Danyel Reiche (ed.)

Handbook of Renewable Energies in the European Union

Case studies of all Member States

Foreword by Hermann Scheer

PETER LANG

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Case studies of the EU-15 States
in collaboration with Mischa Bechberger, Ruth Brand, Matthias Corbach, and Stefan Körner

Forewords by Hermann Scheer, Claude Turmes, and Stephan Kohler

Second, completely revised and updated edition
including DVD

PETER LANG
Frankfurt am Main · Berlin · Bern · Bruxelles · New York · Oxford · Wien

Bibliographic Information published by Die Deutsche Bibliothek
Die Deutsche Bibliothek lists this publication in the Deutsche Nationalbibliografie; detailed bibliographic data is available in the internet at <http://dnb.ddb.de>.

ISBN 978-3-653-01905-6 (eBook)
ISBN 3-631-53560-0
US-ISBN 0-8204-7686-2

Europäischer Verlag der Wissenschaften
Frankfurt am Main 2005
2., revised and updated edition

Printed in Germany 1 2 3 4 6 7

www.peterlang.de

Acknowledgements

In the first edition of this book which was issued in autumn 2002 it was written at this place: "If this handbook can contribute to a better understanding and a further diffusion of renewable energies, it will have achieved its goal". If one looks to the impressive growth rates of renewable energies in some EU Member States, this target was partly reached and perhaps this publication could contribute to this development. At least, several positive reviews and personal communications gave us this impression. Many people who are active in the field of renewable energies used the *Handbook of Renewable Energies in the European Union – Case Studies of all Member States* as source of information and permanent reference book. Such a reference book should consist of current data and describe recent developments. The sold out of the handbook gave us the opportunity to update all the information about renewable energies in the "old" European Union (EU-15). Information about the Accession States are given in the *Handbook of Renewable Energies in the European Union II – Case Studies of all Accession States* which was published at the end of 2003.

In this second edition in all case studies data from 2003 was used (instead of 2000 in the first edition). All the recent developments in the field of renewable energies were integrated, such as new support schemes (in Austria, the Netherlands and Sweden, for example), and changing administrative responsibilities like in Germany. As in its predecessor all chapters have been carried out using the same structure. At the beginning of each case study a definition of renewable energies is given for the individual country. The starting position in energy policy and the main actors are described then. Next, the instruments for promoting renewable energies are shown and each section concludes with an analysis of current obstacles and conditions for future success. This approach takes into account that success or failure cannot only be explained with the choice of particular instruments. Background conditions have to be considered.

I would like to thank all the authors for their cooperation, reliability, and analyses. Most of the authors were the same as in the book from 2002. The case studies about Italy, Luxembourg and Portugal were written by new authors (Rosaria di Nucci, Henri Kox, Isabel Soares). The authors of the introduction of this book and the Spain-chapter were the same like the last time, but they got a co-author (Mischa Bechberger). Mischa Bechberger also arranged the appendix, which concludes some general data about the 15 States. Ulrich Laumanns overworked the service chapter of Stefan Lange at the end of the book, which informs the reader about the most important associations, websites, and journals pertinent to the subject matter. Finally, Claude Turmes and the German Energy

Agency wrote new forewords (in addition to the one and only by Hermann Scheer in the first edition). The German Energy Agency will also support us in the distribution of the book. I am very grateful to Paul Kellet and the Irish Renewable Energy Information Office (REIO). The REIO sponsored the DVD "Smart Energy Policies" which is part of this book. I think the DVD information is very relevant and of the highest quality.

Matthias Corbach and Ruth Brand were new members of the editing team, which read and revised the drafts of the case studies in co-operation with the authors. Besides Ruth and Matthias, Mischa Bechberger, Stefan Körner, and myself belonged again to this group of people. Stefan Körner was once more also responsible for the formatting of this book.

I am very thankful to Dr. Hermann Scheer and Claude Turmes for writing the forewords. I would especially like to thank the German Federal Environment Foundation that supports me (as well as Ruth Brand and Mischa Bechberger) with its scholarship program. This is the financial basis for projects like this one. I am very pleased that there was once again excellent cooperation with Michael Rücker, Andrea Kluska, and Thomas Trumm from the Peter Lang publishing house.

Renewables are growing, but fossil energies are still dominant in the EU. The aim of this collection of systematic case studies describing national renewable energy policies in Europe is to identify obstacles and success conditions of a further diffusion of renewable energies because it is still a far way to reach the long-term target of an energy system which is mainly based on renewables. But first steps are done.

Dr. Danyel Reiche, Berlin/Hanover in May 2005

Content

Hermann Scheer

Preface

This handbook presents a survey on renewable energy applications in the EU Member States. It will help to overcome information gaps about the different levels of development and policies, and it will serve as a road map for scientists, policy-decision makers, producers and investors. The current solar map of the European Union, which is sketched in this handbook, shows a vague and at the same time contradictory picture. Above all, it is noticeable that there is no direct link between the given natural potential of renewable energies and the respective active technical-economical use of this potential. This applies at least to *new* renewable energies, which include all forms of renewables except hydroelectric power produced by dams, which have been in operation for a long time and are already integrated into the conventional energy supply system.

The natural potential for wind power for example, is clearly greater in the UK and France as compared to Germany, due to their long seacoasts. However, in 2004 Germany had around 20 times more installed wind power capacity when compared to the UK and about 44 times more than France! It is widely known that the natural potential for solar heat and the production of power by photovoltaic systems is clearly larger in Southern Europe than in central or Northern Europe. Nevertheless, this is not mirrored by any means in the actual implementation: substantially more solarthermal systems are installed in Austria than in Italy or Spain, and in Greece there exists a factor more than in Southern Italy. Biomass is used in Austria much more systematically and extensively than in its neighbouring country Switzerland, although both have quite similar natural potentials. The number of such examples could be extended almost at will.

These differences make it clear that the determining factors for the potential of renewable energies that are actually utilized, neither the natural potential nor the achieved technological standard, because relevant technologies are equally available everywhere within the domestic market of the European Union. Investment costs are not decisive either, since they are lower in relation to the energy performances in those areas where solar radiation is more intense or where the wind blows more frequently or faster. Other factors are obviously more relevant.

