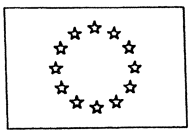

COMMISSION OF THE EUROPEAN COMMUNITIES

Brussels, 20.11.1996
COM(96) 576 final

Communication from the Commission

ENERGY FOR THE FUTURE:

RENEWABLE SOURCES OF ENERGY

Green Paper for a Community Strategy

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Executive Summary

The European Union's current energy situation calls for effective management of all available resources in order to attain Community objectives. A well balanced fuel mix, in which all appropriate energy sources play their proper role, is essential to support sustainable economic growth. Renewable sources of energy are currently unevenly and insufficiently exploited in the European Union. Although the potential is significant, renewable sources of energy make a disappointingly small contribution of less than 6% to the Union's overall gross inland energy consumption. European Union energy consumption is predicted to grow steadily in the future. Even a significant increase in the use of renewable energy sources, as pleaded for in this Green Paper, will not be enough to satisfy the expected demand. If, therefore, the Community does not succeed in attaining a significantly higher share of renewable energy in its energy balance, it will become increasingly difficult to comply with the international commitments concerning environmental protection. Secondly, failure to increase the share of renewable energy sources will have negative effects on other important policy objectives, in particular security of supply, economic and social cohesion, and - at least in the medium to long term - economic competitiveness.

The present Green Paper constitutes the first phase of a two-step approach to develop a strategy aimed at ensuring a greater use of renewable sources of energy. The establishment of a Strategy for Renewable Energy Sources was foreseen in the Commission's White Paper "An Energy Policy for the European Union" and specifically included in the indicative work programme attached to that document. The present Green Paper describes the current situation, the advantages of an increased use of renewables vis-a-vis Community objectives, and sets out the basic elements of a policy strategy to be implemented at both Community and Member State levels. The Green Paper reinforces the strategic aim of promoting renewable energy sources as an integral part of energy policy and a number of other policies and sets the objective of doubling the contribution made by renewable energy sources to the European Union's energy balance by 2010.

The level of exploitation of renewable energy sources varies significantly between the Member States. These variations are due to different geographical and climatic conditions in the Community as well as differences in the policies which have been put in place in support of renewable sources of energy. Technological development in the field of renewables has, in recent years, been significant and many of the technologies either are, or are becoming, economically viable, in particular in certain regions of the Community and compared to the economies of other decentralised energy applications. Nevertheless, due to market failures and other obstacles, renewable energy technologies still have difficulties in "taking off" in marketing terms.

Renewable sources of energy should be actively promoted for a number of reasons. Development of renewables goes hand in hand with the objective of protecting the environment and reduce CO2 emissions from the energy sector. Renewable energy sources are indigenous sources of energy and can therefore contribute to reducing dependency of

energy imports. Development of renewable energy sources can actively contribute to employment creation, and deployment of renewables is an important aspect of regional development with the objective of achieving greater social and economic cohesion between the regions of the Community. Moreover, the expected growth in energy consumption in many third countries, in particular Asia and Africa, and which to a large extent can be satisfied using renewable energy, offers hugely interesting business opportunities for EU based industries which in many areas are world leaders as regards renewable energy technologies. Finally, the general public favours development of renewables more that any other source of energy mostly for environmental reasons.

Under the prevailing economic conditions, a serious obstacle for a greater use of certain renewables, has been the cost associated with their exploitation. Although the cost curve for most renewables is dropping rapidly, the use of renewables is in many cases hampered by higher capital cost than those related to conventional fuel cycles. This is particularly the case due to the fact that fuel and energy prices currently do not reflect the full cost, including the external cost implied for the society for the environmental damage caused by the use of conventional and fossil fuels. Secondly, a significant obstacle is that renewable energy, technologies, as is the case for many other innovative technologies, suffer from lack of confidence from investors, governments and users, low levels of knowledge about their technical and economic potential and a general resistance to change and new ideas.

To counteract these obstacles, it is, in this Green Paper, proposed to implement a policy strategy consisting of four distinct elements.

Firstly a clear ambitious, and yet realistic, increase in the contributions of renewables to the Community energy balance should be aimed for at Community level. If we were to double the contribution by 2010 compared to the current level, this would mean achieving a contribution by renewables to the gross inland energy consumption close to 12%. An ambitious objective provides the necessary means for focusing the minds of decision makers at all levels and enables a continuous monitoring of progress with a view to rectifying or adjusting policies.

Secondly it is proposed to strengthen Member State co-operation on renewables. To achieve the target, strong policies will have to be implemented at national level and it is necessary to have a mechanism for coordinating efforts at Community level. The Commission's recent proposal for energy policy co-operation around agreed energy policy objectives, one of which is effective promotion of renewables, is an important instrument in this respect.

Thirdly it is suggested that the Community reinforces its policies affecting development of renewable sources of energy. The provisions of the Treaties and the internal market requirements offer substantial opportunities for the promotion of renewable energy sources. Moreover, given the fact that cost currently constitutes the largest barrier to a more widespread use of renewables the policy instruments must address in particular this problem. Internalisation of external cost is a key concept in this respect, to which the Commission

remains committed. Accompanying measures, including continued and strengthened policies and support for Community RD&D, training actions, awareness building, pilot schemes etc. must be continued and reinforced.

As policies in other areas than energy, including external affairs, agriculture, regional policy, fiscal policy etc., also have a major impact on the conditions under which renewables are developed, it is fundamental to the strategy that these policies facilitate the development of renewable energy sources. It is also important that the coordination between the decision-makers in the various fields is improved.

The fourth element of the strategy is a proposal for a strengthening assessment and monitoring of the progress towards achieving our objectives for the penetration of renewables.

The aim of this Green Paper, as the first step in a two-step approach, is to stimulate wide consultations and discussion with all interested parties and the Community Institutions. This document sets out a broad framework, but does not make detailed proposals. On the basis of the conclusions that the Commission will draw from the wide debate, a more detailed Community Strategy with an Action Plan will be established by mid-1997.

1. Background

Introduction

In energy policy, there are no simple solutions, no one energy source that will solve all problems, that will be limitless, pollution-free and cheap.

Energy policy since the first oil crisis in the 1970's has built up incrementally, one step after another. Energy policy priorities have evolved. In 1973, the issue was energy security and safeguarding our economies from external energy developments beyond our control. Better energy planning techniques were developed and comprehensive energy policies and programmes, combining a variety of instruments, were set up. The second oil shock in the late 1970's was a reminder of the need to stay vigilant in terms of energy security.

In the 1980's environmental issues rose to the fore. Concerns over acid rain or greenhouse gases reached their peak at the UN Rio Conference in 1992. With energy prices (primarily oil) dropping in real terms environmental concerns raised new issues. It became generally accepted that the present energy system, from extraction through to use, is responsible for much of our man-made climate change problems, and that energy consumption can result in irreparable damage to the global environment. How to re-orient our energy systems without facing a potential new collapse of our economies became and remains a major challenge.

With the economic recession setting in at the end of the 1980's, the energy sector became an important element in the Community's strategy to establish an internal market as a response to increased competition and globalisation of markets. Although the internal energy market process has been a long and difficult one, important progress has by now been achieved. Agreement has been reached in the Council of Ministers on the first phase of liberalisation of the electricity sector and negotiations on liberalisation in the gas sector are well under way. This will lead to significant changes to the way in which large parts of the European energy system is functioning. It will gradually bring market forces into play in sectors which for too long have been under government control and based on monopolies and central planning. The energy sector will nevertheless keep its specific characteristics. As a sector of strategic importance to the overall well-being of the economy, the necessary element of public service will be preserved. But winds of change are blowing.

The European Union does not have an over abundance of cheap, clean and reliable conventional energy resources. Dependence on imports is considerable. This does not mean that the Community is energy resource poor. The Union has reasonable supplies of oil, coal, natural gas, nuclear and considerable potential for renewables. They all have their strong points and their weaknesses. But it is certain that the resources have to be managed well in order to support all Community objectives.

Renewable energies are non-depletable forms of energy, including, in particular, hydropower, wind and solar energy (both thermal and photovoltaic), biomass and geothermal energy. Municipal and other organic waste although depletable, is normally also classified as renewable sources of energy. The list of renewables furthermore includes a number of technologies which are still at an experimental stage or which have still to prove their economic viability, such as wave, tidal energy and hot dry rock.

Hydroelectric energy is one of the traditional forms of renewable energy and has already been exploited for a long period. Large scale hydro has in the past been generally more economic than small scale. Available large hydro resources have thus been widely exploited. Small scale hydro power resources (less than 10 MW per site) are, however, still available in many regions of the Community.

Wind energy is harnessed by modern-day wind turbines to generate electricity. Turbines can be deployed singly, in small clusters or in larger groups known as wind farms. In recent years the economic viability of wind turbines has increased markedly. Another development, which could become important, is the move towards developing wind farms located off-shore.

Solar energy derives directly from the sun's light and heat. It can be captured in the form and fabric of a building or by solar collectors, or converted directly into electricity using photovoltaic (PV) cells.

Biomass comprises material either specifically cultivated as energy crops or derived from agriculture and forestry operations and can be used to produce solid, liquid or gaseous fuels. Waste from the agricultural sector can be treated thermally or biologically to produce energy. Treatment of municipal waste has to respect the overall waste strategy which gives priority to prevention of waste and recycling. The residual municipal waste can - depending on the waste stream composition and other circumstances -be considered as a source of renewable energy.

Geothermal energy involves tapping the heat below the earth's surface through boreholes driven into a hot aquifer or injecting cold water through hot dry rock. The hot water produced is brought to the surface. There are both high enthalpy and low enthalpy sites in the Community.

The policy context related to renewables.

Promotion of renewable sources of energy has for a considerable period of time been a central objective for Community energy policy. The Council Resolution of 16 September 1986 concerning new energy policy objectives for 1995 and convergence of the policies of the Member States[1], clearly places promotion of renewables among the sectoral objectives to be

[1] OJ C 241 of 25.9. 1986 p.1.

used as guidelines for examining the convergence and the cohesion of the Member States' energy policies. This central objective was confirmed in the Council's Recommendation of 9 June 1988[2] on developing the exploitation of renewable sources of energy. With the ALTENER programme[3] the Council for the first time adopted a specific financial instrument for the promotion of renewable sources of energy. In the annex to the ALTENER Decision the Council sets the objective that renewable energy sources should be increased to cover 8% of the total energy demand for EUR-12 by 2005[4]. The European Parliament, for its part has constantly underlined the role of renewables. Most recently the European Parliament[5] strongly pleads for the establishment of a Community action plan for renewable sources of energy with the objective of increasing the proportion of renewable energy sources in the EU's primary energy mix to 15% by 2010[6].

In the White Paper "An Energy Policy for the European Union"[7] the Commission on the basis of a comprehensive analysis of the current energy situation presented its views as regards Community energy policy objectives and instruments to be applied to achieve these objectives. Three key energy policy objectives are identified; i.e. improved competitiveness, security of supply and protection of the environment. Promotion of renewable energy sources is, among other policies, identified as one important element in achieving these objectives. The Council Resolutions on the Commission's Green and White Papers[8] on energy policy both emphasise the importance of renewables.

It is also worth noting that several Member States at a national level have adopted ambitious targets for the contribution of renewables to their energy balances, and are promoting renewable energy sources through a variety of economic and political incentives.
In fact, all Member States either have, or have in the past, adopted quantitative targets for the overall contribution of renewable energy sources to their energy balances or for the contributions to be made by one or more specific renewable energy sources. In the Netherlands the Government is aiming for an increase in the contributions to primary energy

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2 OJ L 160 of 28 June 1988, p. 46

3 Council Decision of 13 September 1993 concerning the promotion of renewable energy sources in the Community, OJ L 235 of 18.9.1993, p. 41.

4 Targets in ALTENER are calculated following the direct physical convention employed by the Statistical Office (EUROSTAT). This differs from other targets calculated using the substitution principle: 220 TOE/GWh.

5 Doc. P 216.788/fin, Resolution on a Community action plan for renewable energy sources.

6 See footnote n°4.

7 COM (95)682 of 13 December 1995

8 ...

consumption to 10% by 2010. In Denmark the quantitative target of 12% of energy consumption is aimed for by 2005 and - in the longer perspective - a 35% contribution by 2030. In Spain and Greece overall targets for a contribution of 1100ktoe by 2020 and 1800ktoe by 2005, respectively, have been established. In France the Government has established specific sectoral objectives, including the construction of 1500 stand-alone photovoltaic systems by 2005 and a 5% contribution from renewable sources to transport fuels, also by 2005. Italy, Ireland and the UK have adopted targets of 675MW renewable electricity capacity by 2000, 241MW by 1999 and 1500MW by 2000, respectively. Germany in 1990 adopted the target of 100MW additional wind energy capacity over a 5 year period. Having achieved the target during the first year of this programme the target was further increased to 250MW which was successfully achieved in 1995.

These targets are supported by various national policies ranging from capital subsidies, fixed buy-back rates (such as the German stromeinspeisungsgesetz), fiscal incentives, support for third party financing, surcharge arrangements (such as the UK non-fossil fuels obligation (NFFO) and public support for RD&D. Some Member States also encourage utilities to set up a new renewable energy capacity through voluntary agreements with utilities or through legislative requirements for distributors to buy a certain amount of their requirements from renewable energy sources. Schemes for export supports have also been established. It is not possible in the framework of this Green Paper to provide a complete picture of all the efforts undertaken at national level in support of renewable energy sources. The level of commitment varies, however, considerably from one Member State to another. While some have completely integrated favourable policies towards renewable sources into their general energy policy and planning framework, others have not adopted the use of renewable energy sources into their strategies for meeting global environmental targets. It is important to note that with such a variety of different national schemes and incentives, which furthermore constantly change as a result of new policy priorities, the level of transparency and predictability is insufficient for the renewable energy industry to fully benefit from public policy incentives and to establish long-term stable business prospects within the EU.

Other industrialised countries, in particular the US and Japan, have also set up comprehensive policies for the promotion of renewable energy sources. In the US, where renewable energy sources, primarily hydro-electricity, amount to 5.3% of total energy demand, promotion of renewable energy began early and was in particular stimulated through the Public Utilities Regulatory Policy Act (PURPA) of 1978, which obliges utilities to purchase power from independent producers at avoided cost levels. More recently, the 1993 Climate Change Action Plan included a number of measures related to renewable energy sources, with particular emphasis on commercialisation programmes for wind power, photovoltaics, biomass, geothermal energy and on environmentally sound upgrading of existing hydro-electric projects. Biofuels for the transport sector is also the subject of significant Government interest. Furthermore, generation procurement regulation is an area which is currently undergoing rapid change in the US electricity supply industry. Integrated Resource Planning (IRP) requires utilities to look at all alternatives for energy supply, including demand side measures and renewable energy sources. At State level, there are however, significant

variations in the commitments taken, with, in particular, California in a leading role. As one example, a distribution surcharge-funded renewable programme was included in the electricity restructuring bill proposed earlier this year in California.

Japan has, in spite of the limited technical potential for renewable energy sources, set an ambitious target of more than doubling the contribution from renewable energy sources from the current level of 1.2% (1994) to 3% of total energy demand by 2010. R&D is supported in the framework of the New Sunshine Programme. In addition a range of financial incentives, including subsidies, tax credits and low interest loans are provided. Japan has in particular concentrated on the development of photovoltaic applications, the main objective being to stimulate market expansion and thereby benefit from large scale production. To that end a 70,000 roof-top programme has been set up. In addition, the Japanese Government has actively stimulated industry to set up manufacturing operations of PV cells in nearby countries with low wage cost, which, together with a significant R&D effort, has made Japan a world leader in this technology.

