yearly Average System Marginal Price: 35 €/MWh.

Ireland: These figures relate to projected costs under the PSO of existing AER plants and AER6 contracts (based on an estimate of the successful build rate).

Luxembourg: Subsidies from MENV are excluded in table 6. The FdC support is not limited in time. The MENV support can be given for 20 years for photovoltaic plants (45 cent/kWh) and 10 years for hydro, biomass and biogas Plants (2.50 cent/kWh).

The Netherlands: Costs in 2010 are very uncertain. Levels of the subsidy and capacity of renewable production is hard to forecast and will strongly be influenced by the start of emission trading and future change in policies.

Norway: This support is administered by ENOVA under a transitional period (awaiting policy decisions). R&D support by the Norwegian Research council is additional and not included in table 6.

Portugal: Support is granted lifetime of investment. This period can be changed by law.

Spain: Total support for renewables waste and CHP in 2003 was 1 180 Mio Euro of which 492 was support of renewables and 171 supported use of waste. The calculations for 2010 have the corresponding numbers: 3 552 Mio Euro in over cost for renewables, Waste and CHP and for Renewables an additional cost of 1.573 Mio Euro.

Sweden: The costs for 2003 are calculated as the average certificate price times quota obligation plus environmental bonus for 2003 (2.0 Cent/kWh). Calculations for 2005 and 2010 are very uncertain and based on assumptions of market price of certificates and quota obligated electricity consumption set to 100TWh. Technical development and market introduction support for off-shore and mountain installation of wind power is an additional support system and is not included in table 6 (38.4 Mio euro over 5 years).

vi. Shares for each technology in Member States

Austria

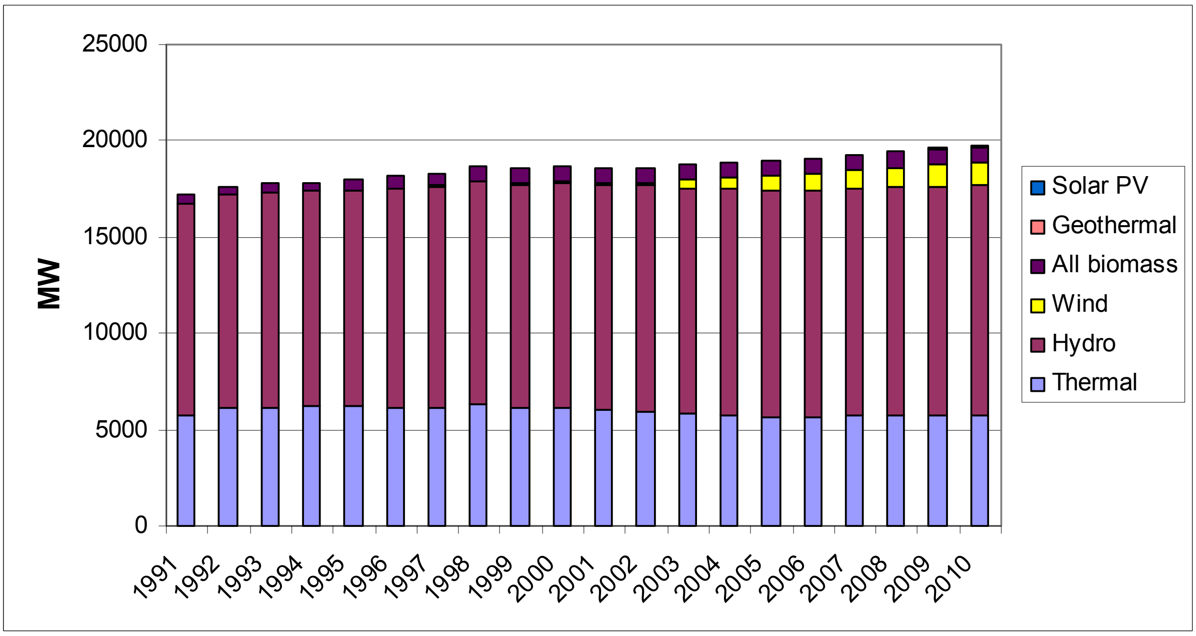


Figure 31: Installed capacity in Austria 1991 – 2010

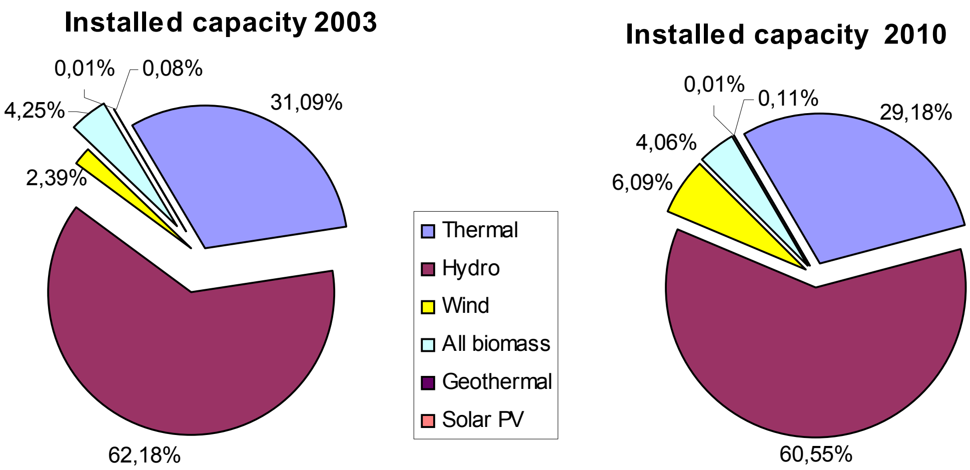


Figure 32: Comparison of the technology shares in Austria 2003/2010

Austria has a forecasted growth in total production capacity of 4.7 %. The important change in technology composition and the main contribution of RE capacity is an increased share of wind power from 2.4 to 6.1 %. The feed-in tariffs from 2003 is the main Austrian support system. The tariffs are particularly expected to stimulate wind (7.8 cent/kWh), bio and small hydro. Projected cost of support for RE-E in 2007 is 289 Mio €. Support is granted for 13 years.

Wind is considered to be the technology where Austria most efficiently can archive a high growth of RE-production, even though wind still is small in absolute terms. As a result of the new feed-in tariffs introduced in January 2003 Austria experienced a strong growth in wind capacity 2003 (see Figure 31). Installed capacity increased with close to 200% and to about 415 MW (This can be compared with a 40% growth in 2002). There is however uncertainty on concerning financing and future support system and the positive development from 2003 is not likely to continue in 2004.

Belgium

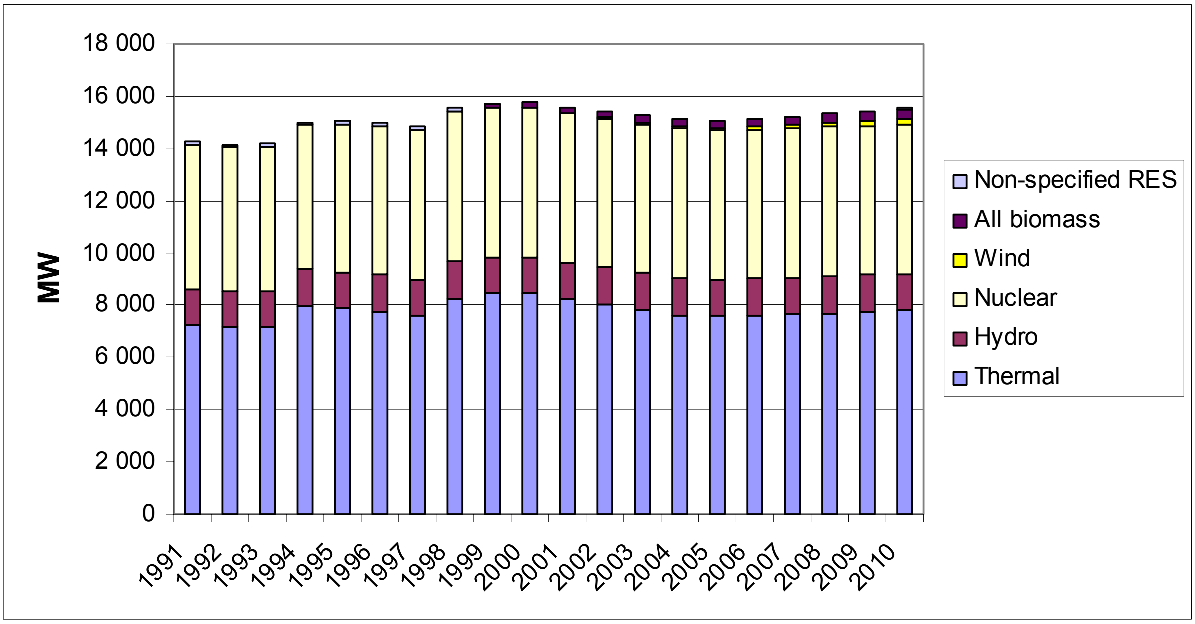


Figure 33: Installed capacity in Belgium 1991 – 2010

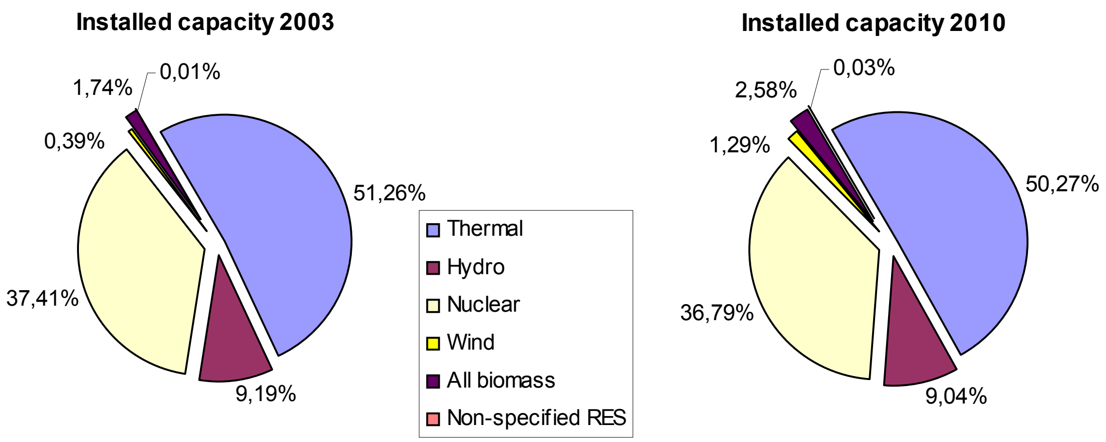


Figure 34: Comparison of the technology shares in Belgium 2003/2010

Installed capacity is projected to increase with 1.7 % compared to 2003. The increased RE capacity is planned to be covered through additional wind and bio mass capacity. The Belgian main support system is green certificates with three regional markets for the regions Flanders, Walloon and Brussels. The support generated from the certificate trade so far has been highly affected by the penalty charge since certificates have been banked in expectations of future higher prices. It is therefore too early to value the effectiveness of the system, but an indicator for the successful operation of the system is the 75 % wind energy growth rate in 2003.