For the evaluation of practical introduction strategies, it is absolute necessary to identify the following factors:

One factor is the right legal framework. Thus, it is a question of whether and where political initiatives have already been taken for the market introduction of renewable energies. It is without a doubt, that in both absolute and relative numbers, Germany, Denmark and Spain have the most wind power systems and

in Germany, even the most photovoltaic systems are installed as a result of feed-in laws, which ensured a guaranteed minimum feed-in reimbursement. This model has proved to be the most successful compared in relation to other political concepts, such as subsidy investments for renewable energy systems or competition based on politically determined minimum quotas and tenders. The quota models only appear to be more dynamic for the market in theory, in reality they cannot work dynamically due to systematic reasons. The most important reason is that renewable energy is primarily a matter of the technology market and not of the classical energy market: with the exception of bio-energy, costs are primarily related to the technology supply, because no primary energy costs incur and transportation and distribution efforts are smaller or even omitted completely for certain applications (e.g. in the context of solar construction). The market rules of the conventional power supply are not transferable to renewable energies. Quota models do not give any certainties for investors and they reduce the motivation to invest only for short term economical reasons. However the "solar conversion of investments" looks different, its efficiency results from fuel and infrastructure costs are avoided on a long-term basis and motives for investments are more diverse.

A second factor is of cultural nature. This becomes particularly obvious, when we compare the current feed-in laws of Germany and Italy, which both became effective on January 1st 1991. Both laws established quite comparable basic conditions for renewable energies. However since then, the German law induced a constantly growing dynamic for the introduction of renewable energies, in contrast to the Italian law which did not. There can be only one explanation: German society was already mentally and socially prepared for the use of renewable energies due to the aggressive work of independent organizations and their campaigns supporting renewable energies. This motivated an increasing number of people to actively use the legal framework of renewable energies – engineers, craftsmen, architects, entrepreneurs and above all operators of renewable energy systems. Nevertheless, this was not the case in Italy during the 1990's and this lack of "human capacity" impeded pioneer activities in the field of renewable energies.

These prerequisites are of crucial importance for the mobilization of renewable energies. Three substantial differences exist between atomic/fossil energy and renewable energies. The first is the ecological difference between those energies which produce toxic emissions and those which are emission-free or emission-neutral. The second difference, is that renewable energy is inexhaustible compared to atomic/fossil energy. Thirdly, there exists a structural difference that cannot be ignored, if a successful introduction of renewable energies is achieved: due to a smaller energy density of a very broadly spread natural supply of renewable energies, a fundamental structural change is mandatory in order to supply these energy options. The substitution of atomic/fossil energies

by renewable energies requires less large-scale energy systems and investors but numerous small systems and investors. Thus, it involves the conversion from the highly centralized conventional energy system to a decentralized system for renewable energies. In the field of future fuels from biomass, which are the most obvious and the most economically achievable approach for the substitution of petroleum, agriculture businesses and regional producers of bio-fuels will continuously be taking over the role played by the mineral oil companies. The role played today by large-scale energy entrepreneurs in the economic system will continue to decline and will be replaced by producers of renewable energy technologies.

Therefore, the conventional energy mentality is a psychological barrier when considering renewable energies. The use of renewable energy requires a new energy mentality, which is beyond the scope of conventional energy protagonists and which opens one's eyes to the specific requirements of renewable energies. In order to achieve that, renewable energies need an active and participating society. Without this quintessential aspect, the existential necessity of society substituting atomic/fossil energy for by renewable energy cannot be realised. It leads to the most extensive structural change in the economy since the beginning of the industrial age, whose history up to now is also that of the fossil energy industry.

Claude Turmes

Preface

The XXI. century will be the renewable energies century. Renewables will play an ever-increasing and fundamental role in the next decades. Their advantages such as environmental and health impacts for society, the important contribution they can make to reduce the dependency on and conflicts for highly volatile oil without creating new problems like nuclear waste or proliferation, and the job creation and local economic added value potential are fast becoming fully recognised.

However, what will above all make renewables the energy of the XXI. century is their enormous diversity. Renewable energies come in a vast range of sizes and technologies, passive solar architecture, wood pellets, biogas combined heat and power, solar heating, solar PV, solar thermal electricity, hydro, geothermal, wind, marine energies like sea current, wave, tidal and osmosis to transport fuels like bio-ethanol, bio-methanol, rape seed, biomass based synthetic fuels and green hydrogen. There are more than 21 established renewable energy technologies that can guarantee a constant energy flow through their intelligent use and geographical distribution if the right systemic approach is taken to energy policies.

The present book gives an overview of the wide diversity of renewables in the member countries of the European Union. It assesses not only the actual status of renewables, but shows also clearly under which political framework conditions (stable economic incentives, lowering of administrative barriers, good knowledge of the technology by relevant actors) the promising renewable technologies develop. On the other hand it identifies also those countries where the natural development of renewables is hindered by all kinds of obstructions, be it from large market players or politicians. The detailed lecture of the different national chapters of the book will therefore be a very valuable source of information for all actors of energy politics, academics, lobbyists and above all policy makers at local, regional, national, and European level.

Renewables have the potential to cover 80 % or more of all energy needs by the end of this century. How quickly this will happen is depending on the right mix of policy instruments efficiently applied at the relevant levels (EU, national, regional, and local).

It will also heavily depend on our ability to move from supply orientated and single technology dominated energy discussions to *a systemic approach to energy policies* based on three pillars:

- *energy intelligence:* supply side (renewable) energies should always be part of a policy mix in which demand side (energy conservation and energy efficiency) measures play an important role.

- *appropriate energy density:* Low temperature uses like heating and cooling should always be supplied by low density energies like the "waste" energy from electricity production (co- or tri-generation of electricity/heating/cooling or low temperature renewable like solar thermal collectors. Using high value energies like electricity or gas just to heat or cool houses is unsustainable.

- *as local as possible:* energy production should always be as close as possible to the place of energy use: this reduces not only transport losses and enhances the security of supply but also strengthens local and regional economies.

Green buildings: a basis for a sustainable energy system

Energy use in the EU building sector accounts for at least 40 % of overall energy use. The introduction of low density renewables along with the use of co- or tri-generated heating and cooling networks based on biomass or high temperature geothermal will increase the use of renewable energy in the building sector. This will reduce EU's oil dependency, unnecessary electricity consumption and diminish gas use in buildings thus freeing up gas for the electricity market.

Instead of spending money on buying gas and oil, investments in intelligent buildings and in renewables would trigger hundreds of thousands of new jobs in Europe. This could be encouraged with mandatory high level minimum standards for new buildings, a broadening of the existing EU building directive to all buildings bigger than 250 m^2, a new EU directive on mandatory minimum shares of renewables in the heating and cooling sector and a EU scheme for cheap loans at the European level (as already exists for nuclear reactors).