As far as the European Community is concerned, a strategy for renewable energy sources is required for a number of reasons. First and foremost it is clear that without a coherent and transparent policy strategy and without an ambitious objective for renewables, these sources of energy will not make major inroads into the Community energy balance. Without a clear and comprehensive strategy accompanied by legally binding measures, their development, which is highly desirable for the reasons detailed below, risks being weakened and delayed. This argument is further substantiated in chapter 3 of this Green Paper which presents a series of energy scenarios and their impact with respect to renewable energy sources. A long-term stable framework for the development of renewable sources of energy, covering the political, legislative, administrative, economic and marketing aspects of renewables is in fact the top priority for the economic operators involved in development of renewables.[9] Furthermore, as the internal market develops, a Community-wide strategy for renewable energy sources is required to avoid imbalances between the Member States or distortion of the energy markets.

Remarkable technological progress related to renewable energy technologies have been achieved over recent years. The cost curves are rapidly dropping and many renewables have reached the point of economic viability or are coming close to it under certain conditions. Europe is to a large extent the world leader in this area. A strong competitive position in the global market place can only be maintained and further improved as a function of a significant and growing home market. A clearly defined strategy will preserve and strengthen the position of the European Union industry in this respect.

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[9] This was the main message from the round-table with different market actors at the Milan Conference "Renewable Energy Sources in the Internal European Market" on 17 - 19 June 1996.

A policy for the promotion of renewables will require across the board initiatives encompassing a wide range of policies covering agriculture, external affairs, research and technological development, including demonstration, fiscality, regional and environmental policies. A key objective of a strategy for renewable energy is to ensure that the need to promote these energy sources is recognised in new policy initiatives as well as in implementation of existing policies in all of these areas. In fact, a generally accepted strategy is required to ensure the necessary coordination and consistency in implementing these policies at Community, national and local level.

This Green Paper is the first major step in the establishment of such a strategy. It sets out the objectives related to renewable sources of energy, it identifies the key obstacles for more widespread use of renewables and it outlines the Commission's intentions as regards how to overcome these obstacles in order to significantly increase the share of renewables. The present Green Paper contains, in particular the political philosophy related to renewable energy sources and it outlines the areas in which further action could be undertaken. The Communication should primarily serve as a discussion document on the basis of which, and as a second step, a fully developed strategy with an action plan for increasing the share of renewable energy sources in the energy balance of the Community will be developed by mid-1997.

2. The current situation for renewable energy sources: The potential for renewables in the European Union is unevenly and insufficiently exploited.

The need for a Community strategy arises from the fact that overall, renewable sources of energy still make only a limited contribution to the Community's energy balance. There are signs, however, that this is changing. The resource base is better understood, the technologies are improving steadily, attitudes towards their use is changing and the renewable energy manufacturing and service industries are maturing. But renewables still have difficulties in "taking off," in marketing terms.

Table 1 shows the share of renewable energy sources in gross inland energy consumption in the European Union and in the Member States. The table is compiled in accordance with the definition of renewable energy sources given above, i.e. including large scale hydro-power and energy from waste.

Table 1. Share of Renewable Energy Sources in Gross Inland Consumption.

	1990	1994
Austria	22.1	24.1
Belgium	1.0	0.8
Denmark	6.3	7.0
Finland	18.9	19.3
France	6.4	7.2
Germany	1.7	1.9
Greece	7.1	7.2
Ireland	1.6	2.2
Italy	5.3	6.4
Luxembourg	1.3	1.3
Netherlands	1.3	1.4
Portugal	17.6	17.5
Spain	6.7	6.2
Sweden	24.7	24.0
United Kingdom	0.5	0.6
European Union	**5.0**	**5.4**

Source: Eurostat

The table shows the contributions made in 1990 and 1994, and displays a relative stability around 5% for the European Union. The table also highlights considerable variations between the situation in the various Member States. Annex 1 shows the current breakdown by renewable energy source and by Member State. The current market penetration of renewables corresponds to a contribution by these sources of approximately 65Mtoe. This reflects a mere 16% of the technical potential for renewables which is estimated at approximately 400Mtoe.

The unexploited technical potential is particularly significant with respect to biomass, including energy crops, wind and solar energy.

The large differences between the Member States can be partly explained, obviously, by different geographical and climate conditions. Some Member States have large hydro resources, some none at all and some Member States have large quantities of biomass, e.g. from forestry operations, and some have significant potential for developing wind energy in the form of non built-up areas with favourable wind conditions. Such factors, however, can only partly explain the statistical differences apparent in table 1. The industrial structure and more particularly the energy policies pursued at a national level also play a very important role. As one example of the results of positive policy incentives for renewables, 70% of the total installed wind energy capacity in the EU is located in Germany and Denmark.

Large scale hydro dominates the the present renewable energy mix. It is a proven mature technology which is cost competitive. There is no significant scope for for further cost reductions of large hydro. Small hydro plants, i.e. plants smaller than 10MW, in 1995 accounted for about 3% of the EU hydro capacity. Capital cost are very site specific and are generally higher per unit of electricity produced than for large hydro installations. It is however expected that new construction techniques and control systems will reduce capital cost and increase the number of accessible sites .

Biomass comprises residues from forestry and agriculture, energy crops and biofuels. Forest residues are currently the most important element, comprising in particular wood chips. Biomass residues are mainly used as a fuel in heating installations and electricity generation from forest residues is almost exclusively limited to large scale industrial installations. Overall, biomass costs have been reduced considerably, as will be further illustrated in section 4.3., and it is expected that further cost reductions can be achieved on the basis of improvements in biomass conversion technology. As regards energy crops there is not yet an established market, primarily because of the relatively high cost of the crop compared to the relatively low conversion efficencies. There is, nevertheless, good scope for increasing the crop yield which, combined with improvements of biomass gasification systems, could significantly improve the market prospects for energy crops. Biofuels, mainly rape seed oil and bio-ethanol, have a small market in certain Member States, in particular in France and to some extent in Germany, Austria and Italy. The market is created by tax incentives, as biofuels are currently not competitive compared to petrol and diesel. Markets are, however, expected to grow moderately as a consequence of cost reductions expected from new production methods and the production of biofuels from low cost cellulose feedstocks.

Wind energy is, in some Member States, currently the fastest growing energy source for electricity production. Wind turbine cost have dropped 30% since 1990, and although unit cost are very dependent on site wind speeds, wind energy is one of the most cost-competitive renewable energy sources with cost as low as ECU 0.05/kWh. Further technological development, such as larger turbines, lightweight towers and variable speed generators, together with the development of high potential off-shore sites, will further drive down cost,

and is likely to result in a significantly higher exploitation of the EU's wind energy potential.

Solar thermal thermal heating technology is almost fully developed. There is nevertheless scope for further cost reductions resulting mainly from larger scale production and better production and marketing techniques. Developments in some Medittteranean third countries, notably Israel, show that cost reductions are possible. At present solar thermal heating is cost competitive compared to electric water heating, in particular in the southern parts of the EU. Solar photovoltaic is the most prestigious renewable energy technology and is, as far as "high tech" is concerned comparable to the best of information technology. Costs have, as will be further illustrated in section 4.3., fallen dramatically with a 25% cost decrease over the past 5 years, but are still significantly higher than for electricity generated on conventional fuels. Cell efficiency is, however expected to continue to increase, and further RD&D, in particular commercialisation of thin film solar cells, could mean that photovoltaic electricity productuion could become competitive in the medium to long term.

Energy from waste represents a significant energy resource. Improvements in re-use and recycling is expected to reduce future waste disposal volumes

Geothermal energy a very small part of the renewable energy production in the EU. It is constrained by capital cost of the prospecting and installation, but there are, on the basis of several successful RD&D projects, prospects for new techniques to overcome some of these constraints. Tidal and wave energy represent a considerable potential and are the subject of some research activity. These sources are however unlikely to be significantly developed in the near term future.

Attempts have been made to categorise renewable technologies according to their potential economic contribution and the timing of that contribution. This is a useful exercise, in order to establish the most appropriate support measures required for further development. Many renewable technologies need little or no further R&D efforts to become competitive. As will be further detailed in this Green Paper, the key to a higher market penertration for these techologies, is to overcome market barriers and market imperfections. For these technologies, which notably include passive solar, biomass, waste, small hydro and on-shore wind turbines, conventional geothermal, the principal political incentives needed are market enabling measures. Photovoltaics, offshore wind farms and energy crops require further RD&D, with particular emphasis on the demonstation phase while more basic research is required for tidal, wave and hot dry rock geothermal energies.

3. ***Forecasts for market penetration of renewable energy sources; Renewables can make a major contribution to EU final energy consumption.***

The most recent long-term energy forecast established by the services of the Commission, "European Energy to 2020"[10] presents a scenario-based approach reflecting the uncertainty and sense of transition that pervades the energy sector today. Four different scenarios are developed to produce a range of energy futures that could apply over the next 25 years. "European Energy to 2020" contains a powerful illustration of the need for action as regards the specific promotion as regards renewable energy sources. Depending on the policy assumptions the contributions by renewable sources of energy by 2020 could be as much as 13.7% or as little as 9.5%[11].

The "Conventional Wisdom" scenario denotes the "Business as usual" world in which economic growth gradually weakens as demographic changes means slower growth in the labour force. Under this scenario many of the world's social and economic problems remain. Energy policy under this scenario remains fragmented as a result of unresolved conflicting objectives and the environmental approach stays limited. Energy prices increase smoothly and the price of crude oil reaches 31US$/bbl in 2020, in real terms. Energy demand proceeds with the continuation of current action taking some concern on increasing efficiency, but nevertheless increases by close to 1% per annum. Under this scenario the renewable energy penetration remains by and large weak and leads to a market share of renewables by 2010 of 7.7%.

Under the "Battlefield" scenario, the world reverts to isolationism, power blocks and protectionism making economic integration very difficult. Globalisation is seen as too ambitious and the geopolitical system fragments into blocks with tension and friction between and within the block. Energy policies under this scenario aim at reducing import dependency, precautionary principles prevail on CO2 concerns and internalisation of cost is only achieved in the transport sector. The "Battlefield" scenario postulates slow growth, in particular after 2000 and a sharp increase in oil prices, precipitated by an oil price shock, plunges the world economy into a deep recession by 2005. This is followed by economic stagnation from 2010 to 2020.

Renewable energy sources fare generally worse under this scenario than under the "Conventional Wisdom" scenario. Not even the increasing oil prices by 2005 can assist a positive development for renewable sources of energy, in particular due to the economic recession which follows. Renewable energy sources by 2010, under the "Battlefield" scenario,

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10 *European Energy to 2020, A Scenario Approach, European Commission 1996.*

11 *Renewable energy market penetration figures and statistics in general suffer from the weakness that various statistical conventions concerning, in particular, the conversion criteria used. Depending on the convention used, very different results can be obtained. This Green Paper consistently applies the Eurostat convention, i.e. the physical conversion principle.*

make a limited contribution to overall gross inland energy consumption of a mere 7.4%.

Under the "Hypermarket" scenario, the emphasis is on market forces, liberalism and free trade and in which global economic integration is self reinforcing and continued. Under this scenario it is assumed that liberalism and privatisation deliver results, and economic growth is boosted by the competitive market environment. Energy policies are driven by the desire to minimise Government control and maximise efficient operation of the markets. External costs are not internalised and overall taxation is cut steeply. Not surprisingly, renewable energy sources have major difficulties to arrive at increased market penetration. By 2010 the "Hypermarket" scenario predicts that renewable energy sources will amount to 123MToe, corresponding to slightly more than 7.5% of gross inland energy consumption.

Finally, the "Forum" scenario assumes that the world moves to consensus and cooperative international structures with a strong role for public intervention. The process of global integration produces new imperatives for collective public action and a higher rate of economic growth. Furthermore, it is assumed that VAT and excise duties are harmonised and that tax equality across fuels is obtained. "Forum" is thus the ecological driven scenario and energy policies are mostly affected by concern for the environment. The oil prices, due to weak demand, remain stable at 16US$/bbl until 2020. Nevertheless, strong penetration of new and more efficient energy technologies is expected, mainly driven by stricter environmental standards and higher environmental taxes. "Forum" also assumes that nuclear programmes are re-invigorated and that the contributions from nuclear power to gross inland energy consumption will be more than doubled by 2020 compared to the "Conventional Wisdom" scenario.

In the short and medium term, renewable energy sources, although to a lesser extent than under the previously described scenarios, still fail to make a major contribution to the EU energy fuel mix. By 2010 renewables under the "Forum" scenario are predicted to account for approximately 9% of gross inland energy consumption, although the increase is expected to continue through to 2020 where the contribution of renewable energy is predicted to exceed 2020Mtoe (i.e. 13.7% of growth inland energy consumption), which is more than the contributions of any other conventional fuel, considered individually.

Renewable energy market penetrations by 2010 of between 7.4-9% compared to the present close to 6% cannot but be considered disappointingly low. In fact, it has to be concluded that all scenarios developed under the 2020 exercise fail to deliver a significant market penetration of renewable sources by 2010. Only the "Forum" scenario results in a significant breakthrough, but in this case this comes very late and is only achieved around 2020. However, it must be considered that the 2020 scenarios only to a limited extent include specific measures for promotion of renewable energy, as they were established primarily to illustrate the consequences for the energy sector as a whole of various assumptions relating to global energy markets and geopolitical outlook.

With a view to illustrating the potential effects of specific policy initiatives in the field of renewable energy sources, the Commission, in the framework of the Altener programme, has initiated the TERES exercise[12]. The TERES II study, which will be published shortly, builds on the "Conventional Wisdom" scenario developed in the Commission's "European Energy to 2020" exercise but goes further by adding various specific renewable energy policy assumptions to form three further scenarios. The basic underlying assumptions as regards increasing overall energy demand and rising oil prices (to 31US$/bbl by 2020) are, however, identical to those in the 2020 study.

The first of these three additional scenarios is the so-called "Industrial Policies" scenario, which is based on the policy proposals put forward by the European renewable energy industry[13]. These assumptions include:

- some specific incentives for renewable energy use, including subsidy and fixed buy-back rates;

- increased R&D leading to a 10% cost reduction for renewable energy sources;

- land availability for energy crops for energy crops guaranteed at 12% set aside; and

- internalisation of external costs of conventional fuels for the biomass market.

The econometric modelling[14] based on these policy assumptions lead to a predicted forecast for a contribution by renewable energy sources to gross inland energy consumption at of 9.9% by 2010. Continuing the forecast under "Industrial Policies" assumptions shows that the growth will be significantly slower from 2010 to 2020 leading to a renewable energy market penetration by that latter date at 11.4%. An interesting conclusion which can be drawn from this is that the policies proposed by the renewable energy industry to a large extent - with the one exception of wind energy, which due to rapid technological progress increases significantly - are insufficient to reach the targets established by the industry itself.

The second scenario under TERES II is the "ExterNe Internalisation", which is based on the Commission's exercise undertaken under the same name, assumes that all external costs of convention fuel cycles are internalised. Under this scenario all renewable energy sources are

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12 *TERES, the European Renewable Energy Study by ESD, London and the European Commission (1994) and TERES II (to be published by the Commission in 1997).*

13 *Including most notably AEBIOM (European Biomass Association), EEWC (European Energy from Waste Council), ESHA (European Small Hydro Association), ESIF (European Solar Industry Federation) and EWEA (European Wind Energy Association).*

14 *The forecasts made under TERES II are based on the SAFIRE market penetration model developed under the Community's JOULE II programme.*

characterised by moderate growth leading to a slightly higher overall contribution to gross inland energy consumption than predicted under the previous scenario. In particular, wind, geothermal and solar thermal technologies will benefit under this scenario, while the total renewable energy penetration is predicted to amount to 10.1%.