Denmark

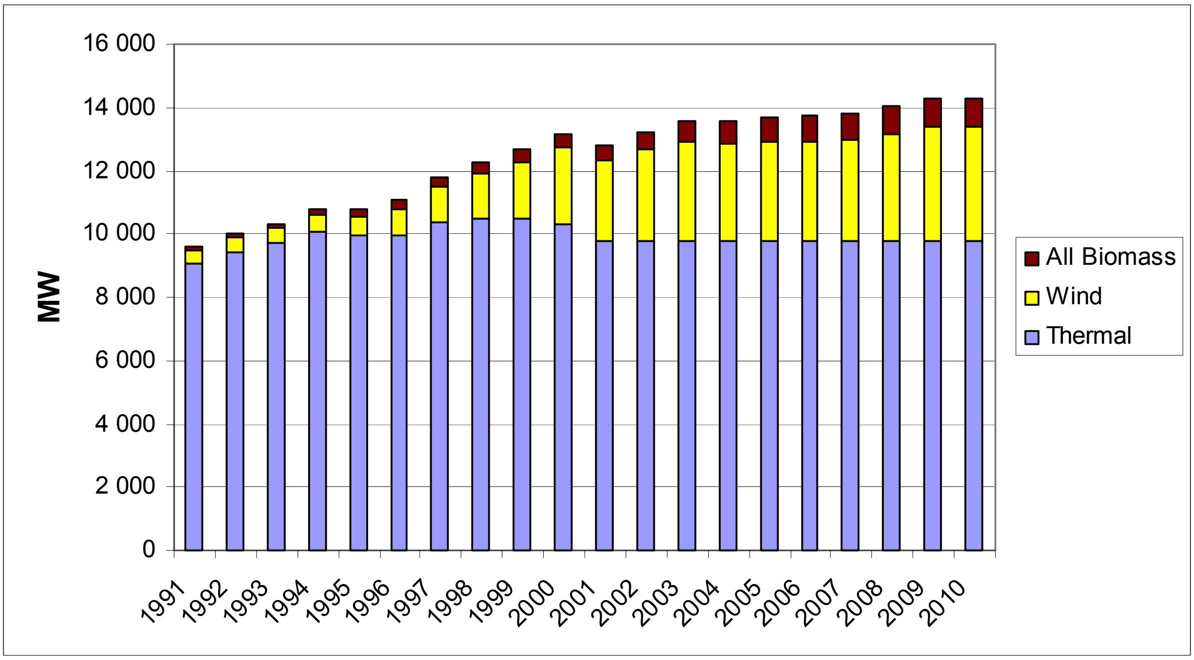


Figure 35: Installed capacity in Denmark 1991 – 2010

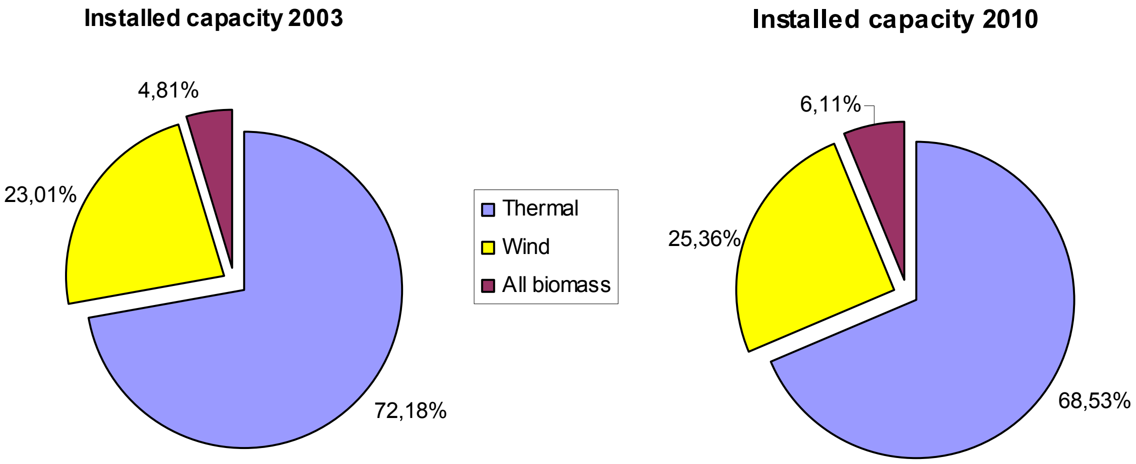


Figure 36: Comparison of the technology shares in Denmark 2003/2010

Installed capacity in Denmark is forecasted to grow with 5 % and almost everything is projected to be covered through a 16 % increase in wind power capacity 2003-2010. Denmark has the highest share of wind power in Europe (23%) and is a pioneer country in off-shore installations of wind power.

Main supporting activity in Denmark today is feed-in tariffs for old installations of wind power in a transition period (typical 10 years). After this the production is sold on market conditions and gets a premium corresponding to the CO2-tax until the aged of 20 year. New turbines get a premium in 20 year in addition to the market conditions. For biomass and biogas feed-in tariffs are combined with a premium.

The latest political agreement (29 March 2004) includes the construction of new offshore wind farms and replacement of wind turbines in unfavourable locations with new wind turbines build in other places. This agreement calls for increased research and development and demonstration of advanced energy technologies. The objective is above all to ensure that the whole production of electricity from wind turbines and local power-and-heating plants (CHP) will be sold under market conditions.
The planed new offshore wind farms will get support after a tendering scheme through bidding for the lowest support.

Finland

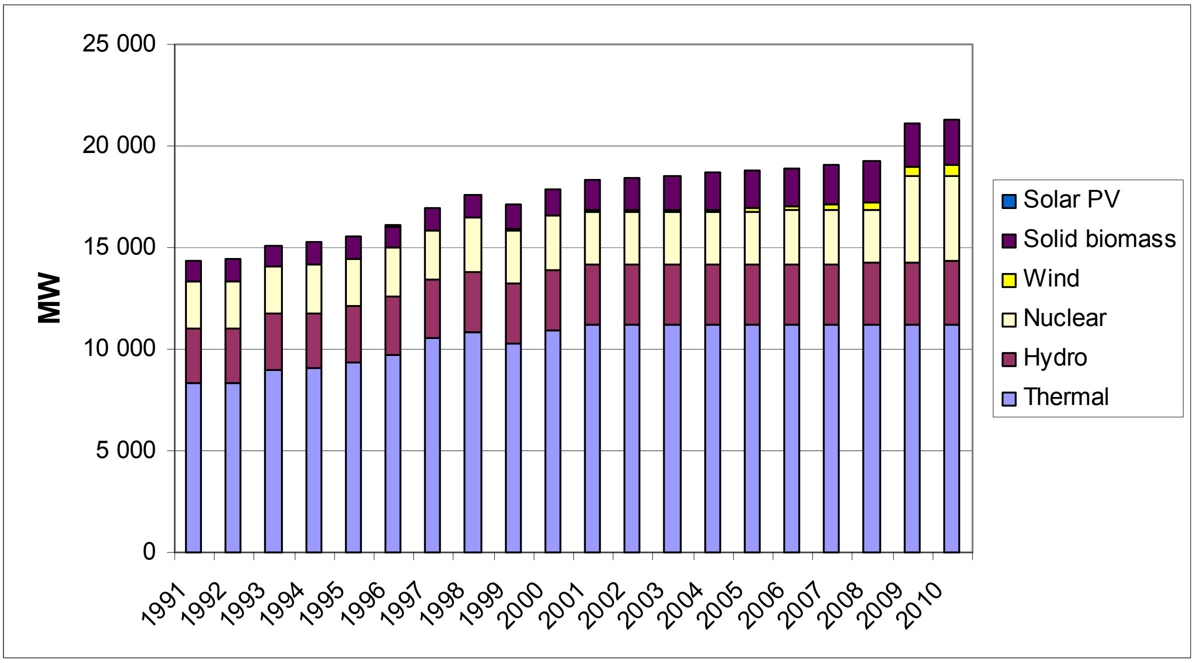


Figure 37: Installed capacity in Finland 1991 – 2010

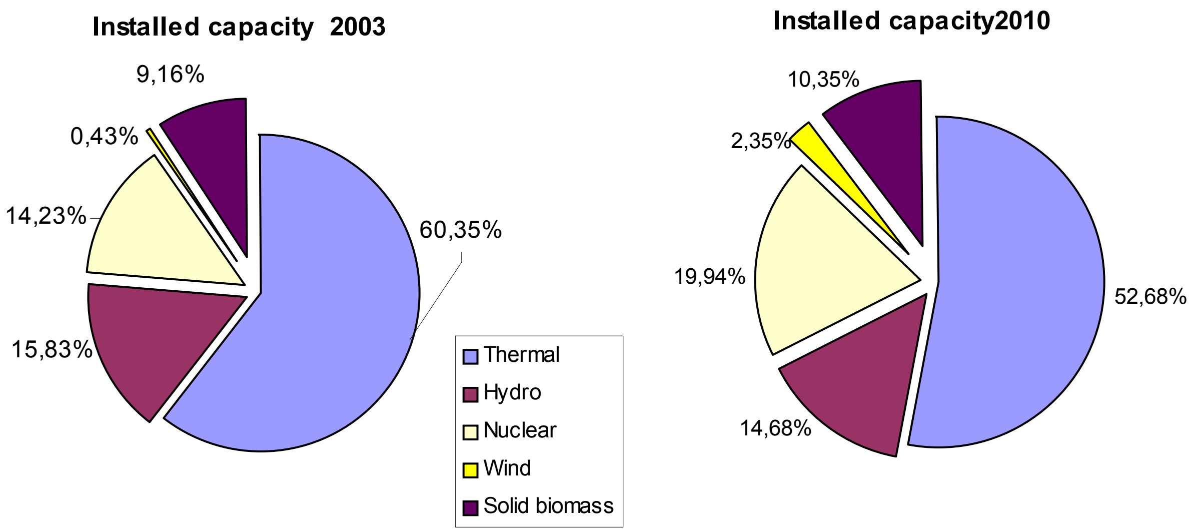


Figure 38: Comparison of the technology shares in Finland 2003/2010

Finland's major change in installed capacity is the planned fifth nuclear power plant. The share of wind power has a relatively large relative projected increase, but is only expected to cover 2.4 % of installed capacity in 2010. The remaining increase in RE-E is planned to come from biomass. The Finnish support system has been very effective for bio fuelled electricity generation, but as today it does not sufficient for increased investment in wind power. The support systems are mainly fiscal policy (tax exemption for end users) and investment grant.