Green electricity: Aiming for a European wide 100 % renewable electricity system

The EU is leading the world in Green electricity. Wind and solar are today the fastest growing sources for electricity in the EU. As a result the costs of renewable energy are falling rapidly. The technical potential for renewables is greater than current EU energy demand. Biomass, wind and geothermal are expected to be more widely deployed in the next 10 to 15 years, while solar PV but also solar thermal electricity and marine renewables like energy from sea currents, energy from tidal and energy from waves are all being rapidly

developed and expected to become commercially viable on the short to medium term.

The greater use of renewables for electricity production is not hampered by technical but political problems. In order to facilitate the rapid introduction of renewables a number of policy instruments must be introduced, this includes measures to facilitate the reduction of the overall electricity use, *stopping environmentally harmful subsidies to coal, gas and nuclear and ensuring fair access to the distribution networks for renewably produced electricity and biogas.*

Policy instruments at the EU level must at a minimum focus towards a requirement that 35 % of the electricity consumed in 2020 is from renewable sources. Particular attention must be placed on the introduction of measures for the already mature and viable technologies for example with a biomass action plan and a coordinated large scale North Sea wind energy project. A much greater percentage of funds should be earmarked for renewables and energy efficiency in the European R&D FP7 program, to boost technical development of non-mature renewable technologies and to accelerate their cost reductions. A third directive on electricity and gas market is needed to introduce measures such as full ownership unbundling, fair access to storage, reduction of market power of the dominating companies and fully segregated decommissioning funds in order to put an end to economic discriminations against renewables in the internal electricity market.

Transport: Efficiency first, renewable fuels second, hydrogen third

Today's transport policies are causing a huge import dependency on highly volatile oil, creating dramatic health problems and are also responsible for the fastest growing increase in CO_2 emissions of any sector. Without significant reforms in the very structure of the transport sector and a substantial increase in efficiency a higher share of renewable fuels will be difficult to obtain.

System efficiency gains are needed through structural measures such as better urban and regional planning, shift in goods and persons transport from air and road to train, buses and the development of bicycle and pedestrian mobility in urban cities. The car of the 21st century has to be lighter, smaller and hybrid first. Mandatory performance targets for cars like the newly introduced Californian model are important to give the car manufacturer a clear and stable framework for their future investments.

Before engaging in a new policy for alternative fuels, EU and national governments should carefully analyse the total environmental impact of different fuel sources and conversion technologies. The well-to-wheel energy

chain analysis – developed by the Commission Joint Research Center in their CONCAWE study – must be undertaken for different fuels including the different biofuel paths. Engaging into a so-called hydrogen economy without having achieved large shares of renewables is dangerous because it will favor nuclear or coal produced hydrogen.

Deutsche Energie-Agentur

Preface

Our challenges for the twenty-first century include protecting the climate, saving valuable resources and ensuring worldwide sustainable development. The use of renewable energies will make an important contribution to these goals.

Technologies from Germany for the use of renewable energies have an excellent reputation, both at home and abroad. Long-standing experience in the construction and operation of plants, innovative advances in the area of research and development, and numerous references from all over the world have made "Renewables Made in Germany" a synonym for quality and efficiency.

The German Energy Agency (Deutsche Energie-Agentur GmbH), dena, a national competence center for energy efficiency and renewable energies, supports the international dissemination of the use of renewable energies. Dena's Renewable Energies Export Initiative is helping business build up contacts in interesting markets, use synergies, and solve financing problems. Dena's activities are organized so as to clear away barriers to exports for German business, and to make access to foreign markets easier for them. The services are tailored to the needs of a young industry, and focus on the specific conditions which renewable energy technologies need for their distribution.

The Internet portal www.exportinitiative.de, the series of publications, and expert events provide German businesses with the export know-how they need, in a practically relevantly and technically usable form. A network of German and international actors from government and business supports dena in her efforts to gather the relevant current information.

With comprehensive marketing measures, dena provides information abroad on "Renewables Made in Germany." German RE products are available worldwide, with multilingual catalogues and Internet-based information under www.renewables-made-in-germany.com. The renewable energies business travel program brings German suppliers and potential customers abroad together.

This book is designed to provide a helpful summary of the wide range of energy-policy and energy-economy contexts in the fifteen old EU countries. It also examines the conditions for success – and the challenges for further expansion – for the use of renewable energies.

We hope that the information provided in this book will be helpful to you in gaining access to European markets, and hope that the book, which documents the valuable research of the Berlin FFU, will enjoy broad distribution, and provide interesting information to its readers.

Stephan Kohler

(Managing Director of Deutsche Energie-Agentur GmbH, dena)

www.renewables-made-in-germany.com www.exportinitiative.de

Danyel Reiche and Mischa Bechberger

Renewable energies in the EU-Member States in comparison[I]

Different definitions

Differences between the compared countries begin with the definition of renewable energy sources (RES). A common agreement is that onshore wind, photovoltaic and solar thermal energy are all generally regarded as renewable energies. Hydropower is also defined as a renewable source in all EU Member States, but there are also limitations. There are only a few countries, which do not exclude large hydropower from their subsidy programs, such as Spain, where hydro power plants up to 50 MW or Germany, where – under certain circumstances[1] – hydro power plants even up to 150 MW capacity are classified as RES. Most Member States exclude hydropower above 10 MW. There are some renewable energy sources that are excluded from individual national definitions, because not all RES are available throughout the continent: these include tidal and other wave power, which have a large potential in countries like the UK and in France, which has the biggest tidal power plant in the world[2]; geothermal energy, which has already gained importance in Italy, for example (see table 1); and offshore wind, which has a large potential in all coastal countries but which is still at the beginning of its development[3].

A main difference in the definitions is the acceptance of electricity produced from waste incinerators as a renewable energy source. Some countries like Germany and Greece exclude waste incinerators from their RES-definition. In countries like Belgium, the UK, and the Netherlands, this was the leading "renewable" energy for many years. But since the EU-Directive for the promotion of RES electricity production has been in force since September 2001, only the biodegradable fraction of industrial and municipal wastes can be promoted as a renewable energy source. This means that if half of the energy from an incinerator comes from organic waste, the electricity produced from it is half regenerative and the other half can no longer be counted as renewable.