The last scenario developed under TERES II exercise is the "Best Practice Policies" which assumes that the policies that have been most effective to date in promoting the use of renewable energy sources are applied EU-wide. These policies primarily include:

- Government programmes concentrated on moving renewable energy technologies to commercialisation and improved systems for local planning;

- increased R&D leading to a 20% cost reduction;

- land availability for energy crops increased by 25% and set aside subsidies on 12% of food producing land guaranteed until 2000;

- internalisation of external costs of conventional fuel cycles (similar to ExterNe).

Under the "Best Practice Policies" scenario renewables show strong growth in market penetration compared to the previous scenarios, in particular for solar photovoltaics and biofuels. Progress is especially noticeable in the electricity markets. Overall renewable energy sources under the policy assumptions included under the "Best Practice Policies" scenario amount to 12.5% of gross inland consumption by 2010. Compared to the ecological scenario of the "European Energy to 2020" exercise (Forum) this is a considerable higher market penetration by 2010. Extending the scenarios by 2020, however, shows that the two scenarios converge towards this date with the Forum predicting a market penetration of renewable sources of energy amounting to 220Mtoe corresponding to 13.7% of gross inland energy consumption compared to 13.9% under the "Best Practices Policies" scenario. This illustrates that the policies included as assumptions for the "Best Practice Policies" scenario are more effective in delivering a rapid improvement in renewable energy penetration compared to "Forum" whereas in the latter scenario the growth in penetration continues after 2010, while the "Best Practice" scenario by this date has exploited a large part of the commercially available potential for further market penetration.

In conclusion, the various scenarios clearly illustrate that renewable energy sources can make a significant contribution to the energy supply of the European Union. On the other hand the renewable energy component of the energy mix is very sensitive to changing policy assumptions. Unless specific incentives are put in place, it is unrealistic to expect that the large potential for renewable energy will be exploited and that these sources will make a more significant contribution to the European energy balance. This is clearly shown in the "Conventional Wisdom", "Hypermarket" and "Battlefield" scenarios. Under scenarios favouring environmental protection, i.e. the European Energy to 2020's "Forum" scenario and the "Industrial Policies" and "ExterNe" scenarios of TERES II renewable sources of energy

begin to make a growing contribution to the energy balance but remain below or - in the case of ExterNe - just above the 10% mark. Only under the "Best Practice Policies" scenario developed under TERES II will renewable energy sources develop rapidly and reach more than 12% of gross inland energy consumption by 2010.

Total energy consumption is likely to grow significantly in the EU between now and 2010. "European Energy to 2020" suggests and additional energy demand, depending on the geopolitical scenario, of between 170Mtoe and 296Mtoe. A market penetration for renewable energy source at 12%, corresponds to an additional energy production from renewable energy sources between now and 2010 of approximately 127Mtoe.

4. The advantages of renewable sources of energy: Renewables contribute to achieving Community energy policy objectives, environmental protection, employment and regional development.

European Union energy consumption, as shown in the various scenarios detailed in the previous chapter, is predicted to grow steadily in the future. Even a significant increase in the use of renewable energy sources, will not be enough to satisfy the expected demand. If, therefore, the Community does not succeed in attaining a significantly higher share of renewable energy in its energy balance, it will become increasingly difficult to comply with the international commitments concerning environmental protection. Secondly, failure to increase the share of renewable energy sources will have negative effects on other important policy objectives, in particular security of supply, economic and social cohesion, and - at least in the medium to long term - economic competitiveness. An increased use of renewable energy sources, as a result of a comprehensive strategy, will therefore bring a number of advantages for the energy sector and the economy as such. This section provides an overview as to how development of renewables will contribute to achieving the Community's objectives as defined in the Treaty and in derived policies.

4.1. Environmental considerations.

Most importantly, developments in recent years have highlighted the environmental problems directly linked to the use of fossil fuels, in particular the problems related to CO2 emissions and climate change. Increased use of nuclear energy offer only a limited contribution to solving these problems, due to the fact that only few Member States have chosen the nuclear option. The current overall energy-mix is incompatible with the long-term requirements for sustainable development. A significant limitation of the use of fossil fuels is required to ensure that the Community can meet its CO2 targets contemplated in the Climate Change Convention. This is by now widely recognised, not only by Members of the United Nations International Panel on Climate Change (IPCC), but also by other international organisations, such as the IEA and the World Energy Council (WEC), national governments, and perhaps most importantly, by large segments of the energy industry itself.

Not all renewable energy technologies are totally pollution free, but generally the use of renewable energy sources has the clear advantage that no CO2 is emitted[15]. Furthermore most renewable sources of energy do not result in of SO2 and NOx emissions. Promotion of renewables could also help the EU to achieve its objectives on soil protection and air and water pollution. A coherent strategy should, however, be substantiated by life-cycle analysis in order to arrive at well documented conclusions on environmental benefits arising from the increased use of the various individual renewable sources. Even in the absence of such sophisticated analysis it is clear, as demonstrated in the previous chapter, that renewables comply with the overall strategy for sustainable development. In particular in relation to the Rio Convention's objective to stabilise CO2 emission by 2000 at the 1990 level, a higher market share of renewable energy sources, together with other policy initiatives, notably in the field of energy saving, is fundamental for a sustainable energy strategy. Furthermore, the agreeement for future significant reduction in CO^2 and other greenhouse gas emissions which will result from the current negotiations under the UN FCCC (post Berlin mandate) will constitute a new obligation for the Community. Increased use of renewables will contribute to the fulfilment of these new obligations.

4.2. Security of supply.

Renewables are by definition non-depletable. As pointed out in the Commission's White Paper "An energy policy for the European Union", the situation as regards security of supply is by no means critical at present. The 1992 Gulf Crisis and other related crisis have shown that the Community's energy system is robust and can manage small crisis and conjunctural problems. This may, however, not be the case in the future as dependency grows. The import dependency of the European Union currently stands at approximately 50% but could well, according to most forecast, increase to as much as 70% over a period of 25 years.

In this situation the European Union cannot neglect the development of its indigenous resources. Renewable sources of energy are all indigenous and further exploitation of the potential can make a strong contribution to improving security of supply. Moreover it is important to look beyond the energy needs of the Community. All forecasts show that the energy requirement of the developing world will significantly increase in the future, in particular in Asia. This could obviously affect global energy markets and supply constraints and price increases cannot be ruled out. Renewable energy can cut back some of requirements for imported fuels.

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[15] Use of hydro power, wind and solar energy does not result in CO2 or other gaseous emissions, and in the case of biomass, there are no net emissions of CO2 provided the carbon consumed is replaced by new plants in a closed cycle. Waste incineration, however, does cause CO2 and other emissions, but in a controlled incineration process, these can be minimised if appropriate emission abatement technologies are applied. Overall the objective, as set out in the Community Waste Strategy, is to reduce the amount of waste produced and to use the waste in the most environmentally benign way, including, where appropriate, for recycling purposes.

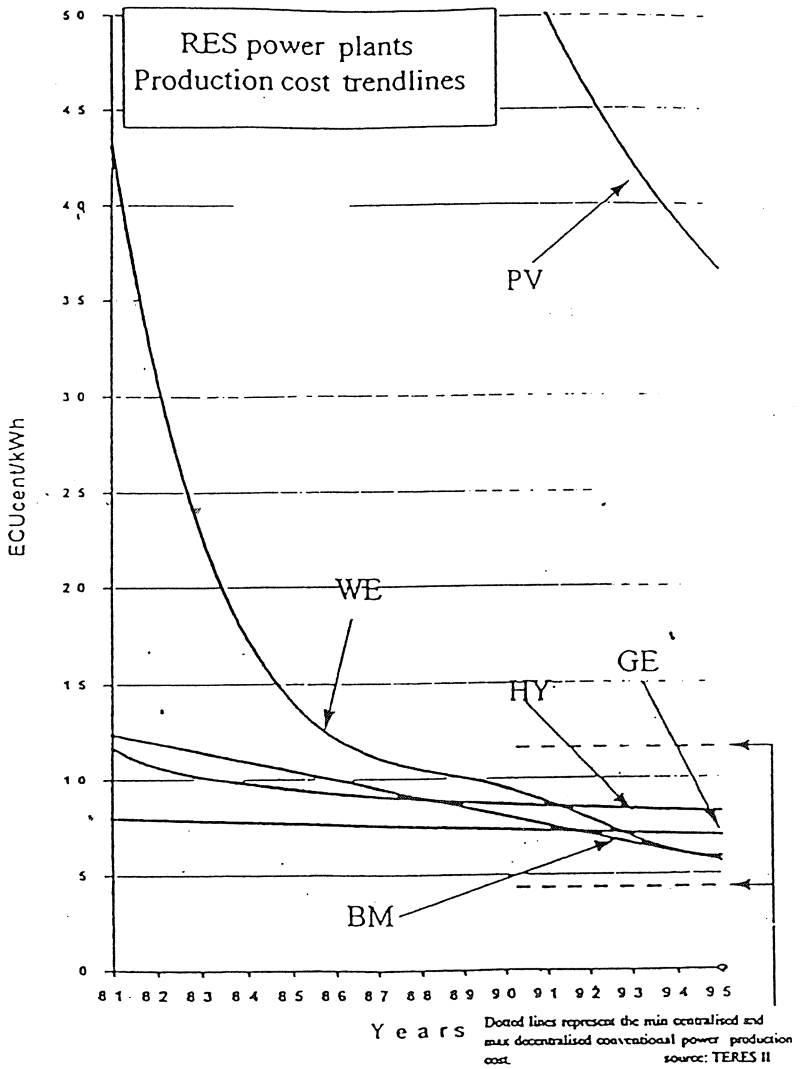
4.3. Considerations related to competitiveness

There are also sound reasons for promoting renewables vis-a-vis the third key energy policy objective, i.e. improving overall competitiveness of European industry. It is feasible to expect that most renewable sources of energy will be competitive compared to conventional sources of energy, in particular in the medium to long term. Figure 1 shows the declining cost curves for the various renewable technologies used in electricity production and a comparison with the cost of conventional technologies.

The trend lines indicated in figure 1 show average costs per sector and are based on commercial and demonstrated technologies. For the installation data, the cost of design, manufacturing, assembly and commissioning are taken into consideration and the total is divided by the installed capacity. The production cost is based on the same principle, but the cost is divided by the KWh produced by the installation on an annual basis. The data on production costs are compared to those produced by the TERES II report.

Some technologies, in particular biomass, small hydro installations and wind, are currently competitive and economically viable compared to other decentralised applications. Solar photovoltaics, although characterised by rapidly declining costs remain much more dependent on favourable conditions. As far as heat production is concerned, solar water heaters are currently competitive in many regions of the Community. There is, therefore, for the technologies which are already economically viable, a significant element of market failure. This, i.e. the importance of non-economic market barriers is further explored in chapter 4.

However, and in spite of the rapidly improving economic viability of renewables, it is evident that the cost related to renewables currently, for some technologies, is the most significant barrier to development of renewable sources of energy. This is particularly the case when renewable energy sources are competing with large centralised power plants based on coal or nuclear fuels which are still by far the most common electricity method in the Community. Many renewable energy sources will thus only be competitive in a situation where prices of conventional fuels will reflect the full cost, including environmental externalities, or when further technological development and mass market penetration has brought down the prices.



Key

PV: Photovoltaics

WE: Wind Energy

HY: Hydro Electricity

GE: Geothermal Energy

BM: Biomass

The Commission's 1993 White Paper on Growth, Competitiveness and Employment[16] argues that clean technologies are a key to future economic prosperity and that the current general taxation system does not lead to an optimal resource allocation. In this light, and with the prospect of a future internalisation of external cost, renewables could make a strong contribution to a sustainable and competitive European energy system. Already at the present point in time, it is worth noting, however, that renewables, as indigenous resources, are not affected by price fluctuations on imported fuels and will thus provide a stabilising effect on energy cost.

Another important aspect is the potential growth of the European renewable energy industry. In most technical areas the European industry is second to none in its ability to provide the equipment and technical financial and planning services required by market growth. Some Member States have, however, already at this point in time benefited significantly from export of renewable technologies and thereby increased their overall export revenue. By way of example the European wind turbine industry currently supplies approximately 75% of the global demand for these technologies. Globally, the renewable energy market potential for further expansion, in particular in developing countries, is impressive and has been estimated at more than ECU 1700 billion by 2020. This offers therefore interesting business opportunities for exports and possibilities for expansion of the European renewable technologies industry. The Commission has already supported the foundation of the European Renewable Energy Export Council, formally established earlier this year and is looking at other ways of promoting renewable energy technology exports. It is clear however, that in order to develop an export market it is eseential that the EU industry is able to expand on its home markets.

4.4. Regional development, social and economic cohesion and employment.

Development of renewables can also bring positive and tangible effects on regional development and employment. Renewables are, by definition, local energies and production of renewable technologies and the installation of renewable energy plants are - in many instances - independent of the existence of infrastructure. Furthermore many less developed regions have a good renewable energy resource potential. Promotion of renewables is therefore a major element in a regional policy and can bring employment to regions which are otherwise deprived of industrial development as well as supply of energy resources necessary for development. Studies show that development, operation and maintenance of renewable sources of energy tends to be much more labour intensive than development of technologies based on conventional fuels. The impact on employment from renewable energy is, according to some studies about five times higher than the employment impacts of further development of fossil fuels. Furthermore the job creation in this sector mostly takes place outside of urban areas where unemployment is often high.

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16 "Growth, Competitiveness and Employment - The Challenges and Ways forward into the 21st Century", the European Commission, 1993.

The tourism sector offers particularly good opportunities for increased use of renewable sources of energy. Regions with a tourism industry need, in particular, to be environmentally preserved and at the same time the tourism industry - most notably in the case of mass tourism - is characterised by increased energy demand specifically at peak periods. Furthermore, there is a growth in tourism in isolated areas such as on islands and in mountainous regions, where fuel deliveries and grid connections are costly or environmentally unattractive. Overall, therefore, increased use of renewable sources of energy can be an interesting alternative to conventional energy production in touristic areas.

The renewable energy industry consists predominantly of small and medium sized enterprises (SME's). As SME's are generally recognised as being a major source of new job opportunities in the European Union the future industrial development is highly dependant on a continued process of creating fast growing firms in "new" industries. Accelerating and strengthening the use of renewable sources of energy and renewable energy technologies should therefore be an important element in the overall Community strategy for supporting SME's, entrepreneurial initiatives, employment and growth for the benefit of industry and the regions of the Community.

4.5. Public opinion and consumer choice.

The European Union regularly carries out surveys on the evolution of public opinion in a broad range of areas. As far as energy is concerned, Eurobarometer's[17] conclusions are clear. Renewable sources of energy are generally seen in a more positive light than any other energy sources.

As energy liberalisation and consumer choice become a fact of life, also in the energy sector, this is likely to have some impact. If many customers have strong environmental preferences, this would be an additional force in the creation of new capacity based on renewables. Consideration needs to be given to ways of stimulating consumer demand for renewables.

