

Sector Report

Renewable Electricity

Background

Renewable electricity has become more and more significant in the European energy market and will play a very important role in the longer term. It constitutes a considerable part of the solution to decreasing import dependency, diversifying sources of production, and contributing to sustainable development in Europe. The European Community has been proactive in seizing opportunities to develop new renewable energy technologies for electricity generation and building-up leading industries. Moreover, renewables have provided an important impulse to realising social objectives such as increased employment opportunities and supporting social cohesion in Europe.

Electricity produced by renewable energy sources (RES-E) is defined in accordance with the Directive for the promotion of electricity produced from renewable energy sources in the internal electricity market (2001/77/EC). The technologies considered include hydropower (large and small), photovoltaics, solar thermal electricity, wind energy (on-shore, off-shore), biogas, solid biomass, biodegradable fractions of municipal waste, geothermal electricity and tidal and wave energy. RES-E in the EU-25 countries amounted to 403 TWh in 2001, corresponding to a share of 13.8 % in gross electricity consumption. Regarding the mix of RES-E in the EU-15, hydropower is the dominant source, but “new” RES-E such as biomass or wind are starting to play a role. Figure 1 shows the historic development of RES-E excluding hydropower, which showed only moderate growth in the period considered. In the new Member States, hydropower contributes more than 98 % to the RES-E share and new RES-E, such as wind energy, have started to develop only recently.

The future potential of RES-E in the EU-25 realisable until 2020 is estimated at about 1,630 TWh, which corresponds to roughly 56 % of current electricity consumption. The largest future potential in the EU-15 is found in the sector of wind energy (45 %), followed by solid biomass (20 %) and biogas (10 %) – but promising future options also include tidal and wave (10 %) or solar thermal energy (3 %). In the new Member States, biomass electricity (45 %) has the dominant future potential followed by wind energy (20 %) and biogas (10 %). However, large hydropower also contributes a relevant share (about 10 %) to the future potential. By 2010, the European Union’s target is to supply 22 % of gross electricity consumption using renewables.

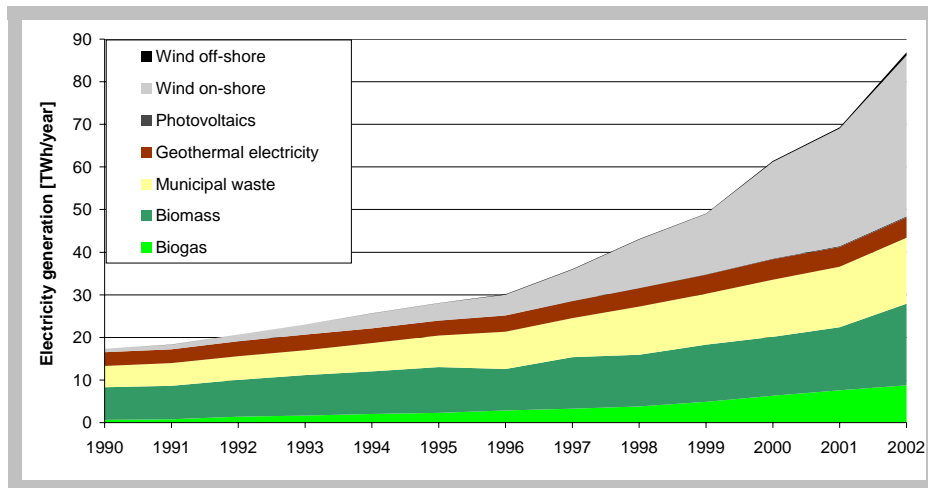


Figure 1: Development of electricity generation in EU-15 excluding hydropower

Objectives of the ALTENER Programme

ALTENER is the Community's programme for the promotion of renewable energies. The primary aim of ALTENER is to implement and complement Community measures designed to develop the renewable energy resource potential. More specifically, the ALTENER programme focuses on the harmonisation of equipment and products, developing the RES infrastructure in order to increase investor confidence, and improving information, dissemination and training. All of these objectives ultimately aim to increase the operational capacity of renewable energy sources.