A particularity is the use of peat in Finland and Ireland, which has considerable shares in the energy balance of these countries[4]. But it is excluded from the

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I This introduction concentrates on the most important findings regarding the latest developments on renewable energies in the EU-15. Nevertheless, as the EU comprises ten new Member States since May 2004, the article takes this fact into account by facilitating data for all EU-25 countries at least in the tables included therein. For more in-depth analysis on renewable energies in the EU Accession States (including Romania, Bulgaria and Turkey) please consult the Handbook of Renewable Energies in the European Union II (Reiche 2003).

definition of renewable energy sources in the EU-Directive. The Directive defines renewable energy sources as wind, solar, geothermal, wave, tidal, hydropower (without any limitation), biomass, landfill gas, sewage treatment plant gas, and biogases. Besides the European definition of RES electricity, the EU-Directive on biofuels (2003/30/EC) of May 2003 also laid down a definition of renewable fuels. Accordingly, bioethanol, biodiesel, purified biogas, biomethanol, biodimethylether, bio-ETBE (ethyl-tertio-butyl-ether) produced on the basis of bioethanol, bio-MTBE (methyl-tertio-butyl-ether) produced on the basis of biomethanol, synthetic biofuels, biohydrogen and pure vegetable oil are defined as biofuels (European Communities 2003a: 3). Only a clear definition of renewable heat at European level is still missing, as there is until now no RES heat EU-Directive.

Different geographical conditions

The natural conditions for renewable energy sources differ widely across Europe. Except for Denmark, countries leading in renewable energies are countries with good conditions concerning rainfall, distribution of rainfall over the year and inflow, which in turn make a high production of electricity from hydropower possible. These countries are Austria, Sweden, Portugal, Finland, Spain, Italy and France (see table 1). Belgium, the Netherlands, the UK and Germany do not have the hydropower potential like Austria, that might be able to realise 100 % RES in the electricity market within the next decades; a vision that is illusory for Belgium, for example.

Another obstacle for renewables is the availability of fossil resources. Countries such as the Netherlands and the UK have access to gas and oil in their own country. If these resources run out[5] and renewables become cheaper (in the UK wind is already cheap), the incentive to increase the share of renewable energies will grow. On the other hand, a country like Portugal already has a high share of renewables, because it totally depends on the external supply of fossil energy resources. Another advantage for Portugal is that there are no old fossil fuel and uranium based energy companies that are resisting renewable energy development. The influence of energy intensive industries such as the Swedish paper industry can be a hurdle for renewable energy development on the one side. On the other side, the Austrian paper industry is one of the largest RES-producers in the country, because it is using its wastes to produce energy.

It is not surprising that solar thermal energy is utilised more successfully in a South-European country like Greece than for example in Sweden (located in the north of Europe). At the end of 2003, Greece had the second most solar thermal applications with about one fifth of the installed total within the 15 Member States. But despite the importance of natural conditions, one cannot explain the

differences between the EU Member States and their use of renewable energies strictly in terms of resource availability. Regarding solar thermal, since a couple of years Germany is the EU country with the biggest cumulated installed solar collector space (amounting to 6.3 M. m^2 at the end of 2004, see BMU 2005: 2), despite less favourable irradiation conditions as in the case of Greece. The latter also applies for Austria, which in 2003 already reached the total installed solar thermal capacity of Greece and was therefore the leading EU-15 country regarding the solar thermal panel surface installed per capita. On the other side, other South European countries like Portugal or Spain with also very favourable sun irradiation conditions only reached a relatively small solar collector surface installed.

Table 1: Production of electricity from renewable sources at the end of 2002 in the EU-25. Share in gross consumption of electricity (European Commission 2004a: 46).

Country	Hydro*	Wind	Biomass	Geothermal	Total 2002	Target 2010
Austria	65.4	0.3	2.6	0.0	**68.3**	**78.1**
Belgium	0.4	0.1	1.9	0.0	**2.3**	**6.0**
Cyprus	0.0	0.0	0.0	0.0	**0.0**	**6.0**
Czech Republic	3.9	0.0	0.8	0.0	**4.6**	**8.0**
Denmark	0.1	13.1	6.6	0.0	**19.8**	**29.0**
Estonia	0.1	0.0	0.4	0.0	**0.5**	**5.1**
Finland	12.4	0.1	11.2	0.0	**23.7**	**31.5**
France	12.8	0.1	0.7	0.0	**13.6**	**21.0**
Germany	4.0	2.7	1.3	0.0	**8.1**	**12.5**
Greece	4.9	1.1	0.0	0.0	**6.1**	**20.1**
Hungary	0.5	0.0	0.2	0.0	**0.7**	**3.6**
Ireland	3.6	1.5	0.3	0.0	**5.5**	**13.2**
Italy	12.1	0.4	0.7	1.4	**14.7**	**25.0**
Latvia	39.0	0.2	0.2	0.0	**39.3**	**49.3**
Lithuania	3.3	0.0	0.0	0.0	**3.3**	**7.0**
Luxembourg	1.8	0.4	1.0	0.0	**3.2**	**5.7**
Malta	0.0	0.0	0.0	0.0	**0.0**	**5.0**
Netherlands	0.1	0.8	2.7	0.0	**3.6**	**9.0**
Poland	1.7	0.0	0.4	0.0	**2.1**	**7.5**
Portugal	16.4	0.8	3.6	0.2	**21.0**	**39.0**
Slovakia	18.8	0.0	0.0	0.0	**18.8**	**31.0**
Slovenia	25.1	0.0	0.8	0.0	**25.9**	**33.6**
Spain	9.3	3.5	1.8	0.0	**14.6**	**29.4**
Sweden	44.0	0.4	2.6	0.0	**47.0**	**60.0**
United Kingdom	1.2	0.3	1.3	0.0	**2.9**	**10.0**
EU-25	**9.9****	**1.2****	**1.6****	**Ø 0.2****	**12.9****	**21.0****

* Does not include pumped storage.

** Based on gross electricity consumption of all EU-25 countries

The same situation can be found in the case of photovoltaic installations. Whereas Germany or Luxembourg with only average sun irradiation conditions are on the top of the European ranking concerning installed PV capacity (Germany) respectively regarding the level of installed PV capacity per capita (Luxembourg), EU Member States with much more sunshine hours per year like Greece or Portugal have installed only small PV capacities until now (EurObserv'ER 2004: 8).

Table 2: Wind energy and population density in the EU-25 in 2004 (sources: European Commission 2004a: 15; EWEA 2005).