5. The problems to be faced: A series of obstacles hinder a more widespread use of renewables

There is a need to take a detached look at the obstacles to the rapid and extensive development of renewable energy sources. The types of obstacles are of a very different nature and must, as such, be clearly defined to develop the policy instruments which can help renewables to overcome the obstacles. One area of particular concern is the issue of internalisation of external cost. Secondly there are a large number of other constraints, including problems related to financing, regulation, technical issues, lack of information, education and training etc. The limited market penetration of renewable sources of energy

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[17] European Commission, Eurobarometer 39.1; European Opinion and Energy Matters, September 1993.

can to a large extent be attributed to the lack of political will and ability to remove these barriers. The attempts which have been made are often fragmented and uncoordinated and have, in most cases, not resulted in a significant improvement of the situation. This Green Paper serves the purpose of identifying the obstacles in order to provide a basis, for concerted action for the promotion of renewable energy sources.

5.1. Cost considerations.

The cost for fully demonstrated renewable energy technologies are rapidly declining as a function of cumulative volume of demand and technological progress. Nevertheless, a key obstacle to a higher market penetration of renewables lies in the cost related to deployment of these energy sources. Therefore an optimal introduction of renewable energy sources is dependent on internalising of the costs of externalities. Fuel cycle externalities are the costs imposed on society and the environment that are not accounted for by the producers and consumers of energy. Studies[18] show that renewables would have a much bigger share of the market, even given the current state of technologies if, for example, fossil fuels, were priced in a way to reflect full costs of externalities, notably the cost related to environmental protection.

Generally, there are significantly lower external cost related to energy production based on renewables than there is to conventional energy. Therefore development of renewables would benefit significantly if regulations were put in place to the effect that energy prices in general would reflect the full cost of production, e.g by way of a general energy tax initiative with taxation levels reflecting the fuel cycle externalities. This would thus not only lead to a significant reduction of CO2 emissions, as shown in the analysis related to the Commission's CO2 strategy, but also to a significantly higher contribution from renewable sources of energy, in particular due to a shortening of the pay back period vis-à-vis conventional sources.

5.2. Technical and non-technical Barriers

As indicated in point 4.3 above, renewables are in many cases economically viable and can effectively compete with conventional energy technologies. Due, however, to a number of market failures they are still generally unable to make a wider impact. These market failures can only be corrected through the application of a variety of policy instruments. This section sets out the principle market barriers leading to such market imperfections.

Projects in the field of energy, be it installation of new production capacity or the construction of transportation infrastructure, are generally characterised by high investments cost in absolute terms. Although this is frequently not the case as regards renewable energy technologies, which are often small scale projects, these are often faced with the difficulty that the attitude of financiers is negative. Furthermore, capital cost for instalment are often

[18] EXTERNE :Study under the JOULE Programme on the Externalities of Energy.

high compared to the running and the fuel cost. It is in fact often not sufficiently well recognised that renewables energy technologies have low running cost due, in particular, to low or zero fuel costs. There are signs that attitudes are changing, but projects have to meet fairly strict criteria before funds are sanctioned. So, even though there is an awareness of the renewable technologies and the business opportunities related to them, problems arise when the details of funding proposals are examined. Among the main financial barriers common to most renewable projects are the long pay-back periods at the current price level. Without clear indications of the long term scenario, equity investors and financial institutions are unable to take a long-term view of the projects. The perceived risks (both technical and market related) by financial institutions, investors, purchasers of equipment, consumers etc. are therefore often overestimated. Combined with the fact that the scale of many renewable projects is often too small for many financial institutions, many otherwise sound and economically viable renewable energy projects are never taken beyond the post-planning stage.

Information, awareness and experience related to renewables is not evenly distributed throughout EU. This affects a large number of groups from policy makers to investors. Developers, engineers, technicians, installers, financiers, investors, planners, utilities and power companies, which are all important players in the decision making affecting renewables, generally suffer from a shortage of knowledge of the opportunities offered by renewable energy technologies.

National power production companies, and in particular monopolies, often have negative attitudes towards renewables, mainly based on a general resistance to change. A centralised approach to energy production is seen to be contradictory to the development of renewable energy sources.

Connection to centralised electricity grids poses both technical and economic problems. Although some have been solved, many grid connection issues remain unresolved, including wheeling charges and standard contracts for utility services in provision of grid connections. The low price paid to autoproducers of electricity in certain countries results in low returns to equity investors. Recognition for reduced transmission losses associated with decentralised energy generation is often not given by utilities either in terms of grid connection facilitation or price.

A problem related to certain grid-connected renewables, notably wind and solar, has to do with the supply variability between day and night and between the seasons. This is a problem which needs creative solutions to be overcome, and which due to the discontinuous supply will affect the market price compared to electricity produced by fossil fuels, hydropower or nuclear. There are however solutions available to deal with such problems, e.g telematics applications or energy storage systems. At a more technical level, interconnection requirements related to safety, control, and equipment specifications may also prove a burden for renewable energy source developers.

In the transport sector biofuels, as is the case for any new fuel type, require appropriate infrastructure to make a wider impact. However, the automotive infrastructure is almost entirely geared towards hydrocarbon making it difficult to market biofuels such as biodiesel. The discussions recently launched at Community level on cleaner car technology provides a good opportunity to further assess how to overcome the market obstacles for biofuels. Clearly, any measure will have to be evaluated in terms of its cost-effectiveness in reducing CO^2 emissions and will have to take into account the implications for other pollutant emissions.

Technical requirement related to non-grid-connected renewable energy sources also create obstacles. Building regulations, for example, often do not take account of the special requirements of installation of renewable sources of energy. Furthermore, the lack of appropriate standards lead to resource demanding and expensive procedures related to installation of renewables. Technical standards, for example on the performance of consumer products such as solar, thermal, water heating, will help to provide the public confidence which is essential for mass marketing. Biomass fuels are another example of a renewable energy sources currently lacking sufficient standards. In some cases, the individual Member States require equipment to go through specific national testing procedures before installation adding significant to the costs and time required for industry to introduce new types of technology on the market. The lack of European-wide harmonisation of such requirements often create serious barriers to trade in renewable technologies.

Although several renewables energy sources have now become mature, innovative and highly efficient, some technologies still have to be developed or fully demonstrated. Some examples are the demonstration of biomass gasification in combined cycles and wind turbines located at very low wind speed sites[19].

As renewable energy projects are often located in areas close to the resources where energy projects are not common, projects may meet resistance from the local residents based on environmental concerns. Although the environmental impact of most renewables is much less severe than that arising from conventional fuel cycles, local issues sometimes outweigh the global environmental benefits. While recognising that wind turbines, specifically, may have some negative environmental impact in the form of noise and visual impact, technical solutions are being developed and the overall positive environmental consequences arrising from the avoided energy production based on fossil fuels should be taken into account when these concerns are addressed.

The current non-transparent, unstable and unpredictable framework for development and deployment of renewable energy sources and technologies resulting from the various and

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[19] The technological barriers to further exploitation of renewable energy are presented in several papers produced for the Thermie-conference "Towards a wider use of energy technology; pre-competitive actions to the benefit of the market", Brussels, 10-11 October 1996.

often rapidly changing national promotional schemes, must be considered to be a serious barrier to further market penetration. It is suggested that this - as is the case with respect to most of the obstacles detailed in this chapter - can only be overcome by the creation of a stable and Community wide framework for renewable energy sources.

6. The way forward: A strategy for renewable sources of energy.

In the development of any policy strategy, well defined objectives are important. Without a clear definition of the direction and the speed of where one wishes to go, it becomes virtually impossible to measure the rate of success and to adjust the policy measures implied. On the other hand, objectives must be realistic and reachable and they should, most importantly, not be used as an excuse for non-action. Objectives which are not accompanied by policies defined to achieve them are worthless.

An ambitious, but achievable objective for the Community could help focus the policy measures needed, and provide the necessary political signal. Different options for such an objective are possible, including a significant improvement in market penetration of renewables achieved by doubling the contribution made by renewables to primary energy consumption in the European Union by 2010. This would require the European Union and the Member-States to take important measures promoting renewable sources of energy to enable the increase of the contribution made by them by that date to a level of 12% of gross inland energy consumption.

It is clear that at Community level, support and promotion of renewable energy sources in a number of policy areas is a prerequisite to wider penetration, However, a significant increase in use of renewables cannot be achieved through action at Community level, only. Industry, users and the Member States will have to play an important role and to take their responsibility for implementing effective policies at national level. The principle of subsidiarity provides good guidelines in this respect. Many necessary policy measures will have to be developed at national level. National programmes for technological development will have to be strengthened, education and training activities have to be increased, information campaigns and awareness building at national and regional level will have to be further developed, etc.

In this context the Commission proposal for cooperation around agreed energy policy objectives will play an import role. As increased use of renewable sources of energy is specifically mentioned as an energy policy objective, the framework to be put in place can be used as a useful mechanism for ensuring increased convergence of Member States' policies in this area.

There are however, a number of policies which can be most effectively applied at Community level. The Community strategy to be established on the basis of this Green Paper and the conclusions to be drawn from the wider debate on renewable energy sources, should set out key elements in this respect. It is essential that the strategy is accompanied by specific

measures and goes beyond the loose commitments made in the past. This preliminary discussion document, as indicated, does not contain a full list of precisely defined actions. It identifies, however, the policies which are required at an EU-wide level, to ensure that the Community lives up to its obligations as regards sustainable development and more precisely development and deployment of renewable sources of energy.

6.1. An ambitious objective for increasing the contribution made by renewables.

A target for the contribution from renewable energy sources can be a good policy tool and can provide a guideline for action. Most Member States have, as indicated in chapter 1, established more or less specific quantitative targets at national level and the Community of 12 had agreed upon a target for 2005 of 8% share of renewables. The question arises as to whether a new Community indicative target should be set for 2010, and if so at what level.

It should be clear that a Community target, would not mean that each and every Member State should reach a certain percentage market share of renewable sources of energy, but rather that the Community as a whole should aim to realise a particular market share by the date 2010. The natural differences between the Member States as regards their use of renewable energy sources are therefore likely to remain, although a specific objective for renewables could stimulate all Member States to make a special effort towards increased exploitation of the available potential. In that sense, an objective for the penetration of renewable energy sources is different from the CO2 targets to which the Member States and the Community are committed in the framework of the Climate Change Convention, which commit Member States individually. Nonetheless, an objective for a significant increase in the use of renewable energy sources would could be an important instrument for attaining the CO2 stabilisation target, alongside other measures such as energy saving.

The Commission is seeking views as to whether to set an indicative target for the contribution by renewable sources of energy to the gross inland energy consumption beyond the current target for the year 2005, on the assumption that an ambitious but realistic objective for 2010 would provide a useful stimulus for policy and would focus minds of decision-makers. Views on other means of giving a political signal and impetus to action for the promotion of renewables would also be welcome, together with views on what benchmarks can be used to monitor progress made.

As outlined under Chapter 4, the Commission believes that the advantages of renewables for energy policy, environmental protection, employment and regional development and cohesion, are such as to justify an important pro-active policy effort towards achieving a significant increase in market penetration in the medium term perspective of the next 15 years. The question arises as to what may constitute a significant increase, what are the kind of measures that would be necessary and what are the resulting implications, in relation to CO2 and other emissions reduction, security of supply, enconomic impacts, employment. Consideration will also need to be given to the cost effectiveness of different measures taking into account opportunity cost, and also to what may be the predicted technological

developments in this fast moving field.

When considering what may constitute a significant result of a concerted policy effort, it is important to know how the situation on renewables may evolve if no specific effort is made. Under three of the four scenarios developed under the "European Energy to 2020" study ("Conventional Wisdom", "Battlefield " and "Hypermarket" scenarios) described under Chapter 3, under which no effort is made to promote renewables, their share may be expected to rise by 1.5% over 15 years to 2010 (approx. 0.1% per year) . Under the fourth scenario outlined in that study ("Forum") which is much more oriented towards general environmental policy measures, but without specific renewables promotion measures, the share of renewables may be expected to rise by 3% to 9% by 2010.

In the scenarios developed under the Terres II study, which take as their starting point "Conventional Wisdom" but assume that certain policy measures assisting the development of renewables are taken, the prediction for the share of renewables are more encouraging. If the measures proposed by the European renewable energy industry are taken ("Industrial Policies " scenario) or those proposed under the Commission's model based on internalisation of conventional fuel external costs ("ExterNe Internalisation" scenario), the renewables share is predicted to be around 10% at 2010 . If however, we take the third scenario ("Best Practice Policies") which proposes that the policies which have been found most effective to date for promoting renewables are put together and applied EU wide, then the renewables share can be predicted to rise to 12.5% by 2010. Taking yet another approach, by combining the results of a number of studies[20] one could predict that under a minimum effort scenario, the share of renewables by 2010 will be 7% , with median effort 9% and with maximum effort 16%.

The Commission is in the process of examining the implications of all the different measures that may need to be taken under the different scenarios, as part of the preparation for a future Action Plan on Renewables, and would welcome views on the feasibility desirability and efficiency of the measures described under Chapter 3 and elsewhere in the document, as part of the Green Paper consultation process.

For the reasons outlined in Chapter 4, the Commission believes that at this critical stage in the development of renewables, a significant pro-active policy effort is required to achieve measurable results. Against the background already described above, a doubling of the share of renewables by 2010, which would mean a contribution of renewable sources of energy in gross inland energy consumption of about at 12%, could be an ambitious, but realistic objective[21].

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[20] DGXII synthesis of the PRIMES, SAFIRE, TERRES, ENERGY 2020 and US studies.

[21] It is important to note, that penetration of the market calculated on the basis of the Eurostat convention, in absolute terms, corresponds to a 15%*penetration* calculated on the basis of the so-called substitution principle (220 toe/GWh). The target proposed by the European Parliament, although not explicitly stated in its recent resolution,

Since the current share of renewables of approximately 6% includes large scale hydro, for which the potential for further exploitation in the European Union, for environmental reasons, is very limited, a doubling of the current level of energy output from renewables would require significant increases in the use of other renewables. This is clearly illustrated by the scenarios outlined in section Chapter 3 of this Green Paper, which showed that most ambitious policy measures are needed to increase significantly the contribution from renewable sources of energy by 2010.

The implications of this are analysed under the TERES II study, in particular with respect to parameters including CO2 emissions, security of supply and employment. With respect to CO2 emissions, the "Best Practice Policy" scenario of 12.5 % share of renewables predicts a reduction in CO2 emissions of 386 million tonnes per year by 2010, is calculated using the previously presented SAFIRE model. As regards security of supply, a doubling the current market penetration of renewables would lead to a reduction of approximately 20% in energy dependency compared to the present situation. With respect to the effects on employment, the SAFIRE model predicts employment benefits as a function of market penetration of renewable energy sources by taking into account direct employment created in construction, installation, operation and maintenance of renewable technologies minus the employment displaced in the conventional energy sector. This study indicated that a doubling of the current share of renewables by 2010 would have a net positive employment effect of more than 500.000 jobs within the Community. This figure appears optimistic, but is worth noting, and includes the net employment indirectly created in the sectors that supply the renewable energy sector, but not the induced effects in the economy as a whole and the employment created as a result of the expected strengthened position of the EU industry on export markets. It is therefore feasible to expect that net employment benefits would be even more significant. It is also worth noting that the bulk of employment creation would take place in rural areas.

In addition to views on an objective for overall renewable energy penetration, the Commission is also interested in views on the establishment of sub-objectives for the individual renewable sources, as well as sub- objectives concerning the contribution to the various sectors, such as electricity and heat production. When discussing objectives, care should be taken not to limit flexibility and to ensure that efficiency is maximised by using the most cost effective renewable energy sources available. This is particularly important because, due to rapid and largely unpredictable technological development, cost curves and relative profitability are likely to shift. Also economic conditions may change significantly and affect the possibility of reaching the objectives. Moreover, the Community is in the process of enlargement. The applicant countries of Central and Eastern Europe generally do not have a well developed renewables sector although the potential is considerable. In an enlarged Union it may therefore be more difficult to achieve the Community objectives.