France

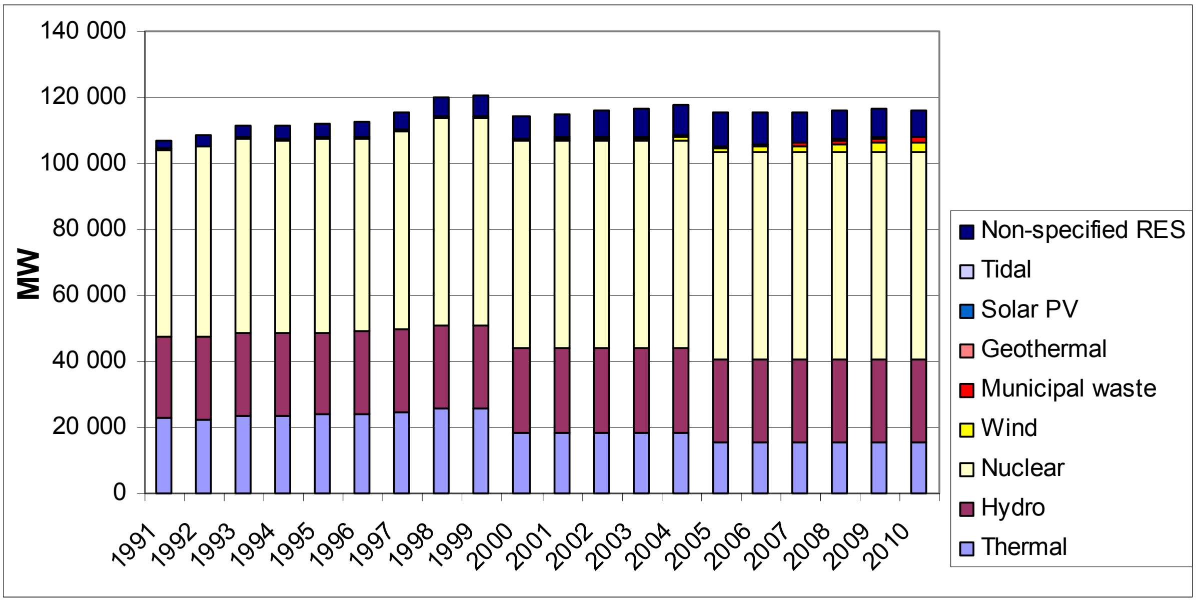


Figure 39: Installed capacity in France 1991 – 2010

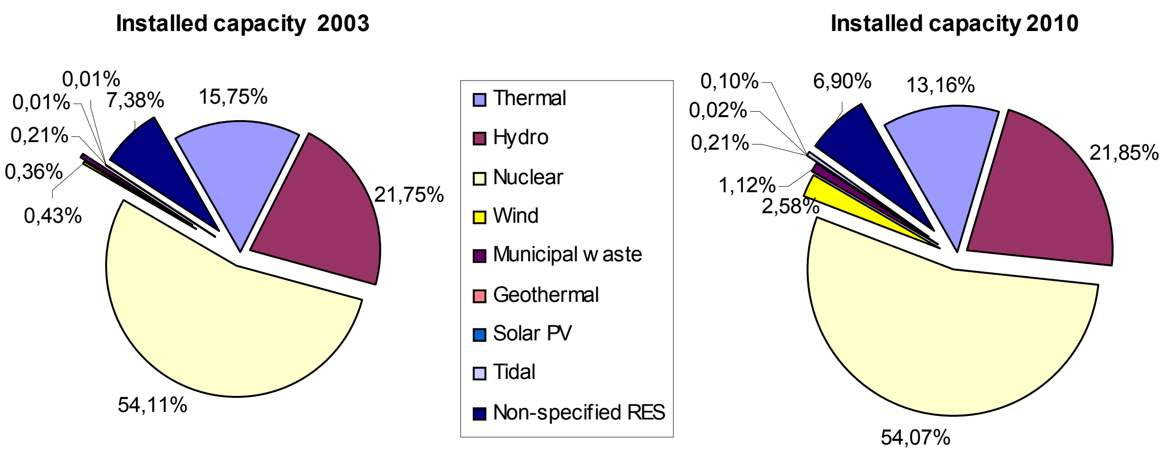


Figure 40: Comparison of the technology shares in France 2003/2010

France's forecast is concentrated on both energy efficiency and increased RE-production. Total installed capacity remains unchanged until 2010, while wind power and waste together cover a decreased thermal capacity. The main policy instrument in France consists of feed-in tariffs. In 2001 and 2002 France replaced the previous subsidy programmes and introduced a feed-in tariffs based support system. Despite good potentials for wind, biomass and geothermal production the main contribution to French RE-production is covered by hydro. Support levels are guaranteed for 15 or 20 years and dependent on technology. The level of support for wind power is 8.5 Cent/ kWh (first five years) and should be enough to finance investments if current technical and administrative obstacles are removed.

Great Britain

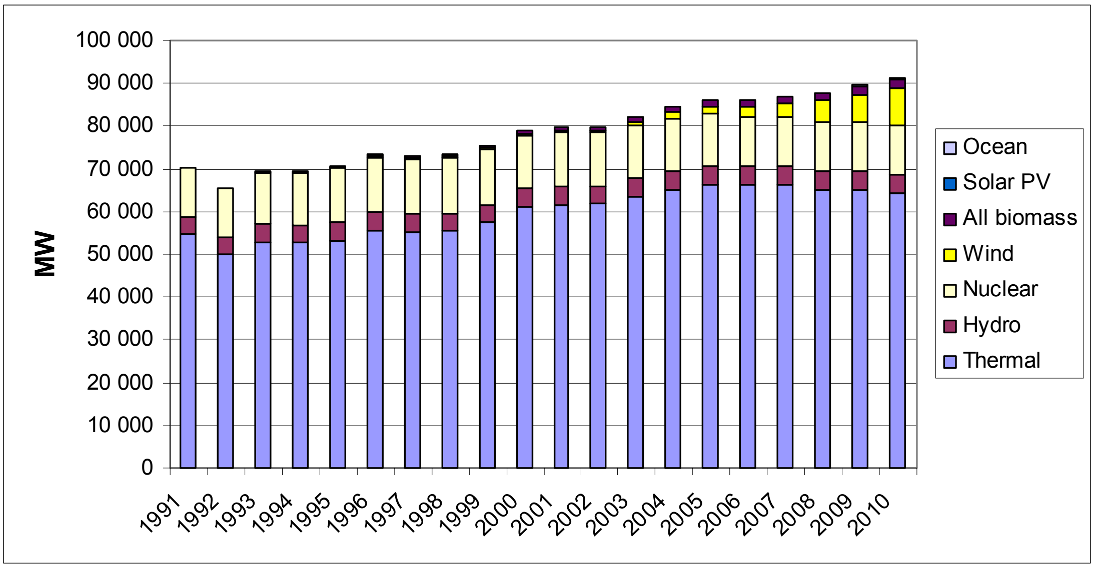


Figure 41: Installed capacity in Great Britain 1991 – 2010

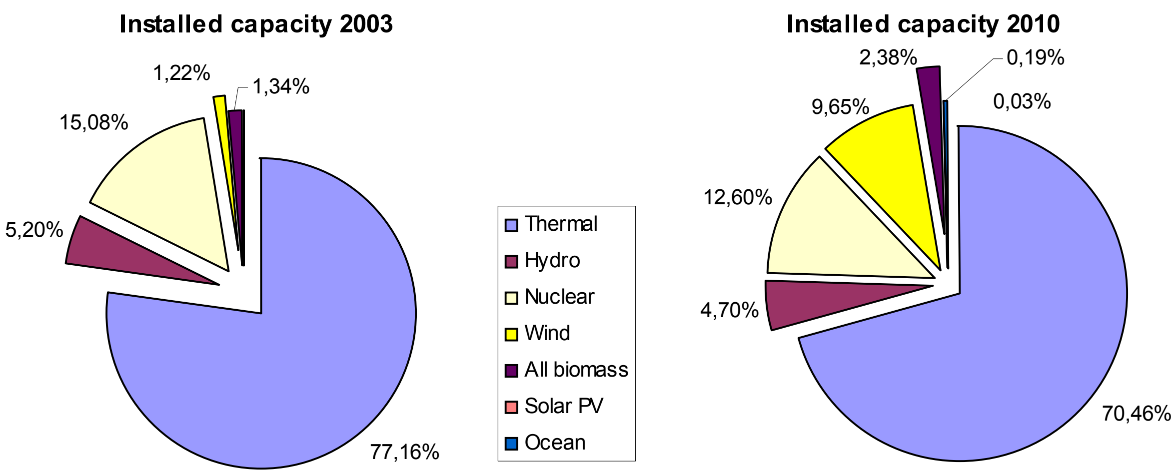


Figure 42: Comparison of the technology shares in Great Britain 2003/2010

Overall capacity is forecasted to grow by 10.9% in 2003-2010. The RE forecast for Great Britain focus on a major increase in the share of wind power. Capacity in the forecast for 2010 is almost eight times higher than the one of 2003. RE is mainly supported by certificate system with mandatory demand and several investment grant programs. Renewables are also exempted from the Climate Change Levy since RE plays a significant role in Great Britain's climate change strategy. During 2003 some 8900 GWh RE received support to a total cost of 580 Mio €. Targets for the obligatory certificate demand are set to 2027 to ensure long term conditions. In 2003 the British government announced new development plans on off-shore wind. Investments around 1.400 MW have so far been approved.