ALTENER complements a number of EU policy measures on renewable energy sources, which have made considerable progress over the last decade. The existing Community legislation for stimulating the development of renewables in the European electricity market comprises in particular:

- The White Paper "Energy for the future" (COM(1997)599) which set a target of doubling the share of renewable energy from 6 % in 1997 to 12 % in 2010.
- The Green Paper on the security of energy supply in Europe (COM(2002)321).
- The Directive on the promotion of renewable electricity (RES-E Directive) on the internal market, aiming at reaching a 22 % share of renewable electricity by the year 2010 and specifying indicative targets for all 15 current Member States as well as for the 10 Accession States (2001/77/EC).
- The Common framework on the taxation of energy products and electricity, specifying minimum tax rates and allowing energy products and electricity from

renewable sources to be exempted from tax (Environment Daily, March 21, 2003).

Further important measures for the promotion of RES-E include the Campaign for Take-Off as well as research and development (R&D) funding under the 4th, 5th and 6th Framework Programmes. Between 1998 and 2002, the period of the 5th Framework Programme, the European Union spent more than 400 million € on R&D of renewable energies. The R&D programme aims at fostering outstanding scientific and technological developments. ALTENER complements this effort for technological innovation very well by focusing on the improved market diffusion of renewable energy technologies in European energy markets. The projects summarised in the sector “Renewable Electricity” are forerunners of this development.

Important Project Results and Contents

All the projects in the sector “Renewable electricity” are funded by the ALTENER Programme. Most deal with the promotion of already defined RES technologies such as wind power, photovoltaics, biomass, biogas and small-scale hydro plants. Only one project concerns hydrogen. Some projects are explicitly directed towards integrating different renewable energy sources in certain buildings or sectors. Other projects incorporate a general view on the promotion of renewable energies with emphasis on special measures to overcome the existing barriers to increased deployment. According to their respective main emphases, the projects of the renewable electricity sector can be subdivided into three main clusters with several sub-clusters:

1. Projects with reference to the promotion of certain technologies:
 - wind power
 - photovoltaics
 - biomass and biogas
 - small-scale hydropower and hydrogen.
2. Integrated RES concepts.
3. General RES projects with emphasis on specific actions:
 - policy-oriented actions
 - market transformation activities
 - awareness-raising actions, and
 - assessments and studies.

Projects with Reference to the Promotion of Certain Technologies

About one third of these projects focus on the promotion of wind energy. Recognising that difficult approval processes and the resistance of local populations constitute the main barriers to the deployment of wind energy, most of the **wind projects** developed methodologies and tools to incorporate socio-economic, politi-

cal or legal aspects into designing wind plants. The software is mainly based on Geographical Information Systems (GIS) and should help planners and decision-makers to find appropriate sites for wind farms. Most tools were tested in case studies or feasibility studies, resulting in a methodological handbook.¹ Some of these projects included special elements of co-operation with the regional industry with an impact on the installation of new plants in Spain² and of a techno-economic analysis of the integration with the electrical grid.³ The most important elements of the planning-oriented projects as well as most of the others comprise dissemination measures such as brochures, workshops, lectures, CD-ROMs, videos and web-sites. Two projects organised conferences; one presenting implemented examples to players and multipliers, and the other on financing and risk distribution issues. Another project considered the financing of plants from a different point of view: an analysis was made of successful examples of having involved the local population in investments in order to increase acceptance.⁴ A special strategy to overcome such obstacles is to use polluted or waste areas for wind farms; a respective planning tool was applied to a former mining region.⁵ With EUWINet,⁶ a web-based information system on the current status of wind energy use in Europe was set up as a platform for exchanging know-how among industry, policy and R&D. A market strategy for Kit-of-Parts wind turbines has been elaborated, with special focus on strengthening the role of SMEs in wind farm development.⁷ Another project addressed industrial SMEs in order to encourage them to invest in small plants⁸. This project initiated a module "small and medium-sized wind power installations" of the Spanish energy agency IDAE, including the offer of third-party financing and led to plans for 11 new wind plants.