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appears to be based on the 15% target adopted in the framework of the Madrid Declaration, which is calculated on the basis of the substitution principle.

If a an indicative target is finally proposed in the Community Strategy, in order to retain flexibility, a tri-annual review procedure could be put in place, which, based on a careful monitoring and assessment of the situation, could provide for the possibility of adjusting the objectives as well as the policies designed to achieve them. It should in any case be clear that any eventual proposals for targets would be objectives to be aimed at and not legally enforceable.

6.2.

Strengthening cooperation between the Member States

The achievement of a significant increase in the share of renewables requires the full commitment of Member States at national, regional and local level. Indeed, most of the concrete measures are to be taken by Member States while fully respecting the principle of subsidiarity. In this context, the Community can add value by encouraging cooperation between Member States in this field. Effective cooperation at Community level is therefore necessary to help ensuring that national energy policies contribute to the attainment of an ambitious objective for the penetration of renewables.

In its Resolution of 23 November 1995 on the Green Paper "For a European Union Energy Policy"[22], the Council identified the promotion of renewables as a common energy objective both for the purposes of environmental protection and of reducing energy dependence. The Council highlighted the need for an improved convergence of energy policies within the European Union towards this goal.

Furthermore, in its Resolution of 7 May 1996 on the White Paper "An Energy Policy for the European Union"[23], the Council invited the Commission to put in place a process of cooperation between the Community and the Member States in order to ensure that Community and national energy policies are compatible with the agreed common energy policies.

In line with the above Council Resolutions, the Commission adopted on 4 October 1996 a proposal for a Council Decision concerning the organisation of cooperation around agreed Community energy objectives[24]. The draft decision identifies the promotion of renewable energy resources as one of the agreed common energy objectives and calls for supportive measures at both Community and national level with the aim of achieving for this fuel a significant share of primary energy production in the Community by 2010.

In the Commission's view, this decision, once adopted by the Council, will provide an appropriate framework for facilitating an effective cooperation between Member States in the

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22 OJ N° C 327/3 of 7.12.1995.

23 OJ N° C .... of ....

24 OJ N° C ..... of .....

field of renewables, in particular due to the specific measures proposed to encourage best practices and the promotion of a cooperative approach to energy analysis and exchange of relevant experience. As detailed above, the current level of market penetration for renewable energy and the policies applied at national level for the promotion of the sources are characterised by very large differences. The question therefore arises as to whether or not there is a need to establish closer cooperation with Member States on renewables with a view to harmonising national initiatives and, if so, what should be the terms of reference for such closer cooperation to be established for renewable sources of energy.

6.3 Reinforcing Community policies.

Community policies in many different areas have implications for the development and the deployment of renewable sources of energy. An effective implementation of the strategy will thus have to rely on policy actions in many areas of Community competence which should all, in an appropriate way, take into account the need to promote renewable energy sources. To ensure that this is done in a coherent and effective manner, the coordination at Community level and within the Commission must be improved. As far as the Commission is concerned, internal coordination would be improved by the establishment of an Inter-Service Group on Promotion of Renewables. Improved coordination within the Commission is a key element of the European Parliaments recent Resolution on renewable sources of energy. This and other actions needs to be undertaken in order to ensure that all Community policies take into due consideration the objective of increasing the role of renewables and to ensure that implementation of policies are undertaken in a coordinated and consistent way.

Outlined below is the Commission's current thinking on the various elements which must be covered by the strategy and the action plan to be developed.

6.3.1 Renewable energy sources in the internal market framework.

The creation of an internal energy market is a key priority of the Community. It forms of integral part of the Community's efforts of creating a stronger and more competitive industrial base to face up to the globalisation of markets and fiercer international competition.

The long and difficult negotiations on the issue of creating an internal electricity market culminated in July 1996 with the adoption of a Common Position on a directive for the internal electricity market[25]. The main trust of the directive is to facilitate the application in the electricity sector of the fundamental principles important to economic activity enshrined in the Treaty, i.e. free movement of goods, free provisions of services, the right of establishment, and non-distorted competition.

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[25] OJ L..... of .....

Renewable sources of energy play a role as a fuel in the electricity sector. The potential is far from used to its full, but important contributions can be made by hydropower, wind, biomass and, to a lesser extent, solar photovoltaics. As the internal market is not yet fully operational, it is difficult to anticipate the effect that the internal market will have on the exploitation of renewables. Experience from countries which have already undertaken considerable market liberalisation, such as the US, suggests, however, that renewable sources of energy can continue to play an important role and can be further developed, provided appropriate market-based instruments are introduced.

Clearly the provisions of the directive on construction of new capacity, which will ensure that new capacity is installed in accordance with objective, transparent and non-discriminatory criteria, will affect positively renewable sources of energy. This is reinforced by the directive which, in listing the criteria for granting authorizations, makes a specific reference to protection of the environment and to the use of primary resources. Furthermore, the directive's provisions on transmission explicitly ensure that Member States may require the system operator to give priority to certain installations, including generating installations using renewable sources of energy. The Commission's proposal for an IRP directive, which is currently the subject of negotiations in the Council, is an important means for boosting the role of renewables in the Community. Experience from the US shows that Integrated Resource Planning (IRP) is of principle importance to the electricity generation procurement process. IRP is furthermore a powerful mechanism to attain the all important active involvement of utilities in the process of promoting renewable energy technologies.

It is, given the current difficulties encountered by many renewable energy operators, necessary to closely monitor the conditions under which renewables are given access to the grid. The Commission will, in the framework of its general monitoring role of the functioning of the internal electricity market, pay particular attention to this aspect and if appropriate propose measures which can ensure that renewables are not discriminated against, and if necessary put forward measures aimed at promoting the wider use of renewables. As indicated in the introduction, the creation of an internal energy market will bring about major changes in the operation of the energy markets. This Green Paper provides, therefore, an ideal opportunity to stimulate the debate as to how this will affect the market penetration of renewable energy sources. The Commission would, in the framework of the consultation process to take place on the basis of the Green Paper, particularly welcome views on how renewable energy sources can play their appropriate role in the internal energy market. The Commission at this stage has identified a series of measures which may be considered in this context. These are presented and discussed in this section.

Renewable energy credits.

Although, as competition on the energy markets increases, regulatory policy measures have to be phased out and replaced by more market oriented measures, fiscal instruments are, certainly in the short and medium term, unlikely to ensure that the Community can significantly increase contributions by renewables by 2010. Consideration could be given

to the idea that a certain percentage of a Member State's electricity requirements will have to be met by renewables, enforced on each individual retail electric supplier, with individual obligations tradeable through a system of "renewable energy credits". Such a system, which to a large extent would resemble the system proposed for tradeable CO2 permits, could serve a two-fold purpose if introduced at an EU-wide scale. Firstly it would promote renewables and secondly it would prevent market distortions arising from similar measures introduced by individual Member States. A renewable energy credit system could, if appropriate, and if judged compatible with current and future EU wide electricity taxation schemes, be coupled with an electricity surcharge mechanism similar to the UK non-fossil fuels obligation. There are, however, a number of unresolved issues which will have to be further clarified if such a system was to be introduced at EU level. These concern, in particular, the practical and administrative aspects and the questions related to sanctions to be imposed in case of non-compliance with the obligations.

If workable solutions to these matters can be found, a flexible market based implementation of a renewable energy credit system could play an important role in ensuring the achievement of policy goals related to renewables at least cost. As it would apply to all utilities it would be competitively neutral. It would most importantly force utilities to maximize the value of the required renewables in order to minimize the impact on their competitive position. They would use technological applications which have the greatest value and they would use their resources and creativity to lower the cost of renewables. In short, the positive forces of the market would be brought to work in the field of renewables. The Commission would be interested to receive views on the desirability and feasibility of such a scheme.

Internalisation of cost and fiscal harmonisation.

Fiscal harmonisation can play a major role in ensuring a correct functioning of the internal market. It is furthermore of crucial importance for a more rapid introduction of renewables. The Commission remains committed to the principle of internalisation of cost as set out in the White Paper on Growth, Competitiveness and Employment. Internalisation of external cost as shown in chapter 3 of this Green Paper, is of prime importance given the current cost constraints related to renewables. As pointed out above, and as shown in countless analysis, an effective policy of internalisation of external cost, most notably that related to environmental degradation, is necessary to ensure that renewables make a significant contribution to the Community's energy balance.

At present, the Community has put in place a system of minimum excise duties for mineral oils. There are however, still considerable variations between the levels applied in the Member States. Furthermore the system only applies to mineral oils and not to other energy sources. In the absence of an agreement at Council level on a CO2 energy tax covering all energy products, the Commission is following the invitation from the ECO-FIN Council of 11 March 1996, in the process of finalising a new proposal designed to introduce a new system for taxation of all energy products.

As far as energy of solar, wind, tidal, geothermal or hydraulic origin, or from biomass conversion are concerned the Commission, with respect to this proposal, intends to include a provision for the application of reduced rates of duty or exemption. This will be an key incentive for the development of renewable sources of energy and an indispensable part of an economic strategy aimed at strengthening market penetration of renewables.

As far as the electricity sector, which has a particularly high potential for utilisation of renewable sources, is concerned, a reformed taxation system should encourage the most polluting parts of the power industry to contribute to technological development in the electricity generation sector. To form an effective incentive to develop and further exploit renewables, it is proposed that an electricity tax should exempt renewable energy sources. As however it is difficult to distinguish at the point of final consumption between electricity produced by renewables and electricity generated by nuclear or fossil fuels, it would be important to put in place a system whereby the renewable electricity producers are fiscally reimbursed.

In 1992 the Commission made a proposal[26] for reduced rates of excise duties on motor fuels of agricultural and forestry origin. If adopted this proposal would enable Member States to encourage the use of biofuels as automotive fuels by making it possible for them to compete directly with conventional fuels. However, this proposal failed to secure agreement at Council. The Commission is now considering how to ensure that progress is made on this issue, bearing in mind the new proposals on taxation of energy products generally, which it is preparing at present.

The Commission recognises that overall the fiscal aspects related to the promotion of renewable energy sources may require further reflection and the Commission will, in particular in the light of developments relating to the adoption of its proposals on taxation of energy products and on the basis of inter alia the reactions to this Green Paper further develop its plans in this respect.

State aid

Member States currently, to varying degrees, offer financial support to renewables in a number of ways. In addition to national research and demonstration programmes these measures cover tax incentives, direct subsidies, low interest financing, development aid for small and medium sized enterprises active in renewables, lower VAT-rates for electricity based on renewables, state guaranteed low interest loans, etc. Whenever there is an element of state aid involved, the Commission has to be notified and authorization for the measure has to be granted, provided that one of the conditions for the derogations of Article 92 of the EC Treaty is fulfilled. The guiding principle for the Commission in assessing aid for

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renewable energy sources, contained in the Community Guidelines on State Aid for Environmental Protection[27], is that the beneficial effects of such measures on the environment must outweigh the distortive effects on competition. State aid for Research and Development in the field of renewable energy sources is subject to the rules set out in the Community Guidelines for State aid for Research and Development[28]. On renewables, the Guidelines on State Aid for Environmental Protection stipulate that in appropriate cases investment aid to renewables, in view of the "especially high priority in the Community" given to the development of these sources, can be authorized also when exceeding the general levels which are contained in the guidelines.

Community guidelines are intended to ensure transparency and consistency in the manner in which the Treaty provisions on State aid are applied by the Commission in relation to the range of instruments used by the Member States in the field of renewables.

In recent years the Commission has dealt with an increasing number of state aid cases in the field of renewables. As foreseen in the White Paper "An Energy Policy for the European Union" the Commission will during the process of revision of the present guidelines, the Commission will consider whether appropriate adaptations are needed for renewables and their contribution to energy policy objectives. A future re-examination of the Community guidelines for environmental protection should take into account the experience gained in this field.

Furthermore, the Commission has dealt with cases where the legislation of a Member State imposes on the energy distributor a purchase obligation (linked to a fixed price mechanism) for electricity produced by renewable energy sources. A key element for the assessment of such cases is whether the price mechanism reflects avoided costs as referred to in the Council's recommendation of 9 June 1988 on developing the exploitation of renewable sources of energy.

Standardisation.

A separate issue related to the internal market is that of standardisation. Standard minimum requirements for renewable technologies are important to boost confidence in the performance of these technologies. Standardisation is included under the scope of the ALTENER programme. However, the actions for developing standards have been re-oriented from the original intentions of creating Community-wide directives to a strategy to develop standards through organisations such as CEN and CENELEC. The reasons behind this reorientation was firstly to place the standards on renewables firmly in the general standardisation framework of the Community and secondly the experience gained in developing directives on energy

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[27] OJ C 72, 10.3.1994, page 3.

[28] OJ C45 of 17.02.1996.

efficiency standards, which have proved to a very cumbersome process.

European-wide standards on renewables serve the double purpose of facilitating the introduction of new technologies into the internal market and to boost confidence in these technologies. This second aspect is of particular importance in the field of renewable energies. There are standards under preparation concerning renewables. They concern in particular the development of solar thermal, solar photovoltaics, wind and biodiesel. The Commission will speed up this work and establish comprehensive mandates for CEN and CENELEC for the most commonly marketed renewable technologies. The mandates will focus on technical reliance and economic performance criteria. Establishment of strict standards for renewables will, in particular, help Small and Medium Sized Enterprises (SME's) to market renewable energy technologies and is thus required to ensure that these energy sources can be fully integrated into the internal energy market

6.3.2. Specific financial support for actions for the promotion of renewables.

With a view to specifically promote renewable sources of energy the Council in 1993 adopted the ALTENER programme. This was the first time that the Council recognised the particular need to increase the efforts at Community level to help renewables penetrate the market. The decision was made as an integral part of the Community's CO2 reduction strategy and thus gave a clear indication of the role renewable energy sources play in combatting climate change and emission of carbon dioxides.

ALTENER is designed to fit into the gap between technical development/demonstration and market deployment. It focuses in particular on the needs for capacity building, information sharing, training and standards development. The ALTENER programme was given a relatively modest indicative budget of 40 million ECU for the period 1993 to 1997. The programme provides different levels of funding for its various elements, ranging from 30 percent to 100% for studies and technical evaluations.

During the period from 1993 to now a total of 213 actions have been carried out under the ALTENER framework. An independent evaluation[29] made in 1996 concludes that the programme has been an important means for focusing attention on the development of renewable energy sources, in particular in some Member States which do not have comprehensive renewable programmes. ALTENER has thus been successful in supporting Member States actions and in promoting the concept of a Community target. The evaluation, however, also concludes that the programme is funded at too low a level to meet Community objectives for renewable energy development.

In a separate parallel proposal for a specific programme for the promotion of renewable

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[29] "Evaluation of the ALTENER programme (1993 - 1997) and proposals for the future" report to the European Commission by Andersson, Del Rio, Janssen and McKeogh, Brussels 1996.

energy sources (ALTENER II), it is proposed that the Community reinforces its promotional policy and ensures that these actions comply with the requirements of an internal energy market. As experience shows that, even in cases where renewable technologies have reached a technically mature level, there is still an insufficient penetration of the market, there is a strong case for the Community to support pilot actions, information schemes, training activities, etc. Moreover there seems to be a special case for more comprehensive actions in the field of awareness building to be implemented, both on the supply and the demand side.