Greece

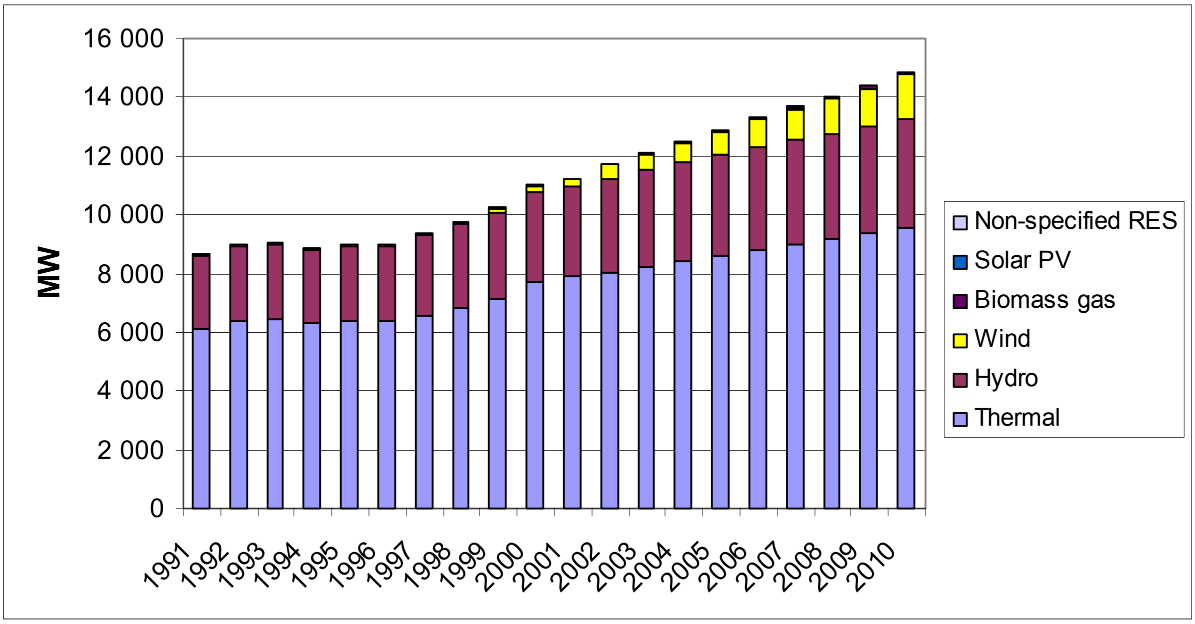


Figure 43: Installed capacity in Greece 1991 – 2010

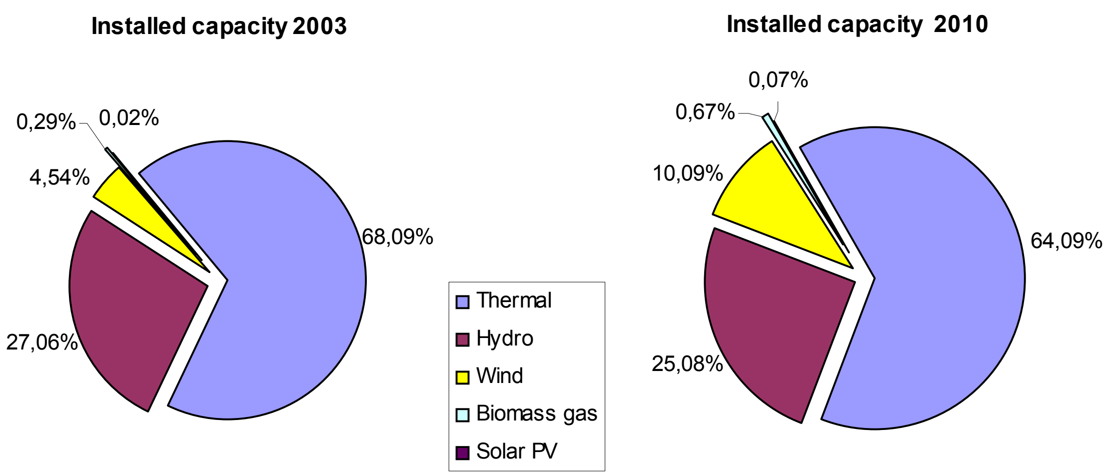


Figure 44: Comparison of the technology shares in Greece 2003/2010

Installed capacity in Greece is forecasted to be 22.8% higher in 2010 which is a relatively large increase. Wind power is projected to grow with 170 % and cover 10 % of installed capacity in 2010, other sources of RE are minor and cover less than 1%. The cost of support schemes in 2003 was 61 Mio €. The combined support system (from 1994) with feed-in tariffs and investment subsidies has created good conditions for private investments in wind and active solar thermal systems. Greece showed the first significant growth in the field of active solar energy due a deduction of the taxable income for end users. The tax deduction is however temporarily stopped for budgetary reasons. An issue for the forecasted expansion of RE (wind, solar) is the current administrative and technical barriers.

Ireland

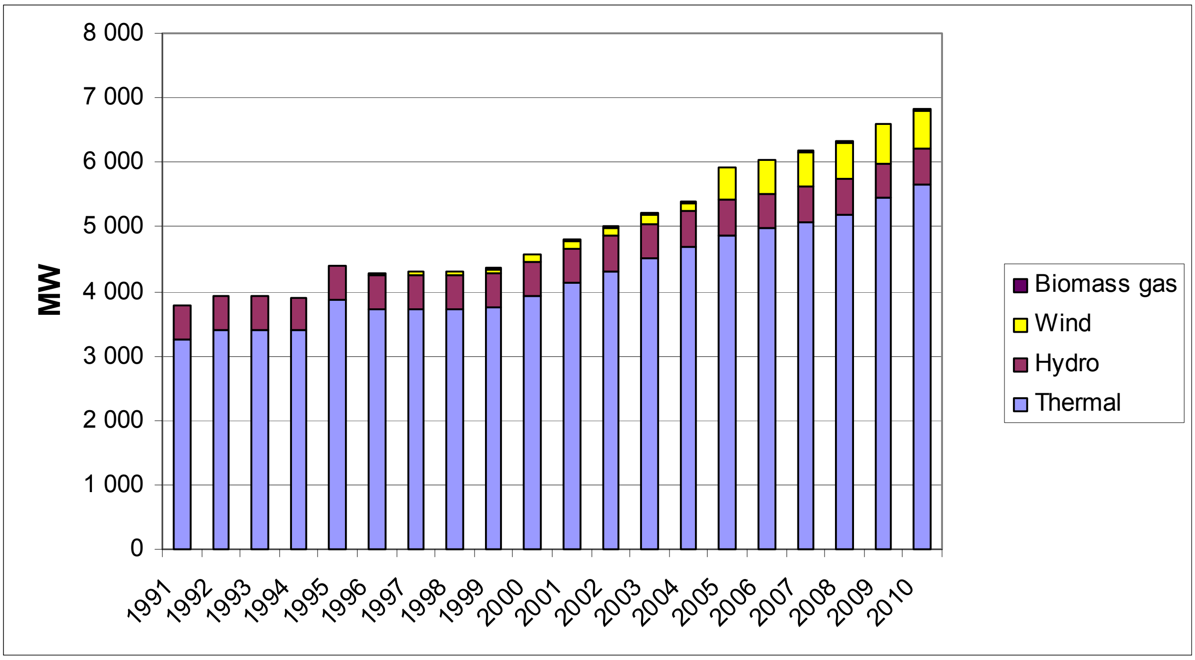


Figure 45: Installed capacity in Ireland 1991 – 2010

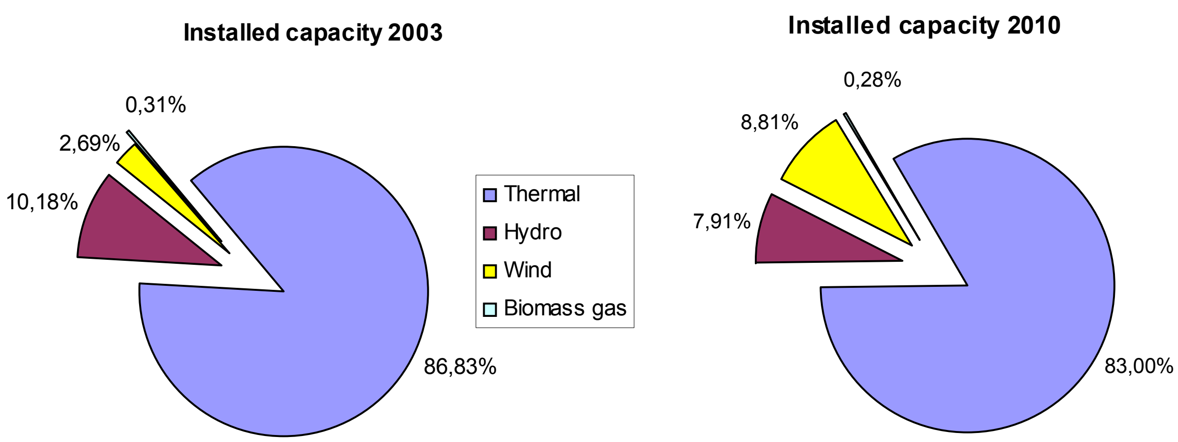


Figure 46: Comparison of the technology shares in Ireland 2003/2010

Overall capacity in the Irish forecast grows with 31 %. The main technology for increased RE capacity is wind, which grows from 2.7 to 8.8 % or 330 % 2003 to 2010. Support levels for wind range from 5.2 up to 8.4 cent / kWh, depending on size and location. Ireland is the last EU state that uses a tendering scheme as the main support system for RE together with some minor investment grant schemes for ocean and tidal technologies. The last bidding round closed in April 2003 and total cost of support system in 2003 are 6.6 Mio. €. The main challenges for the Irish bidding system is to ensure good quality of investments (since the lowest bidders receives contracts) while targets must correspond to an efficient level and mix of each technology. However, there are issues relating to market dominance. There are also concerns, highlighted by the Wind Moratorium implemented in December 2003 (lifted subject to certain conditions in July 2004), relating to the level of wind that can be safely and securely accommodated on a small isolated system. The Government is currently carrying out a review of the design of a future renewable support mechanism.