Country	**Installed capacity in MW**	**Inhabitants per km²**
Austria	606	96.5
Belgium	95	340.9
Cyprus	2	78.9
Czech Republic	17	129.4
Denmark	3,117	125.3
Estonia	6	29.9
Finland	82	15.5
France	386	109.5
Germany	16,629	231.2
Greece	465	83.7
Hungary	6	108.8
Ireland	339	57.2
Italy	1,125	190.8
Latvia	26	35.9
Lithuania	7	52.9
Luxembourg	35	174.0
Malta	0	1,265.8
Netherlands	1,078	391.6
Poland	63	122.1
Portugal	522	113.4
Slovakia	5	110.1
Slovenia	0	98.7
Spain	8,263	81.2
Sweden	442	19.9
United Kingdom	888	243.1
EU-25 Total	**34,205**	**Ø 172.2**

The countries with the best wind conditions in the EU are France, the UK, and Ireland[6]. A wind turbine in Ireland can produce twice as much electricity as the same wind turbine installed in Germany. However, the installed wind energy capacity in Germany is more than eleven times higher than in Ireland, the UK, and France combined (see table 2). Also, the often presumed connection between low population density and success of wind energy does not exist.

Table 2 shows that there are eleven countries with a lower population density than Germany. But no countries, with the exception of Denmark and Spain (when considering installed capacity/per capita), are more successful than Germany.

Different starting positions in energy policy

There are seven countries without nuclear power stations in the EU 15 (see table 3). Some of them, such as Austria and Portugal (hydropower) and Denmark (wind energy) belong to the countries, which are most successful with renewable energies in Europe. There are four countries, which decided to phase out the utilisation of nuclear power: Belgium, Germany[7], the Netherlands, and Sweden[8]. This might increase the share of renewable energies in energy supply over the long term. Among the EU-15 States there are only three countries left which are still supporting nuclear energy: the UK, France, and Finland.

Table 3: Number of nuclear units and contribution of nuclear power to electricity generation in the EU-25 in 2003 (sources: IAEA 2005; VDEW 2005).

Country	Number of nuclear units connected to the grid in 2003	Nuclear share of total electricity supply in % in 2003
Austria*	0	0
Belgium*	7	55.5
Bulgaria****	4	37.7
Cyprus	0	0
Czech Republic	6	31.1
Denmark	0	0
Estonia	0	0
Finland**	4	25.5
France**	59	77.6
Germany*	18	27.6
Greece	0	0
Hungary	4	32.7
Ireland	0	0
Italy*	0	0
Latvia	0	0
Lithuania****	2	79.9
Luxembourg	0	0
Malta	0	0
Netherlands*	1	4.0
Poland	0	0
Portugal	0	0
Slovakia****	6	57.4
Slovenia	1	40.4
Spain***	9	23.6

Sweden*	11	49.2
United Kingdom	31	23.9
EU-25 Total	**163**	**Ø 21.9**

* These countries' governments have decided to phase out nuclear power.

** The Finish parliament decided to build one further nuclear power station in May 2002. Also France, in October 2004, decided to built a new nuclear in Flamanville (Normandy) to be commissioned in 2012 (Corbach 2005: 112).

*** In Spain, a moratorium on the government decision to build five new nuclear power stations has been in force since the Chernobyl disaster in 1986.

**** Between 2005 and 2009 these countries have to shut down two reactors each according to their EU-accession agreements (Reiche 2003: 17).

Different international obligations

The policy for the promotion of renewable energies has been influenced more and more by international obligations. There is the EU-Directive on the promotion of electricity produced from renewable energy that gives all EU Member States reference values for their RES-development until 2010. Table 4 shows that this is a big challenge for all countries; even the forerunners have to improve their RES-performance noticeably. The required increase for Portugal seems very small; this is, however, a significant challenge since the electrical consumption is expected to continue to grow on a high level during the next years. In Greece, Ireland, and Spain the electricity demand is also still rising, whereas the markets in countries like Austria and Sweden are characterised by stagnation and over-capacities. In its first formal assessment on Member States' performance on the 2001 renewable energy Directive issued at the end of May 2004, the Commission mainly concluded that the EU-15 will significantly miss the target to generate 22 % of electricity from renewables by 2010 (respectively 21 % for the EU-25) under current policies and measures, even under a scenario that builds in reductions in total electricity demand as a result of new energy efficiency measures. This is mainly due to a slower market development in the field of biomass electricity. Instead the EU is likely to reach only 18-19 % renewable electricity penetration by the end of the decade, according to the report. The figures equate to a 10 % renewables share of total EU energy consumption, against a target of 12 %. All but four Member States (Germany, Denmark, Spain, Finland) are set to miss their national renewable electricity targets (European Commission 2004: 14). Apart from the Directive on the promotion of RES electricity production, another European Directive on biofuels was adopted in May 2003. It requires the EU Member States to set national indicative targets for the market share of biofuels with reference values of 2 % in 2005 and 5.75 % in 2010 of all petrol and diesel fuels. These ambitious indicative targets will be an important incentive for supporting the diffusion of biofuels in the EU. Furthermore, on 26 June 2003, the European Parliament and the Council adopted the Community's support programme for non-technological actions in the field of energy efficiency and renewable energy

sources, called "Intelligent Energy Europe" (IEE). The duration of the programme is from 2003-2006 with an overall financial framework of 200 million €. It entered into force on 4 August 2003. IEE also includes the ALTENER program, a package of measures for the funding of studies, pilot-projects, dissemination of information, and other activities in the RES field, which will be funded with 80 million € (European Commission 2003: 49).

Table 4: International obligations (sources: European Commission 2004a: 46; European Commission 2004c: 20).

Country	**EU directive***	**Development – until 2002**	**Kyoto target****	**Development until 2002**
Austria	+ 8.1 %	- 1.7 %	- 13.0 %	+ 8.5 %
Belgium	+ 4.9 %	+ 1.2 %	- 7.5 %	+ 2.1 %
Cyprus***	+ 6.0 %	± 0.0 %	-	-
Czech Republic	+ 4.2 %	+ 0.8 %	- 8.0 %	- 25.7 %
Denmark	+ 20.3 %	+ 11.1 %	- 21.0 %	- 0.8 %
Estonia	+ 4.9 %	+ 0.3 %	- 8.0 %	- 55.2 %
Finland	+ 6.8 %	- 1.0 %	0.0 %	+ 6.8 %
France	+ 6.0 %	- 1.4 %	0.0 %	- 1.9 %
Germany	+ 8.0 %	+ 3.6 %	- 21.0 %	- 18.9 %
Greece	+ 11.5 %	- 2.5 %	+ 25.0 %	+ 26.5 %
Hungary	+ 2.9 %	± 0.0 %	- 6.0 %	- 31.0 %
Ireland	+ 9.6 %	+ 1.9 %	+ 13.0 %	+ 28.9 %
Italy	+ 9.0 %	- 1.3 %	- 6.5 %	+ 9.0 %
Latvia	+ 6.9 %	- 3.1 %	- 8.0 %	- 63.1 %
Lithuania	+ 3.7 %	± 0.0 %	- 8.0 %	- 60.2 %
Luxembourg	+ 3.6 %	+ 1.1 %	- 28.0 %	- 15.1 %
Malta***	+ 5.0 %	± 0.0 %	-	-
Netherlands	+ 5.5 %	+ 0.1 %	- 6.0 %	+ 0.6 %
Poland	+ 5.9 %	+ 0.5 %	- 6.0 %	- 32.3 %
Portugal	+ 0.5 %	- 17.5 %	+ 27.0 %	+ 41.0 %
Slovakia	+ 13.1 %	+ 0.9 %	- 8.0 %	- 28.2 %
Slovenia	+ 3.7 %	- 4.0 %	- 8.0 %	- 1.1 %
Spain	+ 9.5 %	- 5.3 %	+ 15.0 %	+ 39.4 %
Sweden	+ 10.9 %	- 2.1 %	+ 4.0 %	- 3.7 %
United Kingdom	+ 8.3 %	+ 1.2 %	- 12.5 %	- 14.9 %
EU-15 Total	**+ 8.2 %**	**- 0.8 %**	**- 8.0 %**	**- 2.9 %**
EU-25 Total	**+ 7.2 %**	**- 0.7 %**	-	**- 9.0 %**