It is proposed that ALTENER II includes actions supporting the transitional phase between demonstration and commercialisation. There is a real gap to be filled in this respect, despite Member States' promotional activities and in spite of the support given to certain regions under the framework of the structural funds. Strengthened actions under ALTENER II could help create a competitive market for the renewables industry and thereby reduce costs and create new jobs in the sector. Such action at Community level would be targeted at certain well-defined areas such as photovoltaic roofs, solar thermal heating for sport, tourism and health facilities, active and passive solar architecture, production of bio-methane from municipal biodegradeable solid waste, stand-alone facilities, etc., with the Community support as low as possible to avoid market distortion and calculated to take into account the avoided external cost.The degree of market penetration should be taken into account to ensure that any support will not lead to market or trade distortions. ALTENER II could in this way provide the means for establishing a Community wide market, which, while taking into account that renewables are local resources, is required in order to render the European industry more competitive. This is an important prerequisite for European industry to be able to compete globally in this area. It is proposed that a strengthened ALTENER II, is adopted as an important tool for the promotion of renewable energy sources.

In addition there is a need to examine in more detail how investments in renewables can be increased using other Community financial instruments, in particular the possible sources of finance inherent in the existing Community financial mechanisms and beyond. It is proposed that renewable projects should to a much larger extent be able to benefit from funding from the European Investment Bank (EIB), the European Bank for Reconstruction and Development (EBRD) and other international financial institutions.

6.3.3. Research, development and demonstration.

Research, development and demonstration is a policy area where Community support can have a significant impact and therefore Community efforts need to be strengthened. With most renewable technologies being innovative, with the one exception of large scale hydropower, there is a need for a targeted effort to improve the cost effectiveness, and technical performance and reliability of renewables through research, development and demonstration. The JOULE-THERMIE programme, which covers both traditional R&D and demonstration in the field of non-nuclear energy, intends to devote a significant part of its budget, i.e. 45% to support of activities aimed at developing and promoting renewables. The JOULE-THERMIE programme has an indicative budget of 1030 millions ECU for the four-year

period from 1995-1998. Following the 1995 JOULE call for proposals, 93 R&D projects were accepted for support totalling approximately 80 million ECU in the renewable sector. The 1996 THERMIE call for proposals resulted in the selection of 41 demonstration projects in the renewable sector with a support of 35.3 million ECU. As regards associated measures, notably dissemination of results, 48 projects were supported in 1996 in this sector with a total level of support of 17.7 million ECU.

Under the JOULE and the THERMIE programmes the rate of support which can be granted from the Community budget can cover a maximum of 50% of the eligible cost of R&D projects and 40% of the eligible cost of demonstration projects. This means that projects which carry a considerable amount of financial and technical risk can be implemented with the help of the JOULE-THERMIE programme.

The RTD activities as regards renewable raw material production for destinations other than human or animal consumption are a principle objective of the specific FAIR programme, covering the period 1995 to 1998. The research efforts concentrate on the to non-food applications of crops and the recycling of agricultural and processing residues at the farm level. The total budget for these actions account to 52 million ECU. The research cover a wide range of crops and plants. The research undertaken so far indicates that non-food development of agricultural and forestry biomass offer interesting prospects for a contribution to the development of the rural areas. Consideration should be given to how this programme should be followed up.

Within the existing programmes for Community non-nuclear energy research, development and demonstration renewables features as a high priority. The JOULE and THERMIE programmes have thus offered a major contribution to the maturing process of renewables in the Community. The same is true for some Member States which, by allocating appropriate funding, conduct a future-oriented research and development policy. It is a course for concern, however, that generally, funding for energy RD&D is stagnating or declining in both the private sector, as a result of industrial restructuring, and the public sector as a result of increasing fiscal constraints in government. Although all Member States support technological development of renewable sources of energy, there are, however, very large differences in the commitments that the Member States are prepared to take in this field[30]. It is therefore proposed that the Community programmes concerning technological development in the field of renewables are reinforced. In view of the critical phase at which the renewable energy technologies find themselves at the moment, it is, as part of the strategy, particularly important to establish clear objectives for the 5th Framework Programme.

A renewable energy source, as used nowadays, is seldom sufficient in its own right. In order

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[30] Recent data from the IEA demonstrate that, in 1995, the share of Government funding for R&D in renewables measured as the share of overall funding for energy R&D varies from less than 1% (France)to 46%(Spain). In absolute terms there are similar large variations; IEA Energy Policies of IEA Countries, 1996 Review, Paris 1996.

to guarantee the supply several sources need to be combined. Telematics system and services can play an important role in optimising the supply of energy extracted from renewable sources by automatically and continuously monitoring and adjusting the production parameters. Furthermore, telematics applications can support the optimisation of the energy consumption and adapt production to the consumption pattern. The use of telematics applications and technologies may become a crucial factor in demonstrating the viability of the use of renewable energy sources. Consideration should be given to how such telematic applications and services can be supported in future Community RTD actions in the area of Information Society Applications, in order to assist the promotion of renewable energy technologies.

In the current economic situation, there are significant constrains on public spending in the Community and in the Member States. It is essential that the funding which is available is used in the best possible way and that support to R,D&D activities related to renewable energy technologies is of a scale that guaranties its effectiveness. The Commission will therefore reconsider the funding made for research in the various areas of energy, including the current break-down of funding for nuclear and non-nuclear energy research. While recognising the research work which is essential for the development of technologically less mature renewables, the Commission is convinced that the key to more market penetration of renewables lies at the tail-end of the technological process, i.e. in the market introduction phase. The Commission will, in the implementation of its instruments in this area, pay particular attention to this aspect.

To summarise, the key questions related to RD&D to be addressed in the debate on this Green Paper is the setting of appropriate RD&D priorities in the field of renewable energy sources, in particular with a view to ensuring the best possible renewable energy contribution to the Community energy balance and with a view to contributing to a strengthening of the position of the European renewable industry in the global market place.

6.3.4. Regional policy

A balanced and sustainable economic development in all regions of the Community is another main objective for the Community to which renewable energy sources can contribute. Given the importance of energy to the overall performance of the economic system, energy plays a major role in the Community's policy in the field of regional development. Renewable energy resources are often located in remote and scarcely populated areas of the Community and the promotion of these energy sources, especially in peripheral regions, islands and rural areas, is particularly attractive, as has been demonstrated for instance with the programme VALOREN.

In the framework of the structural funds of the Community financial support for renewable energies for assisted areas can be provided to less favoured regions under Objective 1, in accordance with the priorities and strategic objectives of each Member state concerned. Within the framework of the structural funds, financial support for exploiting renewable energy potential has been granted to virtually all the regions concerned. In Portugal, for instance, support is provided for the development of small scale hydro-electric generators and wind turbines up to a total capacity of 170 MW, corresponding to approximately 1.7% of total electricity consumption in Portugal.

Given the particular benefits arising from development of renewables in the less developed regions of the Community and the positive impact of such a development for small and medium-sized enterprises (SME's), the Commission proposes to place particular importance on these aspects in the implementation of the general policies put in place for regional development and promotion of SME's. Appropriate support would also need to be given to the creation or reinforcement of the role of regional and local structures charged with energy planning and programming functions. The ALTENER programme has already contributed to the development of renewables in the less developed regions and the JOULE-THERMIE also places particular importance to this aspect, as well as to the role of SME's. Furthermore, the Commission has supported regional and local energy management schemes, including the creation of local and regional energy agencies, in the framework of the pilot action known as "Energy Programming at Regional and Local Level". In the future these actions will be continued under the SAVE II programme.

The Commission will, on the basis of the reactions to the Green Paper, further consider how to address the specific problems facing renewables in remote areas, and in areas where development of renewable energy is a appropriate way of fostering economic activity and job creation. As indicated in section 4.4 above, SME's play a paricularly important role as regards renewable sources of energy and the Commission will, therefore, pay particular attention to the specific problems faced by SME's in this area. Furthermore, given the important aspects related to renewables in the tourism industry, the Commission will consider ways in which use of renewable sources of energy can be increased in regions with high touristic activity including how promotion of passive and active solar systems can be made in tourist facilities and installations.

6.3.5. Agriculture and Forestry Policy

In the agriculture and forestry sectors, the production of renewable energy sources represents a considerable potential for additional sources of income for the farmers and the reduction of CO2 emissions as a result of energy crop use. Furthermore, renewable energy sources represents additional employment possibilities in rural areas[31].

In spite of the fact that the instruments of the Common Agricultural Policy (CAP) primarily are directed towards food supply security, the production and development of renewable energy is currently supported by a range of measure. Processing and marketing of agricultural products are promoted under Council Regulation (EEC) No 866/90, in the form of co-funding investment projects with the Member States concerned. Although this scheme typically concerns Annex II products, the oilseeds/biodiesel chain has been included. Investments in heat production (for example biomass heating plants) are excluded from the scheme as "heat" is not classified under Annex II, and control problems could ensue. Investments in renewable energy projects may, furthermore, be made within the context of rural development policy (as described in the previous section) and a number of R&D activities in the agricultural sector are included and actively supported under the Community\s Framework Programme for RD&D, as described in section 6.3.3.

Moreover, the "non-food" set-aside scheme maintains the farmer's right to compensation if land which would otherwise be taken out of production is used to provide raw materials for "non-food" use, including energy. The scheme is limited by two factors. On the one hand, the obligatory rate of set-aside is a function of food cereals supply and demand implies that this rate is subject to change. On the other hand, by-products resulting from the cultivation of certain oilseeds on set-aside land are limited by the Blair House Agreement to one million tonnes of soya bean meal equivalents for the feed/food market annually. The harvest of 1995, based on an obligatory set-aside rate of 12%, resulted in some 950,000 tonnes of these by-products. There is, however, no strategy for raw material production for energy. As such we are faced with the dilemma that the quantity of raw material production associated with, for example, biofuels is dependent on the market situation in the food sector. If there were to be

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[31] *Estimates from the Hearing of the European Parliament of 6 May 1996 envisage a fifteen fold increase in job potential, under a fixed cost scenario, if electricity were to be produced from wood rather than oil or gas. This represents a potential of creating up to 160,000 new jobs in the EU even if biomass were to represent 5% of total energy production. Furthermore, the European Parliament's Committee on Agriculture and Rural Development recently, in the framework of the Commission's White Paper on Energy Policy, unanimously adopted an Opinion highlighting the role of renewables, and in particular biomass, in energy policy. The Committee takes the view that biomass could cover about 10 % of the energy requirements of the European Union by 2010 and about 20 % by 2025. It points out the positive characteristics and effects of an increased use of biomass, and notably the positive income effects for the agricultural sector and illustrates the way in which developments in this area can reduce the needs for subsidies in the agricultural sector.*

a tight supply situation in the food market, the set-aside area would be reduced with a consequent reduction of the quantities of raw materials for biofuels. The biofuels industry, however, requires long term raw material supply security in order to satisfy long term investments. This clearly highlights the limitations of the set-aside scheme as a basis for the supply of raw materials for bioenergy

Additional obstacles for the financial support of the sector include the limitations set by the GATT rules if support of agricultural or forestry raw materials were to result in prices below the world market level. Moreover, the level of premium per hectare required to make biofuels competitive with fossil fuels would burden the agricultural budget significantly. Under current economic, technical and policy circumstances (eg fossil fuel prices, detaxation, energy and environmental legislation) farmers' incomes would have to be supported some 30% over and above the level associated with the general oil seeds scheme to make "non-food" oilseeds for biofuels competitive with food/feed oilseeds. This would imply additional budget resources amounting to some billions ECU for EU as a whole.

Finally, at the Blair House Agreement limits increased production of biofuels from oilseeds grown on set-aside land, as an increase of the one million tonne by-product limit in terms of soya bean meal equivalents can not realistically be expected.

In spite of the specific obstacles there is scope for action aimed at promoting renewables in the agricultural sector. Such action will depend on the specific conditions of the various energy sectors. For liquid biofuels the basic questions relate to the possibility of introducing a policy for raw material supply independent of set-aside. Within the context of a minimum guaranteed area for energy crops, the question of compensating farmers for the loss of income resulting from growing such crops, as opposed to food crops, should be addressed. Furthermore, it should be considered how biofuels could be competitive with fossil fuels if the exemption of excise duties for biofuels were to remain blocked in the Council and whether or not a minimum incorporation of biofuels is required in certain specific markets.

For biomass, in particular, it could be considered if amendment of support programmes, for example Council Regulation (EEC) No 866/90 is required in order to allow the eligibility of heat production from biomass and if it is opportune to establish a specific support scheme for "non-food" raw materials independent of the set-aside scheme.

Leaving aside the question of taxation, agriculture clearly represents a key area for the advancement of renewable energy. Obviously international commitments such as the GATT Agreement in general, the Blair House constraint in particular and the Rio Convention have to be taken into account. The Commission will, on the basis of the Green Paper, consider how the importance of renewable energy in agricultural policy and rural development can be further reflected in agricultural policies. A key question, which must be addressed, is how the conflicting aims between the food and the "non-food" sectors (energy) can be better managed.

6.3.6. Actions in the field of external relations policy

The external dimension of renewables cannot be ignored. In a global perspective renewables play a much more prominent role as an energy source than in the Community, with more than 20% of the worlds energy needs currently being met by renewables. This, however, is due to a significant use of traditional firewood in many developing countries. It should, however, not distract the attention from the fact that there is a large potential for exploitation of other renewable sources in many parts of the world. In many cases the development of renewable sources of energy can improve quality of life to those millions of people which live in areas deprived of modern conveniences made possible by the availability of energy. By way of example, 120 million people in China presently live without electricity. The same is the case for 20 millions Russians.

External relations are becoming an increasingly important part of the European Union's brief. The Union is present in all corners of the world and is operating a number of large scale co-operation and assistance programmes in Central and Eastern Europe, the NIS, Africa, the Mediterranean Basin, Latin- and South America and Asia. The energy component of these programmes is important and although renewables is not in all cases the top may not be the only priority, development of indigenous and renewable sources can often foster economic and social prosperity and cohesion.

The Community's SYNERGY programme, covering energy cooperation with third countries has promotion of renewables among its priorities in certain regions. The programme has, by

way of example, provided support to the renewable energy centre in Elblang, Poland, aimed at promoting renewable energy sources in the entire Baltic region. The Commission has also participated in the so-called World Solar Summit Process initiated in 1993 under the auspices of UNESCO. This process culminated in a solar summit in Harare on 16-17 September 1996. The summit adopted a political declaration and launched a world solar programme for the period 1996-2005 where strategic projects of general interest, notably education and training, and other high priority projects should be implemented.

The energy sector is of major importance for the overall economic development of the Central and Eastern European countries as well as the New Independent States and Mongolia. This is reflected by the share of the energy sector in the PHARE and TACIS programmes assisting these countries in their reform process. Promotion of renewable energy has not been prominent till now, given that the partner countries have not given renewable energies priority in view of the available supplies of fossil fuels, and the difficulties encountered in the restructuring of the energy sector as a whole.

In pursuit of the Europe agreements and the partnership and Cooperation Agreements which expresses the importance of sustainable development and its integration into policies for e.g. energy, the Commission will stress the importance of renewable energies in its contacts with the partner countries. Some small projects for renewable energies already have been

supported, and it has been proposed to support a major renewable energy project in the framework of the PHARE Multicountry programme for 1997. Certain countries, including the Baltic States, Bulgaria and FYROM, have also introduced specific demands for assistance in the framework of their national programmes.