Italy

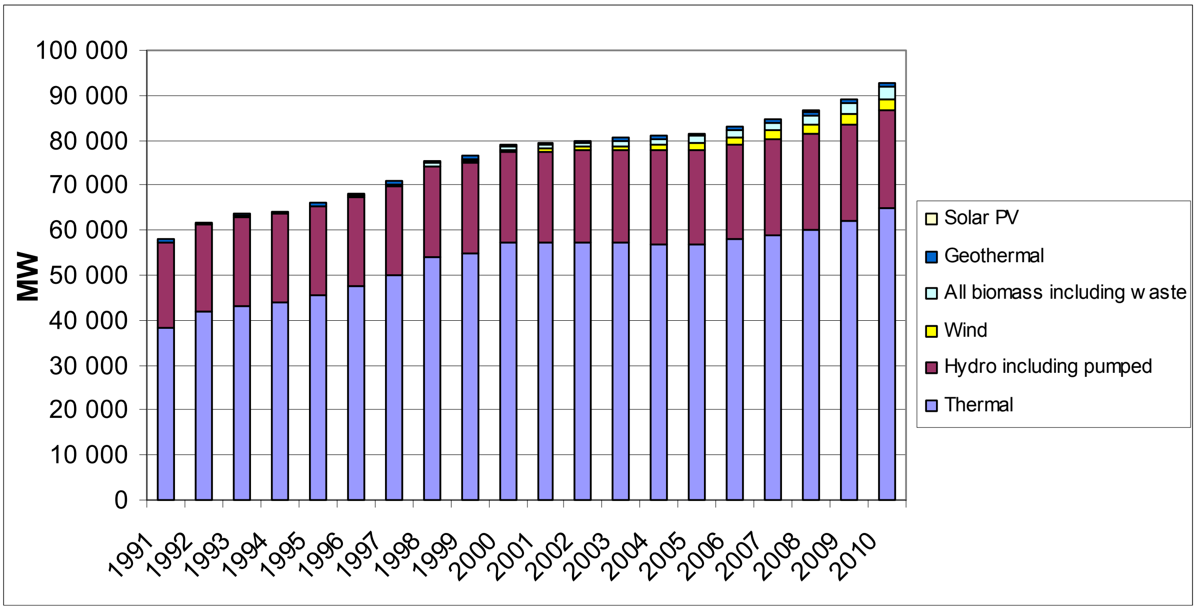


Figure 47: Installed capacity in Italy 1991 – 2010

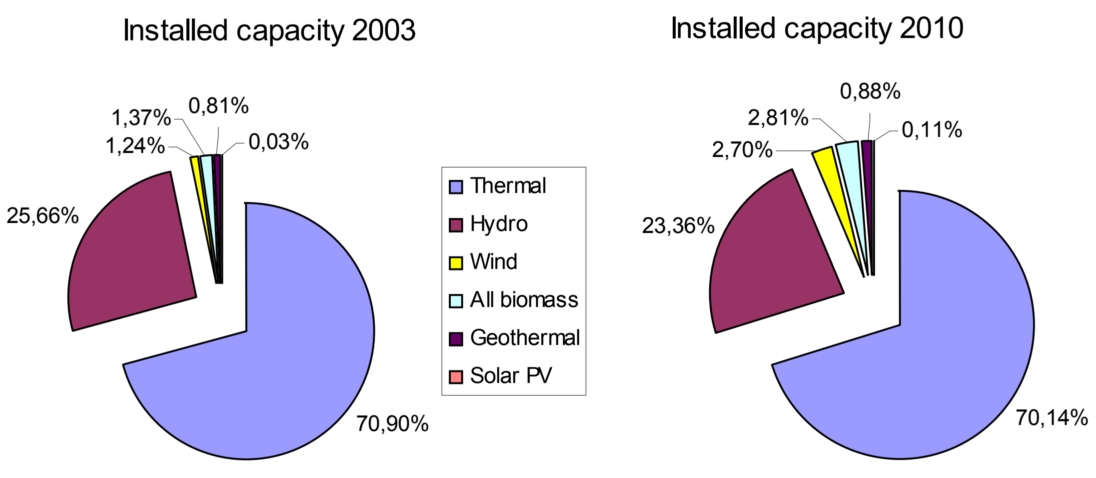


Figure 48: Comparison of the technology shares in Italy 2003/2010

Italy predicts a 15 % increase in installed capacity 2003-2010. Wind power, biomass, geothermal and solar are together forecasted to cover 6.5 % of capacity in 2010 compared to 3.5 % in 2003. In 2003 the Italian certificate system promoted 1.4 TWh and generated a support around 8.4 cent/kWh. Italy has experienced rather strong growth in installed wind power capacity the last couple of years and has a relatively developed production of geothermal energy (8% of RE market in 2002). The major challenges for new production capacity seems to be problems in obtaining authorisation at local level and high costs of grid connection.

Luxembourg

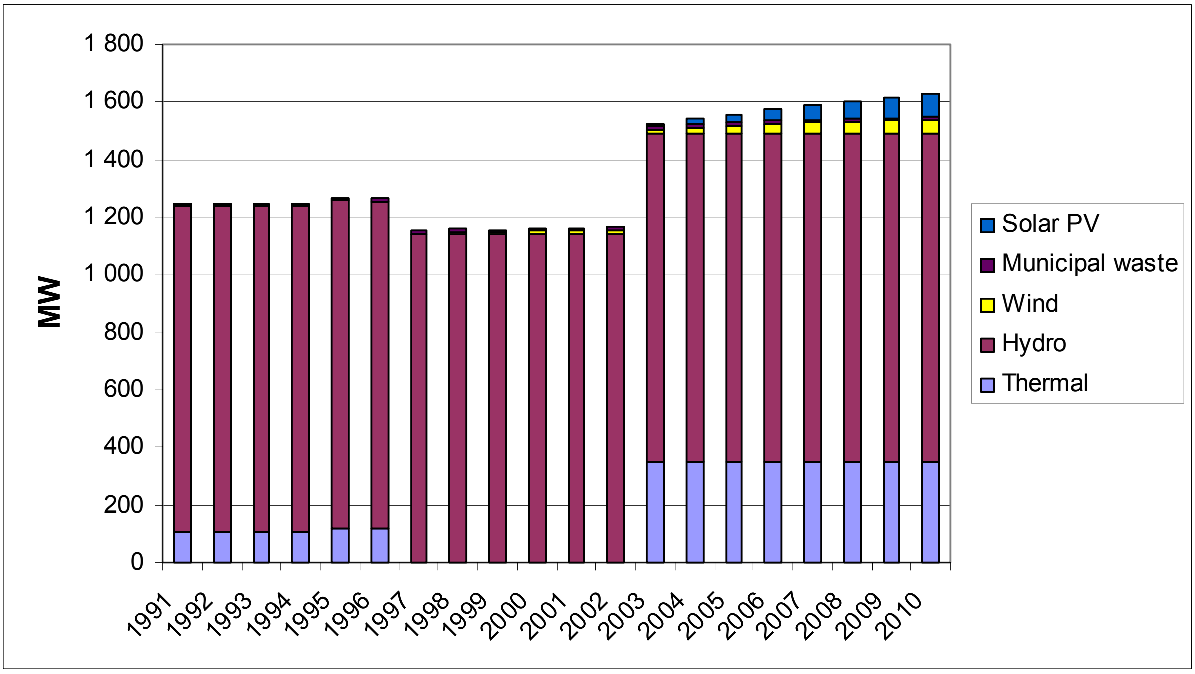


Figure 49: Installed capacity in Luxembourg 1991 – 2010

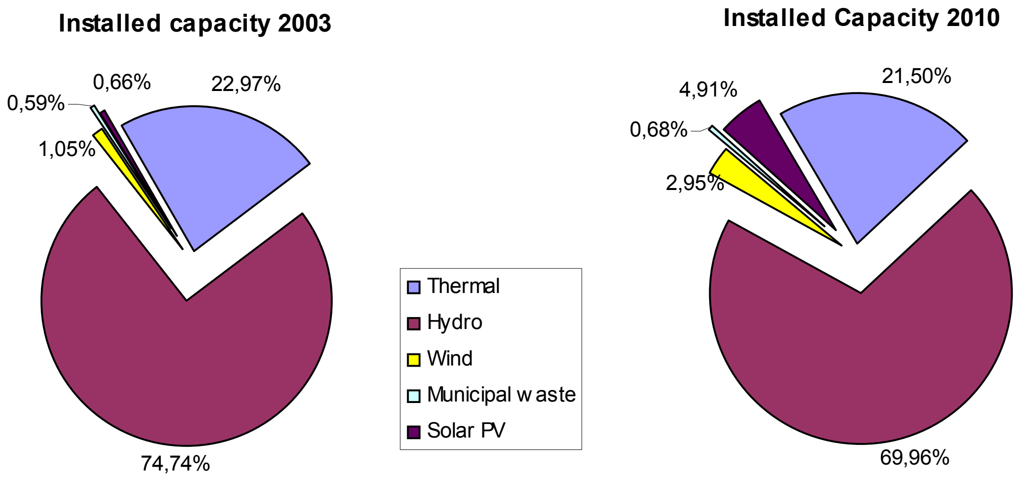


Figure 50: Comparison of the technology shares in Luxembourg 2003/2010

Luxembourg states its target of 5.7% RES in 2010 can be reached if technologies solar and wind power can grow with 700 % respective 200 %. Used policy instruments are feed-in tariffs together with investment grant. Note that the forecasted share of solar PV in 2010 is 4.9 %, which represent the highest share among the CEER states.

The Netherlands

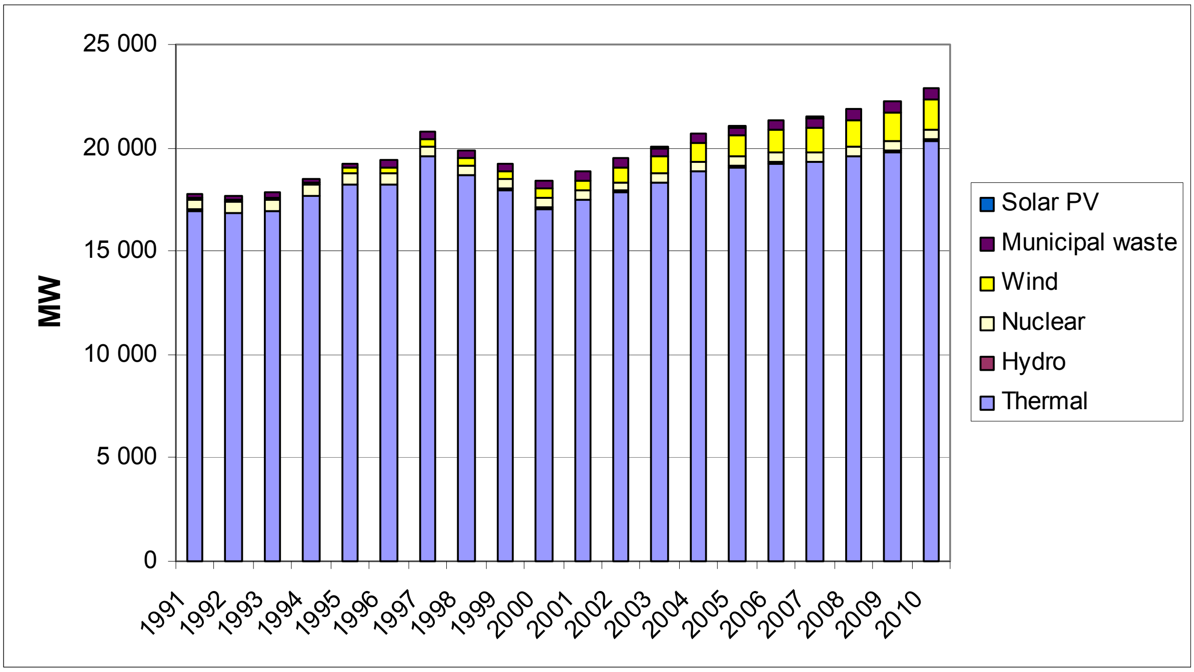


Figure 51: Installed capacity in the Netherlands 1991 – 2010

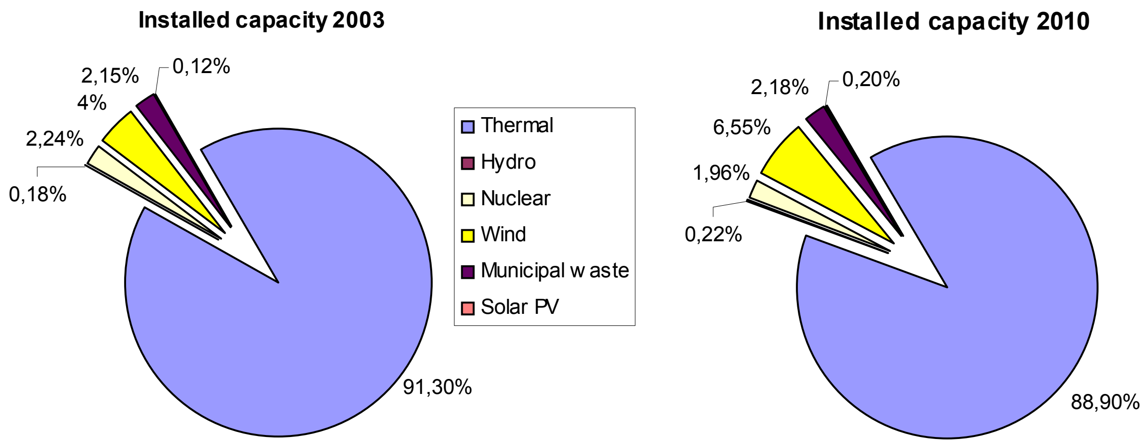


Figure 52: Comparison of the technology shares in the Netherlands 2003/2010

The previous support system in the Netherlands resulted in a significantly higher consumption of RE-E (eco tax), but in none or few new investments. Since July 2003 the main policy instrument in the Netherlands is a source specific feed-in tariff system. There are some other less significant support systems of the forms eco tax (phased out in 2005), certificates and investment grants. The most important source of RE is solid biomass (35 % in 2002 followed by on-shore wind). The RE contribution from wind power is forecasted to grow with 88 % within the period 2003-2010. Support levels for wind power in 2004 is 6.3 cent/ kWh on-shore and 8.2 cent/kWh off-shore. The recent budget constraints and the new policy direction have caused some uncertainties on the market for renewables.