The large majority of wind energy projects concentrate on on-shore applications. Five **off-shore wind** projects have recently been carried out or are still ongoing. All teams developed guidelines for the planning process with different focuses. Based either on desk analyses or derived from practical experience, the tools developed concentrate on the legal framework⁹, information for the public, or socio-economic models in addition to technical factors of the sites and construction elements¹⁰. A survey in Spain showed that there are also acceptance barriers to off-shore plants due to the negative effects expected for wildlife and the landscape with the conclusion to construct plants at a great distance to the shore.¹¹ Another project team carried out a concrete planning process in the Mediterranean.¹² Finally, WindPRO software is being developed as a European off-shore wind atlas and will be made available on the Internet.¹³

Another third of the projects referring to certain technologies concern **photovoltaics**, a few of them in combination with solar thermal applications (see also Sector Report "Renewable Heat"). Three projects can be characterised as studies: one on the joint ownership of PV equipment as an innovative financing scheme carried out in co-operation with banks¹⁴, another on the possibility to transfer the Barcelona Solar Thermal Ordinance on prescribed solar water heating in new buildings to PV

Comment: if the survey showed acceptance barriers to off-shore, why is the conclusion to construct plants in distance to the shore. What does "in distance to the shore" mean? Do you mean "so the conclusion was that plants should be constructed at a greater distance from the shore" or "should be constructed out at sea"?

use¹⁵. The third gives an overview of the effect of social interventions to encourage PV in rural electrification¹⁶. All the other projects focus on dissemination measures, e. g. a workshop on the joint procurement of solar equipment and another on best practice examples of large PV systems. In addition, there was a PV marketing campaign and activities for municipalities including exchange visits and the establishment of a regional consulting agency. Other project results include a PV guide for end-users, a web-site for SMEs in the building trade, a CD-ROM with PV and solar thermal installations resulting from EU-wide housing demonstration projects, which is directed at housing associations and municipalities,¹⁷ and guidelines for PV in social housing¹⁸.

In Italy, a campaign including a solar vehicle “Sun Tour”, brochures, posters, a web-site, a CD ROM and seminars, mainly directed at consumers, but also at municipalities and professionals achieved a good response. Its aim was to regain confidence in solar technology following a period in which this technology had suffered from a negative image due to cheap low-quality panels.¹⁹ In Germany, a three-year regional campaign on solar energy was organised for the general public in co-operation with numerous local partners.²⁰ In another project, a market database of products, installers, consultants, associations and best practice examples was compiled for the upper Rhine region.²¹ One large project is organising PV training courses for political and industrial decision-makers in accession countries.²² Similar to the situation in the wind sector, product quality and supply reliability issues play a leading role in the PV market. A model on the contractual framework was developed²³ and conditions for a standardisation process were studied in one of the projects as an additional support for PV technology besides an intensified and improved training for PV installers through an accreditation and certification process²⁴. One project’s objectives deviated from all the others by concentrating on the production side: the establishment of a solar cell factory was discussed and planned in workshops with the stakeholders concerned.²⁵

Roughly the same number of projects refer to **biomass and biogas**. All of them deal with combined heat and power production (for projects only covering heat, see Sector Reports “Renewable Heat” and “Renewable Fuels”). Most concentrate on small units rather than large-scale applications. Almost all are large projects with EU funds of more than 300,000 € and correspondingly a large number of participants, up to 20 institutions. Some projects deal with building networks in the form of international co-operation between countries with varying degrees of penetration of the biomass technologies, and exchanging experiences and expertise. An EU-wide “virtual biogas centre of excellence” is under construction involving organisations and institutions able to contribute to dissemination activities.²⁶ Another team produced training books and a CD-ROM on solid biofuels combined with a promotion campaign and the establishment of a “virtual biomass network”²⁷; This team found out that qualified energy consultants play an important role in encouraging potential investors. Exchanging know-how was also a key element of an “Olive Oil

Network” about the best practices of biomass use in the olive oil industry²⁸ and of a feasibility study including financial models with private participation²⁹. A number of projects cover the process along the supply and distribution chain (see also Sector Report “Renewable Heat”). One studied the European biomass market place³⁰ and another aimed at network building and putting together a toolbox to establish such networks in order to develop commercial structures and mechanisms for wood heating with CHP.