* Increase of the proportional contribution of RES in the gross national electricity consumption from 1997 (EU-15) respectively 1999 (EU Accession States) to 2010.

** Reduction of greenhouse gas emissions from 1990 levels by the 2008-2012 compliance period.

*** Cyprus and Malta are Non-Annex I Parties to the UNFCCC and thus do not have a target under the Kyoto Protocol.

The liberalisation of the electricity market is on the one hand an opportunity to enter the market for new actors who specialise in offering green electricity, in the case that the market is already fully opened. Table 5 shows that nine of the EU-15 countries had completely liberalised their markets by the end of 2003. On the other hand, the competition may lead to price wars and environmental dumping. This underlines the necessity of political commitments for an ecological transformational process in energy policy.

Table 5: Liberalisation of the EU-25 electricity markets at the end of 2003 (European Commission 2005).

Country	**Level of market opening**	**Year of full liberalisation**	**Top 3 electricity supplier by capacities**
Austria*	100 %	2001	75 %
Belgium	90 %	2007	95 %
Cyprus	35 %	July 2007 at the latest	100 %
Czech Republic	47 %	2006	75 %
Denmark	100 %	2003	40 %
Estonia	10 %	July 2007 at the latest	100 %
Finland	100 %	1997	40 %
France	70 %	July 2007 at the latest	95 %
Germany	100 %	1999	70 %
Greece	62 %	July 2007 at the latest	100 %
Hungary	67 %	July 2007 at the latest	65 %
Ireland*	56 %	2005	90 %
Italy	79 %	July 2007 at the latest	75 %
Latvia	76 %	July 2007 at the latest	100 %
Lithuania	n/a	July 2007 at the latest	80 %
Luxembourg	57 %	2007	n.a.
Malta	0 %	July 2007 at the latest	100 %
Netherlands*	100 %	2003	80 %
Poland	52 %	End of 2005	35 %
Portugal	100 %	July 2004	80 %
Slovakia	66 %	July 2007 at the latest	85 %
Slovenia	75%	July 2007 at the latest	95 %
Spain	100 %	2003	80 %
Sweden	100 %	1998	40 %
United Kingdom	100 %	1998	40 %
EU-25 Total	**Ø 72.6 %**	**July 2007**	-

* Green electricity enjoyed a temporary advantage in the market liberalisation of Ireland and the Netherlands. Customers had the chance to change their supply company if they decided for green electricity. Otherwise, they have to stay with their old supplier until the market is fully opened (which is already the case in the Netherlands but not in Ireland). In Austria, the competition for green electricity was opened six months earlier before the market was fully liberalised there.

At global level, there are obligations set forth by the Kyoto Protocol. The EU has to reduce its greenhouse gas emissions by 8 % of 1990 levels by 2008-2012. According to the so-called "Burden-Sharing Agreement" of June 1998, there are different targets for the 15 "old" Member States. Germany, Denmark, and Luxembourg have to reach the highest reductions. In 2002, only France, Sweden, and the UK had already reached their obligations from the "Burden-Sharing Agreement", Germany was on the track (see also table 4). These obligations set by the Kyoto Protocol and the EU-Directive will confirm the development in the forerunner-countries like Germany, whereas they might be an additional incentive for latecomers such as Belgium.

Political differences

The administrative responsibility for renewable energies lies with the Ministry of Economic Affairs in almost all Member States. This might be an obstacle for the development of renewables, because there are often close connections between Ministries of Economic Affairs and the conventional energy companies. Furthermore, the top priority of those politicians responsible for the economy is most often cost-efficiency. This perspective is a disadvantage for renewables, which are still more expensive than fossil and uranium energy (if external costs are ignored). Therefore, it might be a condition for success if the topic of RES is mainly anchored in the Ministry for the Environment (as in Germany since the elections in autumn 2002) or if there is a separate Energy Ministry, like in Denmark until government changed in 2001. The most recent example for a change of competences on renewable energy is Sweden, where they changed from the Ministry of Industry, Employment and Communications to the newly created Ministry of Sustainable Development in January 2005.

Participation of Green Parties in governments might be another advantage for the development of renewables. The main impulse to phase out nuclear energy in Belgium and Germany came from the Green Party when they had a power sharing role in the national government[9]. The new attractive promoting system for renewables in France was also only possible with the support of the Green Party, which was in power until 2002. But there are also examples of successful conservative governments regarding renewables, as the wind energy development in Spain (before 2004) and in Germany (before 1998) shows.

Differences in planning cultures

One of the biggest barriers for some renewable energies in countries like Greece, Luxembourg, and the UK is the permit procedure. Their planning periods take far more time than in many other countries, for example Germany.

The permit procedure is mainly a disadvantage for wind energy, and the procedure works quite differently in the Member States. In Germany, for example, municipalities have to show in their spatial planning where it is feasible to build wind plants, which makes it easy for investors. In other countries it is much more difficult to get a permit to build. During this process, societal groups exert influence and there is often resistance by them for reasons such as noise pollution and particularly bird endangerment. Criticism often comes from actors, which are supporters at national level. Greece is an example of very complicated bureaucratic licensing procedures, as RES-installations require the agreement of more than 25 public-sector entities at central, regional, prefectural and local level; in addition they need to conform to four national laws and seven ministerial decrees.