Norway

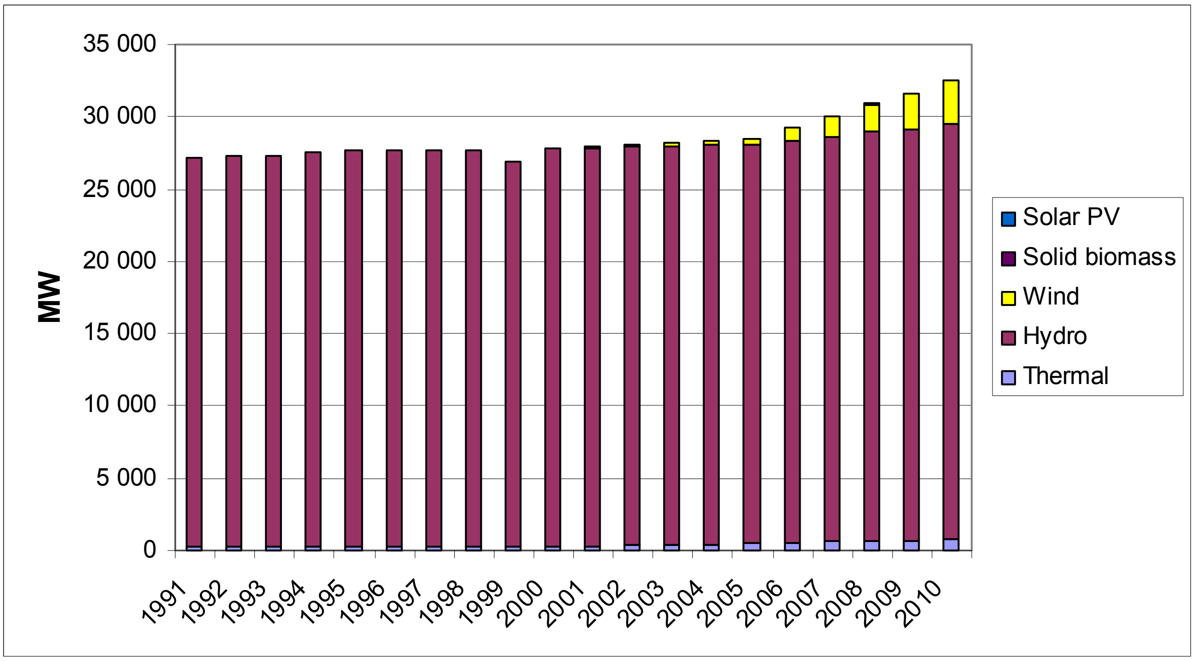


Figure 53: Installed capacity in Norway 1991 – 2010

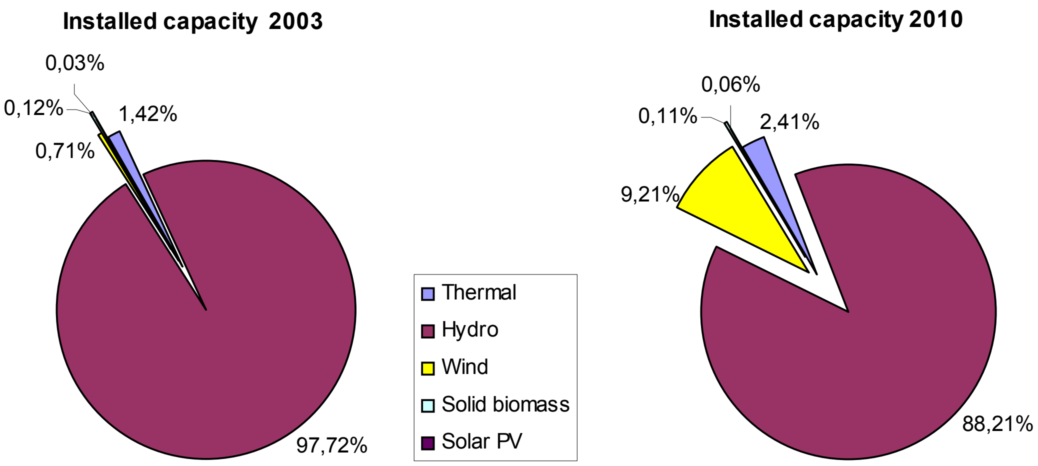
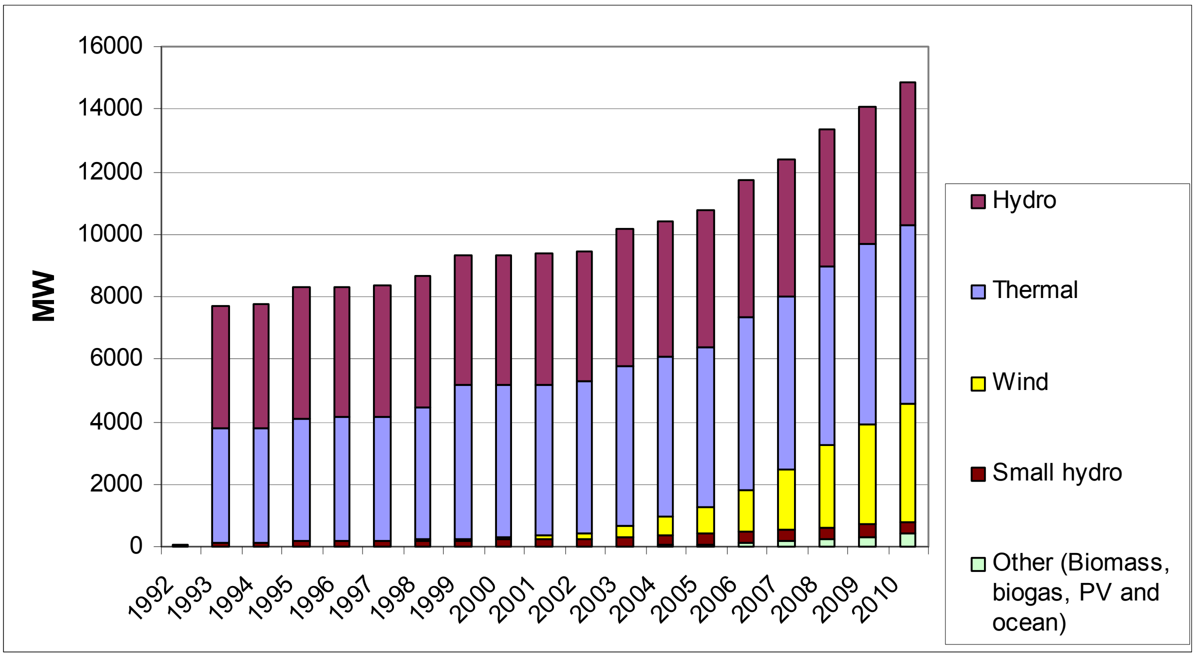


Figure 54: Comparison of the technology share in Norway 2003/2010

As today the Norwegian energy production almost exclusively consist of hydro power. The forecast for 2010 involves a 15 % increase in total capacity and an increase in wind power from 200 to 3000 MW (1400 %). The RE-policy in Norway is currently under consideration and the expected action is an implementation of a common certificates system with Sweden.

The support current levels of support are not sufficient for new investments in renewable electricity production.

Portugal



Source: DGGE (until 2002), REN (after 2002), RCM (2010)

Figure 55: Installed capacity in Portugal 1991 – 2010

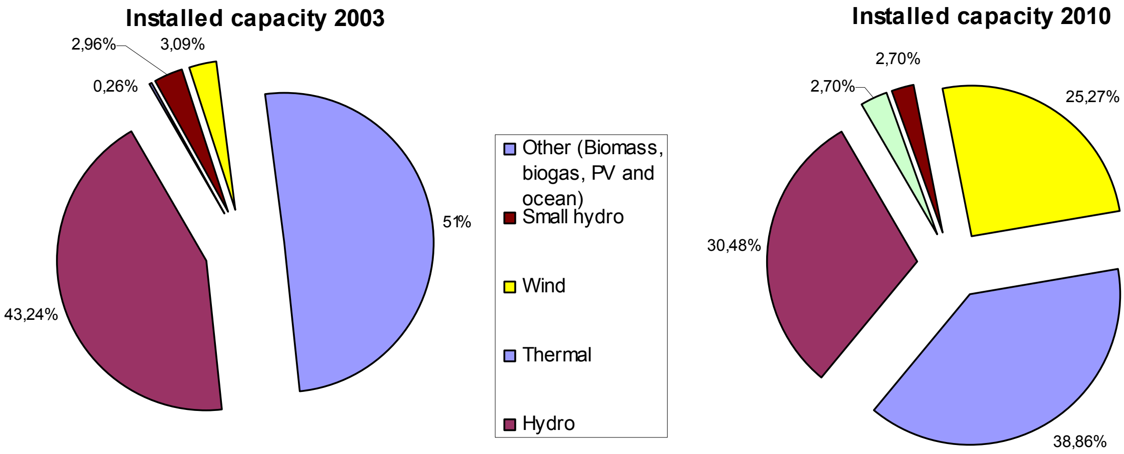


Figure 56: Comparison of the technology share in Portugal 2003/2010

Table 18 below shows the Portuguese policy goals for RE capacity 2010. The goals are established in government resolution.