Two other feasibility studies focus on the technical and market potentials for biofuel microturbines³¹ and high-temperature combustion of biomass³². Two projects are concerned with organic residues from agriculture and the agro-industry: one developed a regional action plan together with a municipality³³, the other investigated barriers, studied potentials and market conditions, and identified promoters and promotion measures in rural areas³⁴. In contrast to the projects on wind energy and PV, only two of the biomass projects developed planning tools. A study of small-scale, wood-fired district heating networks including technological analyses, market conditions and the impacts of biomass use resulted in a handbook for the planning process³⁵. This emphasises the influence of non-technical factors on the realisation of projects and identifies lack of knowledge on the part of decision-makers as a main obstacle. A computer-based model for decision-makers³⁶ worked in a similar area and was validated in pilot cases. An ongoing large project in several EU Member States including accession countries is developing a market- and practice-related tool, besides many other measures for the promotion of bioenergy, which is regarded as playing a key role in achieving the aims of the EU White Paper.³⁷ Finally, another project has just started to collect data from existing biomass plants for benchmarking and to identify best practice cases for dissemination purposes.³⁸

The projects promoting **hydropower** refer to small-scale applications. Analyses of the situation for small hydro plants showed the main barriers to the deployment of this form of energy to be approval procedures, lack of strategic planning and opposition of fishermen and environmental groups. To counter these, best practice examples and concepts for demonstration projects and seminars were launched and a Steering Group was established.³⁹ Another project reviewed existing plants and potentials in 24 EU and accession countries and identified a considerable potential in the reinstatement of shutdown plants.⁴⁰ A methodology for site assessment was set up and compiled in a software package.⁴¹ A project on local planning for small hydro plants is still ongoing.⁴²

There is only one project on **hydrogen** which is still ongoing and deals with an analysis of the European market for hydrogen-based stand-alone power systems in order to identify market barriers and initiate a network of key players as well as promotion measures.⁴³

RES Integration Concepts

A number of projects deal with the promotion of RES integration. They include RES electricity as well as heat production. Some of the projects have a similar approach: they concentrated on a special site or type of building as case studies in different countries, carried out feasibility analyses, initialised and supported implementation and finally developed additional dissemination measures and materials. Cases included a restructured old building site, newly built settlements⁴⁴, mountain communities, mountain huts, urban and sport facilities⁴⁵, information centres on Greek and Spanish islands, rural areas characterised by agriculture and tourism⁴⁶, schools⁴⁷, and hotels⁴⁸. Most of these projects had in common that they used the results obtained for guidelines, handbooks and seminars for planners, decision-makers and users of buildings. Other projects with a more general approach are still ongoing. One is developing a regional planning tool taking the local infrastructure and other specific conditions into account⁴⁹; another aims to set up Regional Advice Units to bring together and train local actors. Finally, one project is undertaking a benchmarking process of the role of building regulations in different countries in order to develop a European model building code for RES integration into residential new buildings and retrofitting concepts.⁵⁰

General RES Projects with Emphasis on Specific Actions

Most of the projects in this cluster fall under types of awareness-raising activities, followed by assessments and studies. Only a few address market transformation activities. Finally, some projects were found on policy-oriented actions.

One of the projects in the sub-cluster “**policy-oriented actions**” deals with the legal and administrative framework for RES.⁵¹ Besides other work packages, it will provide an Internet-based tool with legislative information relevant for RES investors. One team discovered that increasing attention is being paid to tradable green certificates.⁵² It studied different existing certificate systems and drew conclusions for their appropriate design and accompanying incentives. A large project is analysing RES policies in EU countries in order to suggest future initiatives and especially to transfer experiences to accession countries in the form of a conference and workshops with decision-makers and other experts.⁵³ In a small project, a national action plan was developed which concentrated on the tourist industry, especially in Southern European countries.⁵⁴