The lag behind schedule of most of the EU Member States in fulfilling the RES-E target for 2010 can therefore also be explained with the continuity of several administrative and grid barriers for RES-E installations. In its communication to the Council and the European Parliament regarding the performance of the EU Member States on the 2001 renewable energy directive issued at the end of May 2004, the European Commission concluded that – based on the national reports – in several cases, the further take-off of RES-E is still blocked by complex licensing procedures, poor integration of electricity from renewable energy in regional and local planning and opaque grid-connection procedures (European Commission 2004b: 16).

Differences in political promoting systems

Some pressure groups, especially some wind energy associations, emphasise the crucial role of favourable regulation and supportive renewable energy feed-in tariffs (REFIT). These minimum payment systems are indeed very successful: the leading wind energy countries Germany and Spain have feed-in tariffs and almost all old installations in Denmark are based on feed-in tariffs. But it is questionable to suppose that there is a 'natural' superiority of any instrument. There are also many countries with feed-in tariffs (see table 1, 2, and 6), which are not very successful in the wind energy sector, like France and Greece for example. This shows that success depends on the specific construction of the tool. The main explanation for the countries that use feed-in tariffs successfully is that they offer investors long-term security. Germany, for example, guarantees investors the feed-in tariff for a period of 20 years (and even 30 years for hydro until 5 MW). The new Spanish and Portuguese REFIT systems even guarantee fixed remunerations for the whole lifetime of RES installations. The main instruments for promoting renewables are feed-in tariffs, quota obligations, and tenders. In most cases countries decide for one of these instruments (but there are also some examples like France which use a combination) and connect this

with other political instruments such as subsidy programs (which are sometimes financed by the revenue of energy taxes), soft loans, tax allowances, exemptions for renewables from energy taxes, information campaigns, etc.

Table 6: Instruments for promoting renewable electricity in the EU-25 in March 2005 (European Commission 2004b: 66; European Commission 2005: 55; texts in this book).

Country	**Feed-in tariff**	**Quota obligation + certificate trading**	**Tenders**	**CO_2/ energy-tax**	**Environmental funds (subsidies, soft loans, etc.)**	**Tax relief/ exemption /deduction**
Austria	●[1]				●	●
Belgium		●			●	●
Cyprus						●
Czech Republic	●				●	●
Denmark	●	○		●		
Estonia	●				●	●
Finland				●	●	●
France	●		●[2]		●	●
Germany	●			●[3]	●	●
Greece	●				●	●
Hungary	●				●	●
Ireland			●[4]		●	●
Italy	●[5]	●			●	●
Latvia	●		●		●	●
Lithuania	●				●	●
Luxembourg	●[6]				●	
Malta						●
Netherlands	●			●	●	●
Poland		●			●	●
Portugal	●				●	●
Slovakia					●	●
Slovenia	●			●	●	●
Spain	●				●	●
Sweden		●		●	●	●
United Kingdom		●		●[3]	●	●

● = main promotion instrument; ○ = introduction is planned; [1] only for installations which were realised until the end of 2004 (new regulation still unclear); [2] foreseen only for wind farms over 12 MW capacity; [3] parts of the revenues of the energy taxes are used to finance RES projects; [4] In April 2005, the Irish Minister for Communications, Marine and Natural Resources announced the introduction of a fixed feed-in tariff system (DCMNR 2005); [5] only for installations which were realised until the end of 2000; [6] only for installations which were realised until the end of 2004 (but new REFIT system to be adopted).

An important success condition is that there is a technology-specific differentiation in the promoting systems. If the different power production costs of the individual RES technologies are considered in the form of varying remuneration, the possibilities to reach a broad RES supply or technology mix are higher than with a uniform remuneration level for RES power. For example in Germany, the Renewable Energy Sources Act (EEG) established a broad promotion approach with remuneration rates depending on the technology used, the size of the plant and in the case of wind energy in addition also depending on the age and the generated power output of the installation. Photovoltaic energy is still more expensive than hydropower, wind, and biomass. In Germany, Portugal, and Luxembourg, for example, there are different feed-in tariffs and in 2004, photovoltaic power received the highest payment per kilowatt hour in these countries: 0.499 € in Portugal, 0.45 € in Luxembourg, and under certain circumstances[10] up to 0.624 € in Germany, which is the highest payment among the Member States. As a consequence, in 2004 Germany was for the first time world leader in the annually installed PV capacity, with around 300 MW_p of new capacity, outpacing even Japan (with some 280 MW_p of new PV capacity installed). Beside these instruments, the development of renewables is influenced by the general framework in energy policy, by oil and gas prices, and subsidies for conventional energy sources like coal, which is especially subsidized in Germany.

Differences in public awareness

A further condition for success might be public awareness concerning renewable energies. Although opinion polls show a very positive attitude and support of renewables by the general public, this attitude seems to have a strong NIMBY ("Not-In-My-Back-Yard") component. There are especially local resistance movements against wind energy projects. Reasons given are visual intrusion, noise, land devaluation, health problems to people and animals due to radiation, negative impact on local tourism, etc. A new way to strengthen public acceptance of RES projects is followed by Greece (since 2002) and Portugal (since 2005), where RES plants owner must pay 2 % (in the case of Greece) respectively 2.5 % (concerning Portugal) of their RES electricity sales to the municipalities where the particular RES project is located.

In Denmark there are more than 3,000 co-operative wind turbines and between 100,000 and 150,000 owners of them. As of 2002, about 85 % of the installed wind capacity in Denmark was established through local initiatives and owned by farmers or cooperatives. In the same year, at least 340,000 Germans had already invested about € 12 billion in renewable energy projects (Savin 2004: 25). These co-operative models increased the acceptance of wind energy. Another experience in Portugal, France, and Spain for example is that small

hydropower is more accepted than large plants. A crucial question is whether people are willing to pay higher prices for renewables. 30 % of the Dutch households had already decided for green electricity until the end of 2003. This is the highest percentage among the Member States. Policy can influence public awareness with tax exemptions for renewables, which reduces the additional costs for green electricity or biofuels. An interesting innovation comes from Austria: electric bills for end users must contain information about the electricity mix offered. If customers can see that they receive electricity from nuclear or coal power stations, some might change to another company. It also limits the credibility of energy companies such as E.ON that advertise renewable energy sources but sell mainly conventional energy. In its Directive on the liberalisation of the internal EU electricity market of June 2003 (2003/54/EC) the European Parliament and the Council followed the Austrian model: The Electricity Directive introduced the obligation on suppliers to specify the fuel mix and its related environmental impact of the electricity they sell to final consumers (European Communities 2003b).