Wind	3,750
All biomass	150
Biogas	50
Solar PV	150
Ocean	50
Small Hydro	400

Table 18: Policy goals for Portugal 2010 (MW)

The policy aim is to decrease Portugal's dependence on external energy sources, and concerning RE with a special attention to wind power and small hydro. The support for wind is decreasing with load hours. Support level starts with 7 cent/kWh and gradually decreases to 4.3 after 2600 hours. Portugal relies on a feed-in tariff system with additional support mechanisms in tax reduction and investment subsidies.

Spain

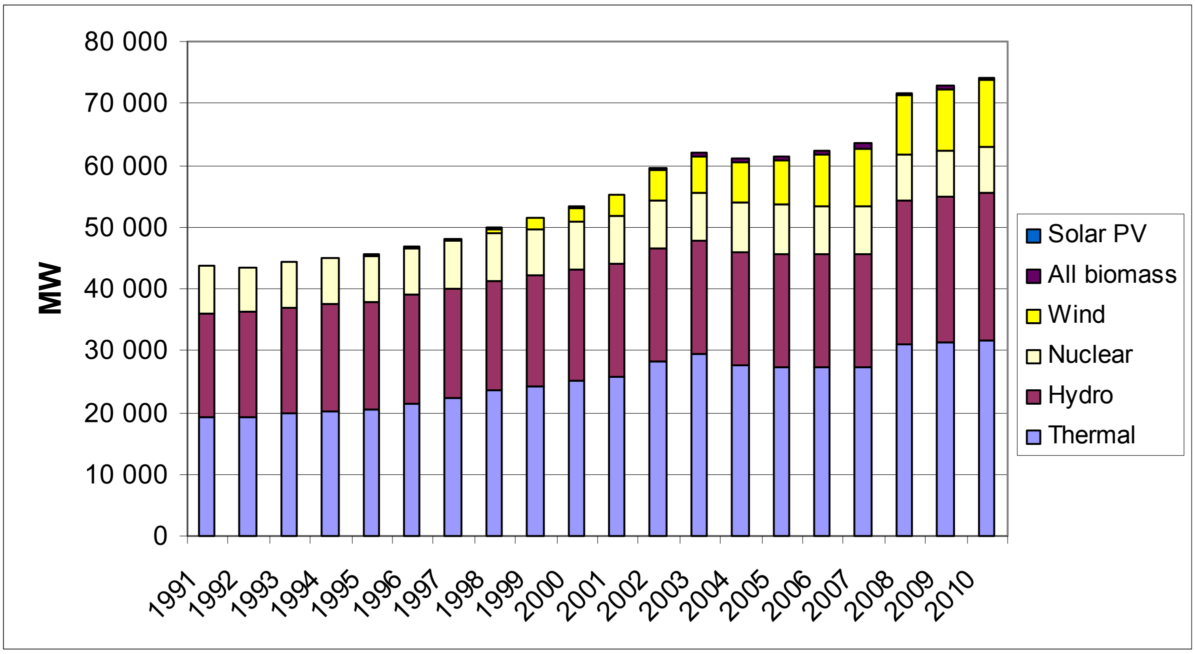


Figure 57: Installed capacity in Spain 1991 – 2010

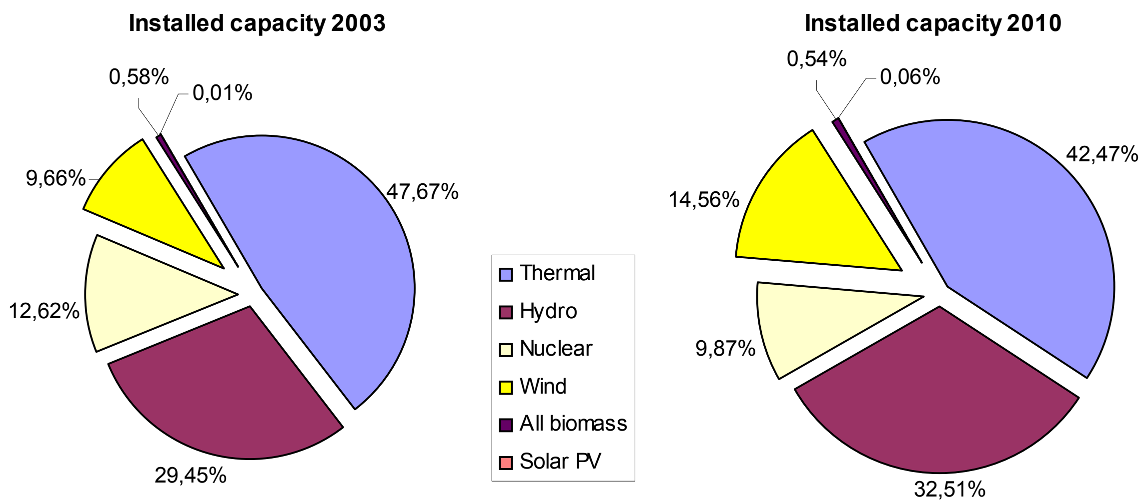


Figure 58: Comparison of the technology share in Spain 2003/2010

Note that information from 2008-2010 can has a different source different than the period 1991-2007 and absolute comparisons should be done carefully (especially Hydro and Thermal). The feed-in tariff support for RES that was implemented in 1997 resulted in a vast increase in RE capacity and above all wind power (even though hydro still is the most important RE-source). The Spanish RE forecast also involves a lot of wind power and corresponds to an 80 % increase 2003-2010. Potential problems are future decreased support levels and administrative barriers for small scale hydro.