In view of the fact that certain regions of Central and Eastern Europe are well endowed with renewable sources, and in view of the fact that renewables especially in rural areas can strengthen the regional development, the Commission recognises the need that renewable sources of energy require increased attention.

As a consequence of the increasing political priorities for establishing a framework for improved cooperation between the EU and the non-EU mediterranean countries, including cooperation in the field of energy, there is also a case for examining in more detail the contributions that renewables could make to the energy needs of this region. Generally renewable sources are plenty and the potential, in particular for solar and wind energy is currently not exploited to its maximum. In the framework of the continuing Euro-Mediterranean energy cooperation the appropriate cooperation and assistance instruments, such as the MEDA programme and the Euro-Mediterranean Forum must, as a matter of priority, address the scope for further cooperation on renewables in the Mediterranean region.

In developing countries in particular renewables can play a key role in accelerating economic and sustainable growth. Renewable energy technologies are particularly well suited in remote areas of developing countries which are often not connected to the grid. Furthermore, the meteorological conditions in many developing countries favour renewable sources of energy, in particular solar energy applications.

Increased energy consumption in the developing countries will be a major factor accounting for the deterioration of the global atmospheric conditions. Although at present high income countries are still the major energy users, by the middle of the next century the developing countries, as defined today, will account for the largest share of the world's commercial energy use. In many developing countries it will be difficult to meet environmental objectives by retrofitting pollution controlled technologies onto energy technologies originally designed without consideration for environmental problems. The use of renewable energy technologies can be helpful in such circumstances because they offer a high degree of inherent cleanliness, without the need for ancillary pollution control equipment.

It must therefore be ensured that sufficient emphasis is given to renewables in the implementation of the Community's programmes in this area. Use can be made of all the various existing cooperation instruments, including in particular the instruments of financial and technical assistance, instruments of economic cooperation, including investment, promotion and cooperation between European and local firms, and instruments of scientific and technological cooperation.

Furthermore the demand for renewable energy technologies will primarily increase in developing countries markets. In particular electricity markets are expected to become fiercely competitive "buyers markets", where the risk of becoming marginalised will be great for many industrialised country vendors, if appropriate technologies are not developed and marketed competitively. Renewables represent a vast potential for economic cooperation of mutual interest to the EU and to third countries. The EU can gain direct and indirect commercial benefits and the third countries can benefit from accelerated sustainable development. The Climate Change Convention provides for joint implementation of measures between contracting parties for the attainment of emission targets. A better use of this facility could contribute to increased transfer of renewable technologies to developing countries and thus provide new export opportunities for the EU industry.

A clearly defined and ambitious renewable energy strategy will therefore also in this respect be indispensable and allow the EU industry to compete successfully in the global market place.

Given the important role that renewable energy sources can play in the external policies of the Community, the Commission will, on the basis of the debate on this Green Paper, further reflect on ways in which the Community can ensure that the potential for developing renewable energy in third countries is sufficiently well emphasised within the existing and future Community cooperation instruments.

6.4. Assessment and Monitoring

The Community's statistical authorities (Eurostat) has established a system for regular collection of statistics in the EU on which the quantitative objective contained in the ALTENER programme can be evaluated. This system is based on a methodology for the collection of data and its incorporation into the energy balances. These essential activities must be continued with a view to monitoring the progress towards the objectives of a Community strategy.

The statistical information related to some forms of renewable energy is based on estimates while others can be measured to the last kilowatt-hour. Residential solar and ambient energies are examples of renewable energy where statistics currently have to be on estimates. However, as the statistics is produced consistently, quantitative monitoring is possible. The quality of statistics can, nevertheless, be improved with field studies and surveys.

There is, furthermore, a case for improving the coordination and data collection as regards the actions on renewables undertaken within the various programmes of the Community. One proposal is that the Commission explores the possibility of creating a database which can register all Community support given to renewables. The database could also, on the basis of a notification system to be put in place, register the actions undertaken at national level in addition to the notifications made to the Commission under the state aid rules. In this way policies affecting renewables and progress towards increasing the share of renewables could

be monitored reliably and effectively.

7. **Next steps.**

This Green Paper is the first step in the establishment of a strategy for renewable sources of energy. It is intended to open up a debate on what are the most urgent and most important measures that could be undertaken at Community and Member State level and on the nature of these specific actions. The Commission therefore invites all interested parties to contribute to the process by forwarding their reactions to this Green Paper and the questions raised in it to the Commission by the end of March 1997. On the basis of this and the consultations with Member States, other Community Institutions and interested parties, the Commission intends to publish a White Paper on a Community Strategy for Renewable Sources of Energy accompanied by an action plan by mid-1997.

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Annex 1

Main indicators in Renewable Energy in the European Union

	EUR 12 1991	EUR 12 1994	EUR 15 1991	EUR 15 1994
Share of RES in Total Inland Consumption (%)	3.7	3.9	5.2*	5.4
Capacity All Hydro (MWe)	57303	57932	87303	88331
Capacity Wind (MWe)	645.5	1626.7	652.5	1671.7
Capacity PV (kWp)	8726	29143	n.a.	n.a.
Capacity Geoth. Elect (MWe)	530	509	n.a.	n.a.
Elect. Production All RES (GWh)	174364	205613	290513	324232
of which (%):				
Hydro	92.8	91.5	91.7	91.1
Wind	0.6	1.6	0.4	1.1
PV	0.0	0.0	n.a.	n.a.
Geothermal	1.8	1.6	n.a.	n.a.
Biomass	4.8	5.3	6.8	6.8
Biofuels Production (ktoe)	n.a.	257.6	n.a.	n.a.

Source Eurostat
* 1992

RENEWABLE ENERGY PRODUCTION IN AUSTRIA

	Year	Renewable Energy Source	Collectors surface (1000m²)	PVC capacity (kWp)	Electrical installed capacity (MWe)	Thermal installed capacity (MWth)	Fuel consumption (tonnes)	Fuel consumption /Heat input (TJ)	Autoconsumption (TJ)	RES electricity generation (GWh)	RES primary energy production (TJ)	RES primary energy production (ktoe)	RES heat production (TJ)	RES heat production (ktoe)	RES heat for domestic use (TJ)	Total primary production (ktoe)	Total inland consumption (ktoe)	Total electricity generation (GWh)
A	1994	Hydro all			11274.0					35706	128542	3070.0		0.0				
A	1994	Hydro -1 MW										0.0		0.0				
A	1994	Hydro 1-10 MW										0.0		0.0				
A	1994	Hydro 10+ MW										0.0		0.0				
A	1994	Wind									0	0.0		0.0				
A	1994	Solar pannels									0	0.0		0.0				
A	1994	Photovoltaics									0	0.0		0.0				
A	1994	Geoth.electr									0	0.0		0.0				
A	1994	Geoth.heat									0	0.0		0.0				
A	1994	MSW									0	0.0		0.0				
A	1994	Wood in h/holds									0	0.0	0.0	0.0				
A	1994	District heating									0	0.0	0.0	0.0				
A	1994	Wood in industry									0	0.0	0.0	0.0				
A	1994	Power stations									0	0.0		0.0				
A	1994	Biofuels									0	0.0		0.0				
A	1994	Landfill gas									0	0.0		0.0				
A	1994	Sewage sludge									0	0.0		0.0				
A	1994	Farm slurries									0	0.0		0.0				
A	1994	A-F industry									0	0.0		0.0				
A	1994	Total biomass								2871.0	130154	3108.5	0.0	0.0				
A	1994	Total primary energy									258696	6179		0.0		8810	26062	
A	1994	Total electricity gener.								38577.0				0.0				54845
A	1994	Total heat production											0.0	0.0				

* Figures for specific energy sources are not available

(Source: Eurostat)

RENEWABLE ENERGY PRODUCTION IN BELGIUM

	Year	Renewable Energy Source	Collectors surface (1000m²)	PVC capacity (kWp)	Electrical installed capacity (MWe)	Thermal installed capacity (MWth)	Fuel consumption (tonnes)	Fuel consumption /Heat input (TJ)	Autoconsumption (TJ)	RES electricity generation (GWh)	RES primary energy production (TJ)	RES primary energy production (ktoe)	RES heat production (TJ)	RES heat production (ktoe)	RES heat for domestic use (TJ)	Total primary production (ktoe)	Total inland consumption (ktoe)	Total electricity generation (GWh)
B	1994	Hydro all			112.7					343.1	1235	29.5		0.0				
B	1994	Hydro -1 MW			4.7					11.8	42	1.0		0.0				
B	1994	Hydro 1-10 MW			45.0					143.5	517	12.3		0.0				
B	1994	Hydro 10+ MW			63.0					187.8	676	16.1		0.0				
B	1994	Wind			5.2					8.6	31	0.7		0.0				
B	1994	Solar pannels	36.4								37	0.9	36.6	0.9				
B	1994	Photovoltaics		48						0.1	0	0.0		0.0				
B	1994	Geoth.electr			0.0			0.0		0.0	0	0.0		0.0				
B	1994	Geoth.heat				8.3					53	1.3	53.3	1.3				
B	1994	MSW					1608200	5307.1		455.0	5307	126.8	181.4	4.3				
B	1994	Wood in h/holds						7384.0			7384	176.4	7384.0	176.4	7384.0			
B	1994	District heating						0.0			0	0.0	0.0	0.0				
B	1994	Wood in industry						0.0			0	0.0	0.0	0.0				
B	1994	Power stations						2461.3		58.8	2461	58.8	2171.1	51.9				
B	1994	Biofuels					7865	296.5			297	7.1		0.0				
B	1994	Landfill gas						24.0		2.0	24	0.6	0.0	0.0				
B	1994	Sewage sludge						92.5	40.0	1.8	93	2.2	77.7	1.9				
B	1994	Farm slurries						0.0	0.0		0	0.0		0.0				
B	1994	A-F industry						311.9	37.2	0.0	312	7.4	274.7	6.6				
B	1994	Total biomass						15580.8		517.6	15581	372.1	10088.9	241.0				
B	1994	Total primary energy									17234	411.6		0.0		10885	50294	
B	1994	Total electricity gener.								869.4				0.0				72236
B	1994	Total heat production											10178.8	243.1				

(Source: Eurostat)

RENEWABLE ENERGY PRODUCTION IN DENMARK

	Year	Renewable Energy Source	Collectors surface (1000m²)	PVC capacity (kWp)	Electrical installed capacity (MWe)	Thermal installed capacity (MWth)	Fuel consumption (tonnes)	Fuel consumption /Heat input (TJ)	Autoconsumption (TJ)	RES electricity generation (GWh)	RES primary energy production (TJ)	RES primary energy production (ktoe)	RES heat production (TJ)	RES heat production (ktoe)	RES heat for domestic use (TJ)	Total primary production (ktoe)	Total inland consumption (ktoe)	Total electricity generation (GWh)
Dk	1994	Hydro all			8.3					32.6	117	2.8		0.0				
Dk	1994	Hydro -1 MW			4.4					16.8	60	1.4		0.0				
Dk	1994	Hydro 1-10 MW			3.9					15.8	57	1.4		0.0				
Dk	1994	Hydro 10+ MW			0.0					0.0	0	0.0		0.0				
Dk	1994	Wind			532.0					1137.0	4093	97.8		0.0				
Dk	1994	Solar pannels	124.0								185	4.4	185.0	4.4	100.0			
Dk	1994	Photovoltaics		0						0.0	0	0.0		0.0				
Dk	1994	Geoth.electr			0.0					0.0	0	0.0		0.0				
Dk	1994	Geoth.heat				7.0					45	1.1	45.0	1.1				
Dk	1994	MSW			72.0	693.0		19060.0		525.0	19060	455.2	13687.0	326.9				
Dk	1994	Wood in h/holds						15414.0			15414	368.1	15414.0	368.1	15414.0			
Dk	1994	District heating						8032.0			8032	191.8	7079.0	169.1				
Dk	1994	Wood in industry						4247.0			4247	101.4	4247.0	101.4				
Dk	1994	Power stations						2179.0		189.0	2179	52.0	1088.0	26.0				
Dk	1994	Biofuels						0.0			0	0.0		0.0				
Dk	1994	Landfill gas			3.5			163.0	62.0	13.0	101	2.4	56.0	1.3				
Dk	1994	Sewage sludge			6.9			641.0	184.0	38.0	641	15.3	322.0	7.7				
Dk	1994	Farm slurries			8.8			557.0	109.0	27.0	557	13.3	357.0	8.5				
Dk	1994	A-F Industry			0.0			30.0	2.0	0.0	30	0.7	28.0	0.7				
Dk	1994	Total biomass						50323.0		792.0	50261	1200.4	42278.0	1009.7				
Dk	1994	Total primary energy									54702	1306.5		0.0		14832	20136	
Dk	1994	Total electricity gener.								1934.6				0.0				40096
Dk	1994	Total heat production											42508.0	1015.2				

(Source: Eurostat)

RENEWABLE ENERGY PRODUCTION IN GERMANY

	Year	Renewable Energy Source	Collectors surface (1000m²)	PVC capacity (kWp)	Electrical installed capacity (MWe)	Thermal installed capacity (MWth)	Fuel consumption (tonnes)	Fuel consumption /Heat input (TJ)	Autoconsumption (TJ)	RES electricity generation (GWh)	RES primary energy production (TJ)	RES primary energy production (ktoe)	RES heat production (TJ)	RES heat production (ktoe)	RES heat for domestic use (TJ)	Total primary production (ktoe)	Total inland consumption (ktoe)	Total electricity generation (GWh)
D	1994	Hydro all			4310.0					19599.3	70557	1685.2		0.0				
D	1994	Hydro -1 MW			417.0					1611.6	5802	138.6		0.0				
D	1994	Hydro 1-10 MW			934.0					5335.9	19209	458.8		0.0				
D	1994	Hydro 10+ MW			2959.0					12651.8	45546	1087.8		0.0				
D	1994	Wind			643.0					1428.0	5141	122.8		0.0				
D	1994	Solar pannels	1146.4								1510	36.1	1510.0	36.1	1007.0			
D	1994	Photovoltaics		10446						4.3	15	0.4		0.0				
D	1994	Geoth.electr			0.0					0.0	0	0.0		0.0				
D	1994	Geoth.heat				20.0					360	8.6	360.0	8.6				
D	1994	MSW			499.0	1400.0		43393.0		2611.7	44816	1065.6	17056.0	407.4				
D	1994	Wood in h/holds						91612.0			91612	2188.0	91612.0	2188.0	91612.0			
D	1994	District heating									0	0.0	0.0	0.0				
D	1994	Wood in industry						10658.0			10658	254.5	10658.0	254.5				
D	1994	Power stations			79.0			22335.0		414.8	22335	533.4	6040.0	144.3				
D	1994	Biofuels					28000	1120.0			1120	26.7		0.0				
D	1994	Landfill gas								523.9	0	0.0	56.0	1.3				
D	1994	Sewage sludge			6.9			13669.0		45.3	13669	326.5	3149.0	75.2				
D	1994	Farm slurries						95.0		6.1	95	2.3		0.0				
D	1994	A-F industry						172.3		13.4	172	4.1	42.6	1.0				
D	1994	Total biomass						181934.3		3615.2	183157	4374.4	128613.6	3071.7				
D	1994	Total primary energy									261861	6254.1		0.0		141094	333991	
D	1994	Total electricity gener.								24640.7				0.0				528229
D	1994	Total heat production											130483.6	3116.4				

(Source: Eurostat)