The large majority of the projects in the sub-cluster address **local policy** in communities or on islands aiming at 100 % RES and respective action plans (see also Sector Report “Sustainable Energy Communities”). Some of the earlier projects concentrated on regions in Spain. The largest project in the sub-cluster analysed four municipalities in different countries with respect to the barriers and potentials for a local partnership with authorities, large and small companies, utilities and

community organisations, and carried out feasibility studies for 100 % RES.⁵⁵ It included awareness measures, feasibility studies, demonstration examples and dissemination, and was carried out with the involvement of many local partners in the team. The topic of another project was monitoring six “inspirational” communities with exemplary activities and successful schemes in order to learn from them⁵⁶. The conclusions drawn and the experiences made have been transferred to other interested communities. In the course of other projects, local or regional action plans have been developed, e. g. for the Universal Forum 2004 near Barcelona⁵⁷, for rural areas like the Dyfi Eco Valley in the UK⁵⁸, and for islands, e. g. implementing RES and energy efficiency strategies in the republic of Cyprus as a transferable example for a typical island situation⁵⁹, or a multimedia approach to be applied by local authorities was developed in order to raise public awareness for RES⁶⁰. In one of these projects focusing on municipal decision-makers in different countries⁶¹, the Climate Alliance – also participating in the project – compiled an electronic information system with indicators for policies, monitoring achievements and a best practice database.

A project on **market transformation activities** developed software for the evaluation of investment risks and the benefits of RES IPPs (Independent Power Producers) compared with conventional options.⁶² A large project with participating institutions from many countries also examined “green” IPPs; innovative financial instruments based on insurance packages were applied to case studies and “RES Investment Clubs” established for local partnerships.⁶³ Two projects are concerned with the integration of renewable energy in the grid. They analyse technical, organisational and economic conditions as well as support systems to accelerate RES grid integration.⁶⁴ The RES-related industrial development in remote European areas is at the centre of an ongoing project.⁶⁵ It is developing regional business development action plans and a replicable methodology on how to overcome socio-economic barriers to RES. A very large project examined the customers’ information needs about the electricity purchased in the context of the new Directive on liberalisation.⁶⁶ It aimed at labelling electricity in order to give customers the chance to buy “green” electricity. As a result, recommendations were made for associated policies to ensure the effectiveness of the label, and two workshops were held for dissemination.

About half of the projects in the sub-cluster **awareness-raising activities** are **training** measures in a broader sense, others involve campaigns and the remainder concentrate on the development and dissemination of tools and materials. The training projects address certain target groups, e. g. architects, engineers, installers or decision-makers. Besides smaller projects focusing on single activities such as a conference or some workshops, mainly materials have been developed: e. g. a CD ROM for training engineers based on awareness levels and educational needs⁶⁷, a distance learning package on wind, solar power and biomass for engineers and technicians⁶⁸, or a training programme for the agricultural sector. In a large project,

a “virtual campus” for renewable energies was established as a platform for exchanging experiences and sharing information, and two electronic solar courses (PV and thermal) are offered⁶⁹.

Different types of **campaigns** have been carried out or are being planned in several projects, usually covering different aspects in the different participating countries, e. g. a TV campaign on biomass in the Czech Republic⁷⁰ or a solar awareness campaign in Spain resulting in a measured significant increase of solar thermal use⁷¹. Another RES campaign mainly addressed at Eastern Europe covers PV, solar thermal energy and biomass activity, and includes the dissemination of best practice examples from accession countries and the creation of a virtual market place for industry, financing institutes and potential investors in new RES project ideas.⁷² Some campaigns were also organised as part of the technology-oriented projects described above.

Finally, some **tools, materials and media** on RES applications are being developed and distributed to various target groups, e. g. software for feasibility studies, a simulation model for the EU RES electricity market for potential investors⁷³, and the application and further dissemination of an already existing method for municipalities concerning development towards a 100 % RES community⁷⁴. A large project cluster comprises an RES handbook for architects and a European “barometer” measuring RES progress in EU countries, the results of which are published together with exemplary RES projects in the “Renewable Energy Journal”.⁷⁵ Another large project elaborates planning guides for biomass, photovoltaics and solar thermal energy use in the main European languages.⁷⁶ In Germany, the PV and solar thermal guides have already gained recognition as standard works for planners and installers.