Sweden

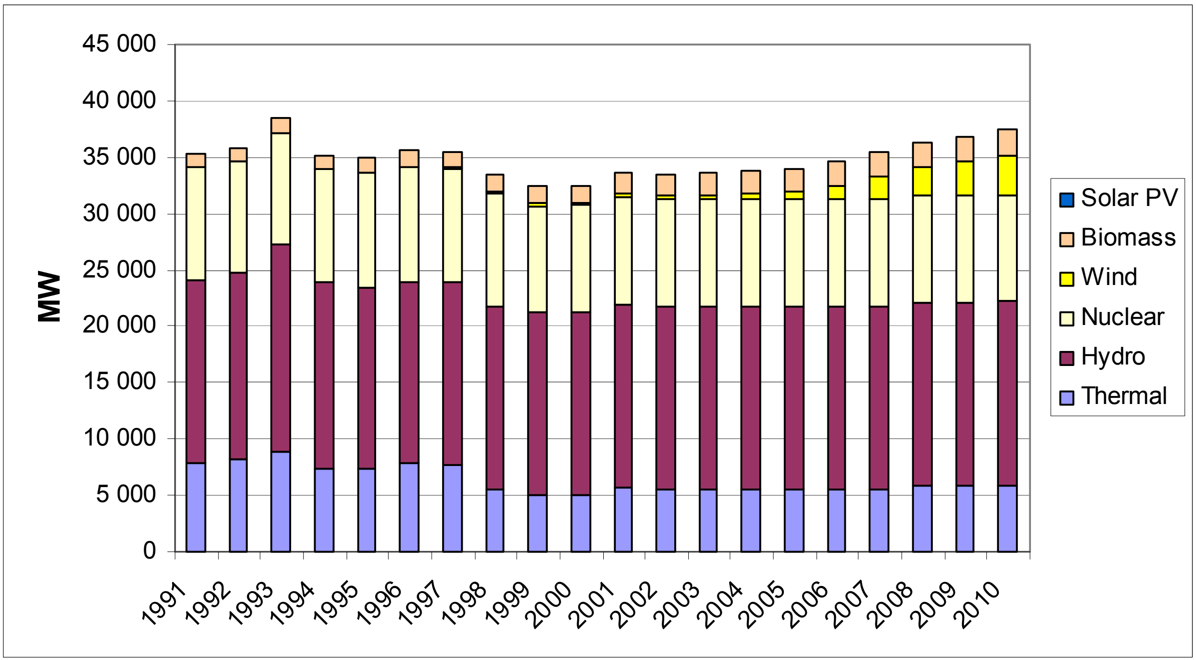


Figure 59: Installed capacity in Sweden 1991 – 2010

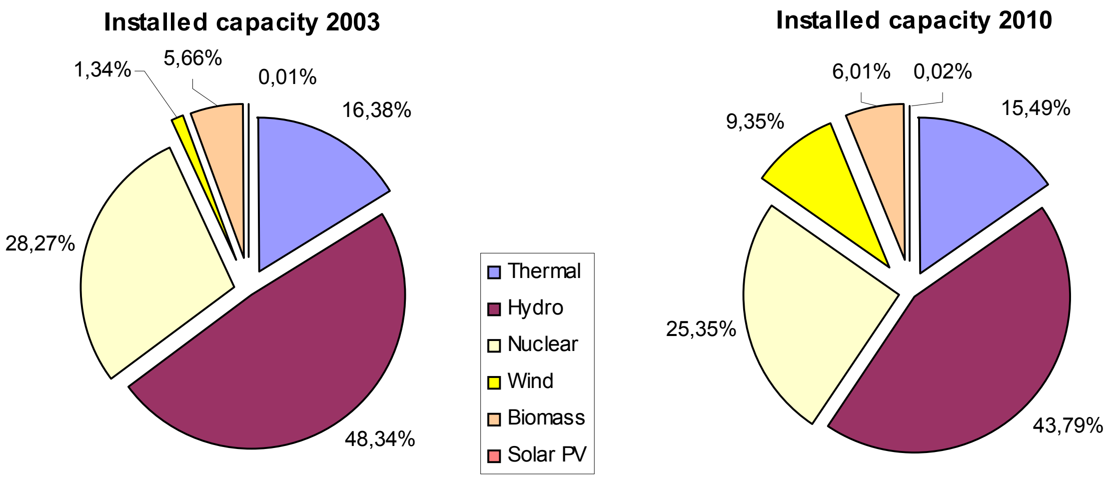
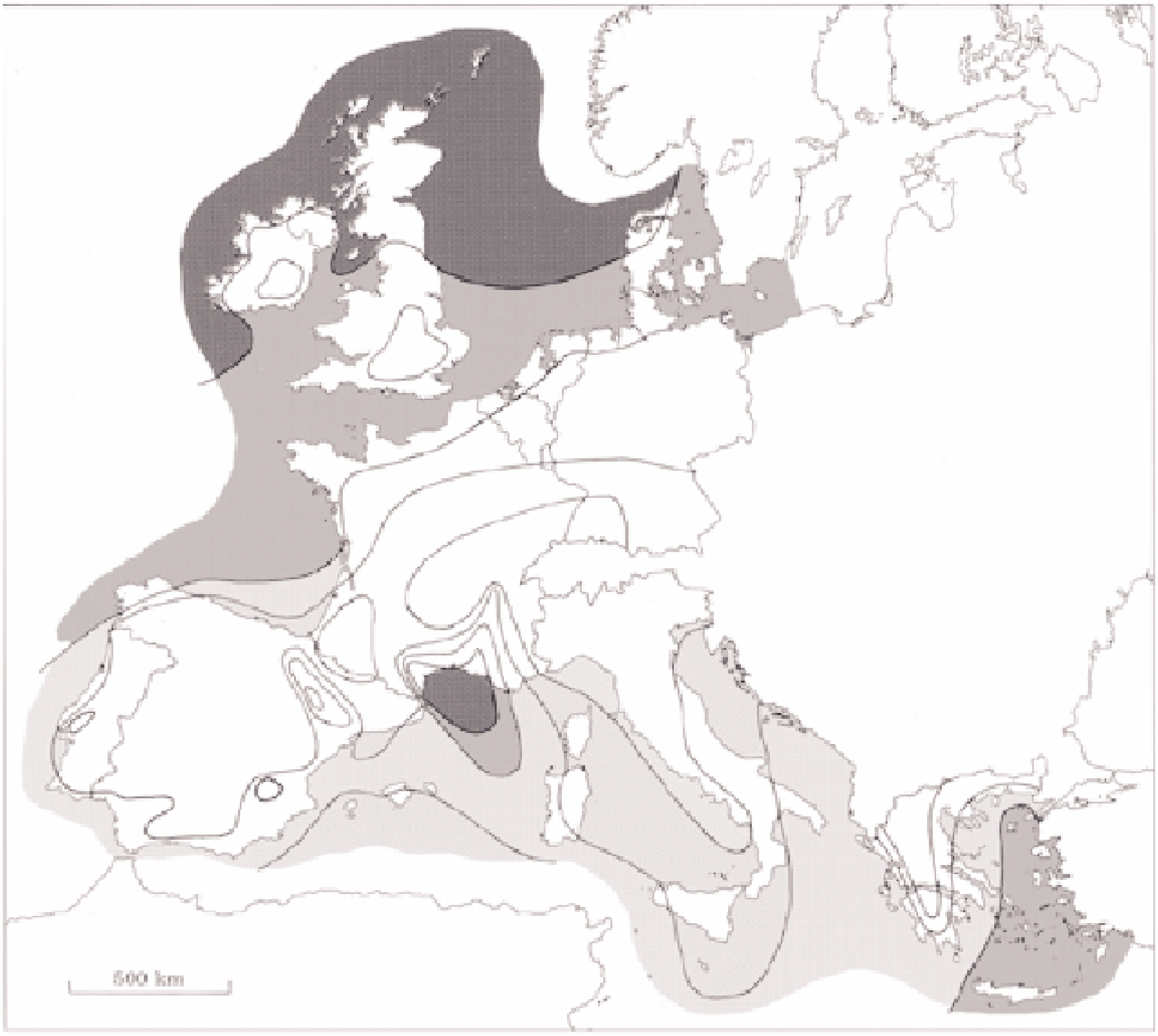


Figure 60: Comparison of the technology shares in Sweden 2003/2010

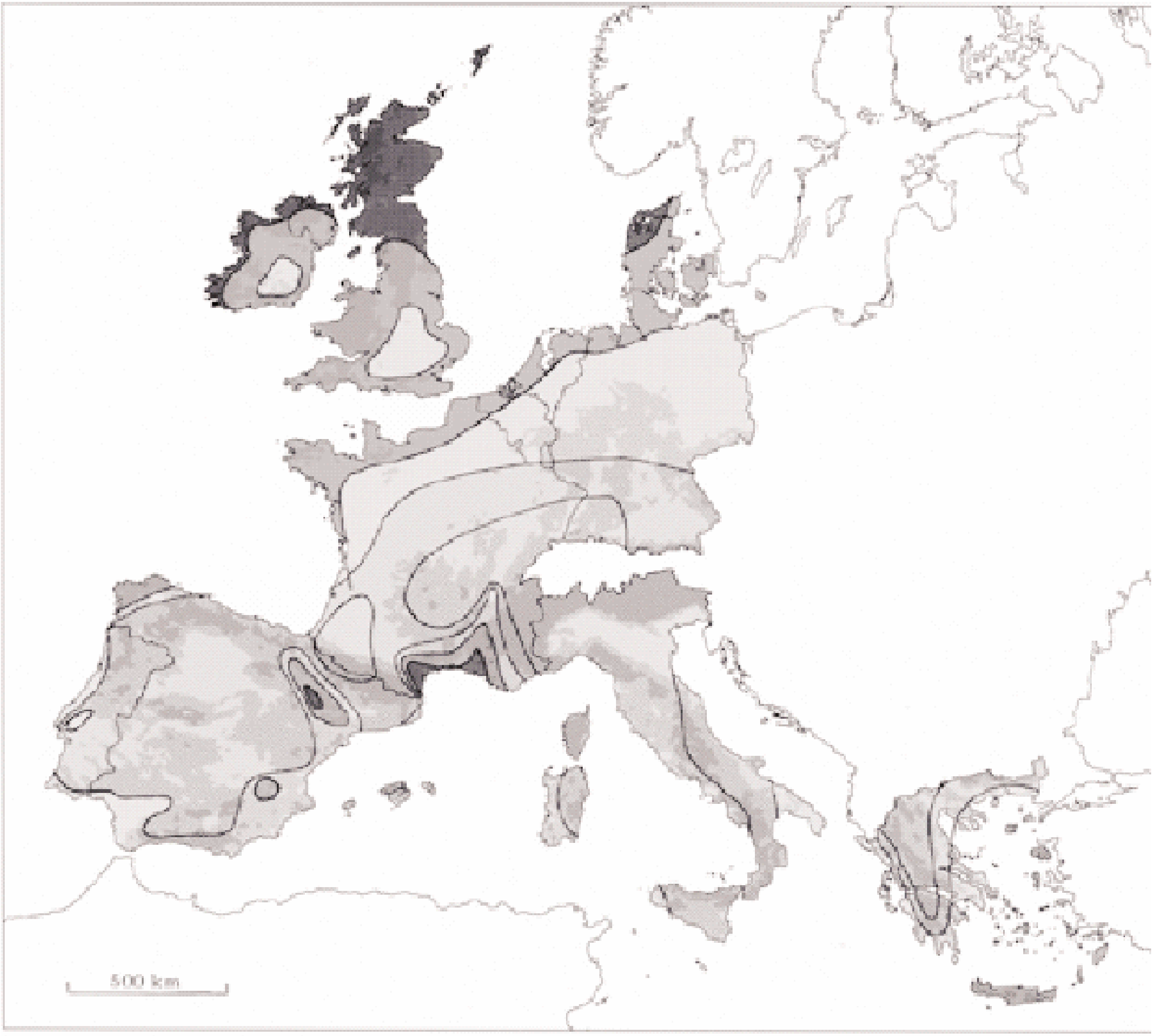
The Swedish forecast for 2003-2010 has an 11.4 % increase in total capacity and an almost 8-fold increase in wind power capacity. The Swedish main support system is a certificate system, but in order to meet the target for 2010 wind power receives an additional support scheduled to 2009. The additional support is divided in an environmental bonus / produced electricity and a market introduction and technical development support. The certificate trade is only a year old and a first evaluation of the system and generated support is performed in 2004. There are plans for a common Nordic certificate market.

vii. Wind potentials offshore



Wind resources over open sea (more than 10 km offshore) for five standard heights										
	10 m		25 m		50 m		100 m		200 m	
	$m s^{-1}$	$W m^{-2}$	$m s^{-1}$	$W m^{-2}$	$m s^{-1}$	$W m^{-2}$	$m s^{-1}$	$W m^{-2}$	$m s^{-1}$	$W m^{-2}$
	> 8.0	> 600	> 8.5	> 700	> 9.0	> 800	> 10.0	> 1100	> 11.0	> 1500
	7.0-8.0	350-600	7.5-8.5	450-700	8.0-9.0	600-800	8.5-10.0	650-1100	9.5-11.0	900-1500
	6.0-7.0	250-300	6.5-7.5	300-450	7.0-8.0	400-600	7.5- 8.5	450- 650	8.0- 9.5	600- 900
	4.5-6.0	100-250	5.0-6.5	150-300	5.5-7.0	200-400	6.0- 7.5	250- 450	6.5- 8.0	300- 600
	< 4.5	< 100	< 5.0	< 150	< 5.5	< 200	< 6.0	< 250	< 6.5	< 300

viii. Wind potentials onshore



Wind resources at 50 metres above ground level for five different topographic conditions										
	Sheltered terrain		Open plain		At a sea coast		Open sea		Hills and ridges	
	$m s^{-1}$	$W m^{-2}$	$m s^{-1}$	$W m^{-2}$	$m s^{-1}$	$W m^{-2}$	$m s^{-1}$	$W m^{-2}$	$m s^{-1}$	$W m^{-2}$
	> 6.0	> 250	> 7.5	> 500	> 8.5	> 700	> 9.0	> 800	> 11.5	> 1800
	5.0-6.0	150-250	6.5-7.5	300-500	7.0-8.5	400-700	8.0-9.0	600-800	10.0-11.5	1200-1800
	4.5-5.0	100-150	5.5-6.5	200-300	6.0-7.0	250-400	7.0-8.0	400-600	8.5-10.0	700-1200
	3.5-4.5	50-100	4.5-5.5	100-200	5.0-6.0	150-250	5.5-7.0	200-400	7.0- 8.5	400- 700
	< 3.5	< 50	< 4.5	< 100	< 5.0	< 150	< 5.5	< 200	< 7.0	< 400

ix. ERRA Report

Available in pdf-format

10 References

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11 Abbreviations

AER	Alternative energy requirement (scheme)
CHP	Combined heat and power
DG TREN	Directorate-General for Energy and Transport
DSO	Distribution System Operator
DTI	Department of Trade and Industry (Great Britain)
FdC	Fund (Luxembourg)
FIT	Feed in tariff
GC	Green Certificate
IEA	International Energy Agency
IEM	Internal Energy Market
IPPC	Integrated Polution Prevention and Control
LCP	Large Combustion Plants
LV	Low voltage
MENV	Ministry of Environmental Affairs (Luxembourg)
MV	Medium voltage
NFFO	Non fossil fuel obligation (Great Britain)
Öko-BG	Ökobilanzgruppe, Balance group (Austria)
Öko-BGV	Ökobilanzgruppenverantwortlicher, Balance group manager (Austria)
RES	Renewable energy sources
RES-E Directive	Directive 2001/77/EC on the promotion of electricity produced form renewable energy sources in the internal energy market
RES-E	Electricity produced from renewable energy sources
RO	Renewable obligation
ROC	Renewable obligation certificate
SEM	Single energy market (CEER Task Force)
SRO	Scottish renewable obligation
TGC	Tradable green certificates
TSO	Transmission System Operator
VAr	Voltage Ampere reactive
VDN	Verband der Netzbetreiber (Germany)