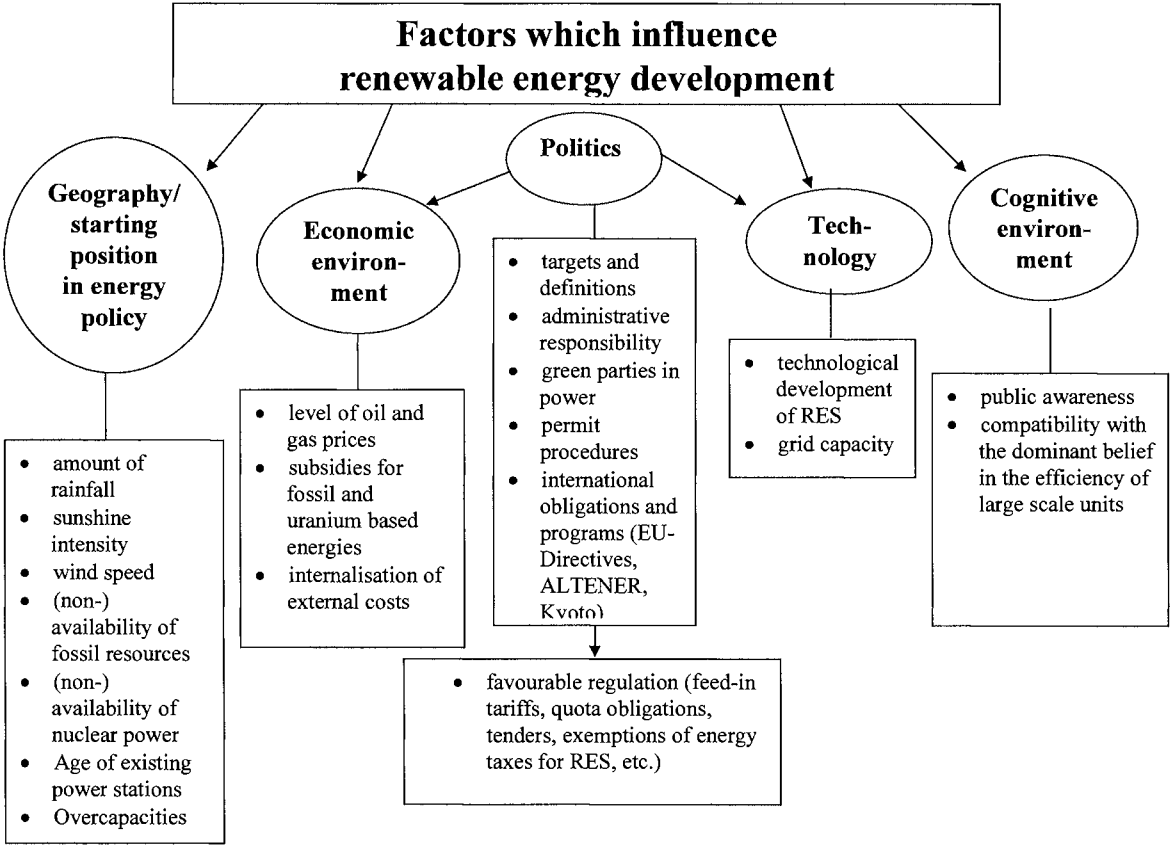
Technical differences

A very important obstacle in some countries is the present grid capacity. In France, for example, grids were not designed to take in decentrally produced electricity but mainly to distribute centrally produced electricity. In Spain, for example, it is questioned that all of the 13,000 MW wind target for 2010 could be reached if no measures for a net extension will be taken. A first innovative step to solve this problem consists in a new financing scheme where all investors with a building permission for one region pay together for the accession to the grid or for a necessary grid enlargement, which reduces the costs for all involved actors. More of those forward-looking concepts to finance net reinforcements are still missing but are of crucial importance for the further growth of RES (Bechberger/Reiche 2004). Insufficient technologies and higher costs are a significant problem for photovoltaic and energy from tides or waves. However, wind energy shows that vast technological development is possible within only one decade. In Germany, the average investment costs of a wind energy plant were reduced from 2,150 €/kW in 1990 to 865 €/kW in 1999. The average capacity of new wind energy plants increased by more than a factor of ten during the same period. The Wind Force 12 study, elaborated by the European Wind Energy Association (EWEA) and Greenpeace, estimated further cost reductions regarding investment costs of wind power plants of more than 41 % until the year 2020 (EWEA/Greenpeace 2003: 7).

Different Perspectives

The most important condition for success might be that a general change in the use of renewable energies is starting to take place: from a decentralised to a more centralised application. This reduces prices in some cases and fits the dominant belief system of the energy industry. Co-combustion of biomass and offshore-wind energy is compatible with the large scale system. Offshore-wind energy is a realistic perspective for all countries in the EU-15 with the exception of Austria and Luxembourg, which have no coasts. There are experiences in co-combustion of biomass in Austria and Ireland, for example. In the Netherlands there is an agreement between the government and producers, in which coal plants have to be as efficient as gas plants by 2010 (regarding CO_2 emissions). Therefore, the producers are forced to co-combust biomass. But one should not only concentrate on these large scale options which are supported from the top-down. Wind energy development in Germany and Denmark showed that bottom-up initiatives may be a crucial success condition. Other renewables like photovoltaics will not fit in the large scale system. Therefore, it is also important that their development is supported from the bottom-up in the future.

The following two figures finally summarize the factors, which influence the development of RES respectively the success of instruments for promoting renewables. In this regard, it has to be emphasized that these figures don't contain any assessment or ranking of the single factors. The importance of single factors differs from country to country and it is always a combination of factors influencing the success or failure of the RES development.


Factors which influence renewable energy development
Geography/ starting position in energy policy
Economic environ-ment
Politics
Tech-nology
Cognitive environ-ment
• amount of rainfall
• sunshine intensity
• wind speed
• (non-) availability of fossil resources
• (non-) availability of nuclear power
• Age of existing power stations
• Overcapacities
• level of oil and gas prices
• subsidies for fossil and uranium based energies
• internalisation of external costs
• targets and definitions
• administrative responsibility
• green parties in power
• permit procedures
• international obligations and programs (EU-Directives, ALTENER, Kyoto)
• favourable regulation (feed-in tariffs, quota obligations, tenders, exemptions of energy taxes for RES, etc.)
• technological development of RES
• grid capacity
• public awareness
• compatibility with the dominant belief in the efficiency of large scale units