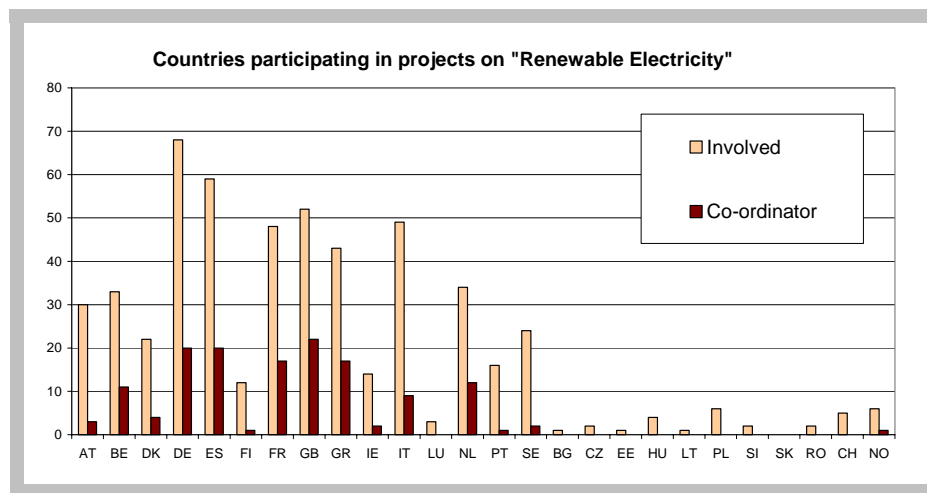
In the sub-cluster **assessments and studies**, the EC database AGORES was developed on RES projects funded by the Commission.⁷⁷ It is available on the EU website. Furthermore, statistical data on RES in the EU have been collected⁷⁸, but only for the year 1998. An international benchmarking project on RES potentials and the attitudes of local governments towards them showed changes in the perceived potentials over time⁷⁹. 105 pilot RES installations and promotion actions were evaluated in a large study⁸⁰; good practice examples are published on the web-site of the “Energie-Cités” association. Finally, a special field of application of RES is being analysed in a project on desalination systems which aims to produce a planning tool for decision-makers.⁸¹

Contractors and International Co-operation

Almost all the projects were or are being carried out by international teams. Between two and 20 partners – six on average – participate in the projects. Recently, the number of partners and countries involved has risen significantly, resulting in

much higher project costs: projects before 2000 had three participants on average and eight after 2000. Countries from all the European regions are represented. A large number of institutions come from Southern European countries. German, Spanish, British, Italian, French and Greek teams are involved most frequently; most co-ordinators are from Great Britain, Germany and Spain. Accession countries are represented in only a few projects. In many projects there is more than one partner from one country. Looking at the number of institutions involved per country, Germany has by far the largest number of participants, followed by Spain and Great Britain.

Co-operation between different institutions and countries is predominantly characterised by participants sharing experiences, international comparisons of conditions and potentials, or applying a methodology or instrument in different contexts. In a few projects, different working steps are carried out in different countries.



Summary

About one third of the technology-oriented projects in the sector “Renewable Electricity” deals with wind energy, one third with photovoltaics and one third with biomass or biogas in CHP applications. In addition, there are a few projects on small hydropower and one on a hydrogen-based stand-alone system. On-shore solutions dominate in the wind energy area; here, mainly methodologies and tools for planners and decision-makers were developed and dissemination measures taken to promote their application. With regard to off-shore wind projects, guidelines for planning were also elaborated.

Different kinds of awareness-raising measures were implemented in many PV projects such as training courses. In addition, work concentrated on the standardisa-

tion of product quality to improve investor confidence, and the development of planning tools. A number of projects focus on the integration of PV, solar thermal, and passive solar energy elements either in buildings or in local planning processes.

Some large projects dealt with biomass- and biogas-use in CHP plants focusing on small-scale units. They established networks, carried out feasibility studies and analysed or implemented promotion measures along the whole supply chain.

Other projects in the sector cover the promotion of renewable energies in general. Policy-oriented actions are often directed at local policy aiming at 100 % RES communities. Projects on market transformation measures include various aspects, e. g. “green” IPPs or the economic conditions fostering faster RES integration into the grid. Awareness-raising activities mainly include training programmes and publicity campaigns. Large numbers of tools, materials and media were developed which address the various target groups, mainly planners and municipalities. Finally, in the sub-cluster of assessments and studies, among others, the frequently visited EC Internet database AGORES was developed with ALTENER projects.

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