RENEWABLE ENERGY PRODUCTION IN GREECE

	Year	Renewable Energy Source	Collectors surface (1000m²)	PVC capacity (kWp)	Electrical installed capacity (MWe)	Thermal installed capacity (MWth)	Fuel consumption (tonnes)	Fuel consumption /Heat input (TJ)	Autoconsumption (TJ)	RES electricity generation (GWh)	RES primary energy production (TJ)	RES primary energy production (ktoe)	RES heat production (TJ)	RES heat production (ktoe)	RES heat for domestic use (TJ)	Total primary production (ktoe)	Total inland consumption (ktoe)	Total electricity generation (GWh)
Gr	1994	Hydro all			2525.7					2605.3	9378	224.0		0.0				
Gr	1994	Hydro -1 MW			2.7					7.5	27	0.6		0.0				
Gr	1994	Hydro 1-10 MW			39.0					96.6	348	8.3		0.0				
Gr	1994	Hydro 10+ MW			2484.0					2501.2	9004	215.1		0.0				
Gr	1994	Wind			26.9					37.4	135	3.2		0.0				
Gr	1994	Solar pannels	1900.0								4104	98.0	4104.0	98.0	4104.0			
Gr	1994	Photovoltaics		235						0.2	1	0.0		0.0				
Gr	1994	Geoth.electr			2.0					0.0	0	0.0		0.0				
Gr	1994	Geoth.heat				27.2					173	4.1	173.4	4.1				
Gr	1994	MSW			0.0			0.0		0.0	0	0.0	0.0	0.0				
Gr	1994	Wood in h/holds						53510.0			53510	1278.0	53510.0	1278.0	53510.0			
Gr	1994	District heating				1.4		0.0			0	0.0	0.0	0.0				
Gr	1994	Wood in industry					293418	4912.0			4912	117.3	4912.0	117.3				
Gr	1994	Power stations			0.5	2.1	4500	68.0		1.4	68	1.6	31.7	0.8				
Gr	1994	Biofuels					0	0.0			0	0.0		0.0				
Gr	1994	Landfill gas								0.0	0	0.0	0.0	0.0				
Gr	1994	Sewage sludge						0.0		0.0	0	0.0	0.0	0.0				
Gr	1994	Farm slurries						1.4		0.0	1	0.0	1.4	0.0				
Gr	1994	A-F industry						30.1		0.0	30	0.7	0.0	0.0				
Gr	1994	Total biomass						58521.5		1.4	58522	1397.7	58455.1	1396.1				
Gr	1994	Total primary energy									72313	1727.1		0.0		9669	24129	
Gr	1994	Total electricity gener.								2644.3				0.0				40623
Gr	1994	Total heat production											62732.5	1498.3				

(Source: Eurostat)

RENEWABLE ENERGY PRODUCTION IN SPAIN

	Year	Renewable Energy Source	Collectors surface (1000m²)	PVC capacity (kWp)	Electrical installed capacity (MWe)	Thermal installed capacity (MWth)	Fuel consumption (tonnes)	Fuel consumption /Heat input (TJ)	Autoconsumption (TJ)	RES electricity generation (GWh)	RES primary energy production (TJ)	RES primary energy production (ktoe)	RES heat production (TJ)	RES heat production (ktoe)	RES heat for domestic use (TJ)	Total primary production (ktoe)	Total inland consumption (ktoe)	Total electricity generation (GWh)
E	1994	Hydro all			12636.0					24351.1	87664	2093.7		0.0				
E	1994	Hydro -1 MW			191.0					649.4	2338	55.8		0.0				
E	1994	Hydro 1-10 MW			1051.0					2745.5	9884	236.1		0.0				
E	1994	Hydro 10+ MW			11394.0					20956.2	75442	1801.8		0.0				
E	1994	Wind			74.9					175.2	631	15.1		0.0				
E	1994	Solar pannels	309.3								1005	24.0	1005.0	24.0				
E	1994	Photovoltaics		1204						2.0	7	0.2		0.0				
E	1994	Geoth.electr			0.0					0.0	0	0.0		0.0				
E	1994	Geoth.heat									273	6.5		0.0				
E	1994	MSW			40.3		652800	4849.0		230.0	4849	115.8	160.2	3.8				
E	1994	Wood in h/holds					7008060	88024.0			88024	2102.3	88024.0	2102.3	88024.0			
E	1994	District heating						0.0			0	0.0	0.0	0.0				
E	1994	Wood in industry					3351787	42100.0			42100	1005.5	42100.0	1005.5				
E	1994	Power stations			182.6		2101980	26379.2		489.8	26379	630.0		0.0				
E	1994	Biofuels						0.0			0	0.0		0.0				
E	1994	Landfill gas						389.6		34.3	390	9.3	0.0	0.0				
E	1994	Sewage sludge						0.0		0.0	0	0.0	0.0	0.0				
E	1994	Farm slurries						34.3		0.0	34	0.8	34.3	0.8				
E	1994	A-F industry						518.1		0.0	518	12.4	518.1	12.4				
E	1994	Total biomass						162294.2		754.1	162294	3876.1	130836.6	3124.8				
E	1994	Total primary energy									251874	6015.6		0.0		32234	97400	
E	1994	Total electricity gener.								25282.4				0.0				161600
E	1994	Total heat production											131841.6	3148.8				

(Source: Eurostat)

RENEWABLE ENERGY PRODUCTION IN FRANCE

	Year	Renewable Energy Source	Collectors surface (1000m²)	PVC capacity (kWp)	Electrical installed capacity (MWe)	Thermal installed capacity (MWth)	Fuel consumption (tonnes)	Fuel consumption /Heat input (TJ)	Autoconsumption (TJ)	RES electricity generation (GWh)	RES primary energy production (TJ)	RES primary energy production (ktoe)	RES heat production (TJ)	RES heat production (ktoe)	RES heat for domestic use (TJ)	Total primary production (ktoe)	Total inland consumption (ktoe)	Total electricity generation (GWh)
F	1994	Hydro all			20773.0					79036.0	284530	6795.5		0.0				
F	1994	Hydro -1 MW			433.0					1872.0	6739	161.0		0.0				
F	1994	Hydro 1-10 MW			1510.0					6457.0	23245	555.2		0.0				
F	1994	Hydro 10+ MW			18830.0					70707.0	254545	6079.4		0.0				
F	1994	Wind			3.4					9.0	32	0.8		0.0				
F	1994	Solar pannels	374.0								587	14.0	587.0	14.0	487.0			
F	1994	Photovoltaics		42						0.0	0	0.0		0.0				
F	1994	Geoth.electr			4.7			0.0		0.0	0	0.0		0.0				
F	1994	Geoth.heat									5070	121.1	4500.0	107.5				
F	1994	MSW			185.0			33670.0		551.0	33670	804.2	19573.0	467.5				
F	1994	Wood in h/holds					27825	299411.0			299411	7151.0	299411.0	7151.0	299411.0			
F	1994	District heating						378.0			378	9.0	321.3	7.7				
F	1994	Wood in industry						59500.0			59500	1421.1	59500.0	1421.1				
F	1994	Power stations			216.0			4952.0		692.0	4952	118.3	1560.0	37.3				
F	1994	Biofuels					102607	4104.3			4104	98.0		0.0				
F	1994	Landfill gas						888.0		119.0	888	21.2	400.0	9.6				
F	1994	Sewage sludge						412.0		22.0	412	9.8	0.0	0.0				
F	1994	Farm slurries						0.0		0.0	0	0.0	0.0	0.0				
F	1994	A-F industry						0.0		0.0	0	0.0	0.0	0.0				
F	1994	Total biomass						399211.0		1384.0	399211	9534.5	380765.3	9094.0				
F	1994	Total primary energy									693534	16564.0		0.0		120880	228535	
F	1994	Total electricity gener.								80429.0				0.0				476337
F	1994	Total heat production											385852.3	9215.5				

(Source: Eurostat)

RENEWABLE ENERGY PRODUCTION IN IRELAND

	Year	Renewable Energy Source	Collectors surface (1000m²)	PVC capacity (kWp)	Electrical installed capacity (MWe)	Thermal installed capacity (MWth)	Fuel consumption (tonnes)	Fuel consumption /Heat input (TJ)	Autoconsumption (TJ)	RES electricity generation (GWh)	RES primary energy production (TJ)	RES primary energy production (ktoe)	RES heat production (TJ)	RES heat production (ktoe)	RES heat for domestic use (TJ)	Total primary production (ktoe)	Total inland consumption (ktoe)	Total electricity generation (GWh)
Irl	1994	Hydro all			230.0					851.0	3064	73.2		0.0				
Irl	1994	Hydro -1 MW			5.6					22.0	79	1.9		0.0				
Irl	1994	Hydro 1-10 MW			23.0					65.0	234	5.6		0.0				
Irl	1994	Hydro 10+ MW			200.0					742.0	2671	63.8		0.0				
Irl	1994	Wind			6.5					18.0	65	1.5		0.0				
Irl	1994	Solar panneis	2.5								4	0.1	4.2	0.1	4.2			
Irl	1994	Photovoltaics		56						0.0	0	0.0		0.0				
Irl	1994	Geoth.electr			0.0			0.0		0.0	0	0.0		0.0				
Irl	1994	Geoth.heat				0.3					2	0.1	2.1	0.1				
Irl	1994	MSW			0.0			0.0		0.0	0	0.0	0.0	0.0				
Irl	1994	Wood in h/holds					102	1735.0			1735	41.4	1735.0	41.4	1735.0			
Irl	1994	District heating						0.0			0	0.0	0.0	0.0				
Irl	1994	Wood in industry						4963.0			4963	118.5	4963.0	118.5				
Irl	1994	Power stations			0.0			0.0		0.0	0	0.0		0.0				
Irl	1994	Biofuels						0.0			0	0.0		0.0				
Irl	1994	Landfill gas						0.0		0.0	0	0.0	0.0	0.0				
Irl	1994	Sewage sludge						0.0		0.0	0	0.0	0.0	0.0				
Irl	1994	Farm slurries						0.0		0.0	0	0.0	0.0	0.0				
Irl	1994	A-F Industry						103.7	23.0	0.0	104	2.5	80.6	1.9				
Irl	1994	Total biomass						6801.7		0.0	6802	162.4	6778.6	161.9				
Irl	1994	Total primary energy									9936	237.3		0.0		3628	10968	
Irl	1994	Total electricity gener.								869.0				0.0				17105
Irl	1994	Total heat production											6784.9	162.0				

(Source: Eurostat)

RENEWABLE ENERGY PRODUCTION IN ITALY

	Year	Renewable Energy Source	Collectors surface (1000m²)	PVC capacity (kWp)	Electrical installed capacity (MWe)	Thermal installed capacity (MWth)	Fuel consumption (tonnes)	Fuel consumption /Heat input (TJ)	Autoconsumption (TJ)	RES electricity generation (GWh)	RES primary energy production (TJ)	RES primary energy production (ktoe)	RES heat production (TJ)	RES heat production (ktoe)	RES heat for domestic use (TJ)	Total primary production (ktoe)	Total inland consumption (ktoe)	Total electricity generation (GWh)
It	1994	Hydro all			12884.0					44665.0	160794	3840.3		0.0				
It	1994	Hydro -1 MW			371.0					1633.0	5879	140.4		0.0				
It	1994	Hydro 1-10 MW			1585.0					7184.0	25862	617.7		0.0				
It	1994	Hydro 10+ MW			10908.0					35847.0	129049	3082.1		0.0				
It	1994	Wind			21.0					6.3	23	0.5		0.0				
It	1994	Solar pannels	180.0								300	7.2	300	7.2	200.0			
It	1994	Photovoltaics		14690						11.1	40	1.0		0.0				
It	1994	Geoth.electr			496.0			87866.0		3417.0	87866	2098.5		0.0				
It	1994	Geoth.heat				682.0					8916	212.9	8916.0	212.9				
It	1994	MSW			74.0			11100.0		189.0	11100	265.1	1540.0	36.8				
It	1994	Wood in h/holds						94300.0			94300	2252.2	94300.0	2252.2	94300.0			
It	1994	District heating						0.0			0	0.0	0.0	0.0				
It	1994	Wood in industry						39600.0			39600	945.8	39600.0	945.8				
It	1994	Power stations			104.0	9.0		2840.0		60.4	2840	67.8	1227.0	29.3				
It	1994	Biofuels					0	5265.0			5265	125.7		0.0				
It	1994	Landfill gas			7.2			293.0		24.3	293	7.0	0.0	0.0				
It	1994	Sewage sludge			1.2			30.0	0.0	2.4	30	0.7	0.0	0.0				
It	1994	Farm slurries						75.0		6.3	75	1.8	0.0	0.0				
It	1994	A-F Industry						30.0		2.5	30	0.7	0.0	0.0				
It	1994	Total biomass						153533.0		284.9	153533	3666.9	136667.0	3264.1				
It	1994	Total primary energy									411472	9827.4		0.0		31240	154104	
It	1994	Total electricity gener.								48378.0				0.0				231498
It	1994	Total heat production											145883.0	3484.2				

(Source: Eurostat)

RENEWABLE ENERGY PRODUCTION IN LUXEMBOURG

	Year	Renewable Energy Source	Collectors surface (1000m²)	PVC capacity (kWp)	Electrical installed capacity (MWe)	Thermal installed capacity (MWth)	Fuel consumption (tonnes)	Fuel consumption /Heat input (TJ)	Autoconsumption (TJ)	RES electricity generation (GWh)	RES primary energy production (TJ)	RES primary energy production (ktoe)	RES heat production (TJ)	RES heat production (ktoe)	RES heat for domestic use (TJ)	Total primary production (ktoe)	Total inland consumption (ktoe)	Total electricity generation (GWh)
L	1994	Hydro all			27.4					86.1	310	7.4		0.0				
L	1994	Hydro -1 MW			0.6					3.1	11	0.3		0.0				
L	1994	Hydro 1-10 MW			26.8					83.0	299	7.1		0.0				
L	1994	Hydro 10+ MW			0.0					0.0	0	0.0		0.0				
L	1994	Wind			0.0					0.0	0	0.0		0.0				
L	1994	Solar pannels	0.3								0	0.0	0.4	0.0	0.4			
L	1994	Photovoltaics		7						0.0	0	0.0		0.0				
L	1994	Geoth.electr			0.0			0.0		0.0	0	0.0		0.0				
L	1994	Geoth.heat				0.0					0	0.0	0.0	0.0				
L	1994	MSW			9.5		131676	1017.0		50.2	1017	24.3	0.0	0.0				
L	1994	Wood in h/holds					64884	644.6			645	15.4	644.6	15.4	644.6			
L	1994	District heating						0.0			0	0.0	0.0	0.0				
L	1994	Wood in industry						0.0			0	0.0	0.0	0.0				
L	1994	Power stations			0.0	0.0		0.0		0.0	0	0.0	0.0	0.0				
L	1994	Biofuels						0.0			0	0.0		0.0				
L	1994	Landfill gas			0.0			0.0		0.0	0	0.0	0.0	0.0				
L	1994	Sewage sludge						34.3	16.5	0.0	34	0.8	1.4	0.0				
L	1994	Farm slurries						0.0		0.0	0	0.0	0.0	0.0				
L	1994	A-F industry						0.0		0.0	0	0.0	0.0	0.0				
L	1994	Total biomass						1695.9		50.2	1696	40.5	646.0	15.4				
L	1994	Total primary energy									2006	47.9		0.0		51	3755	
L	1994	Total electricity gener.								136.3				0.0				1190
L	1994	Total heat production											648.4	15.4				

(Source: Eurostat)

RENEWABLE ENERGY PRODUCTION IN THE NETHERLANDS

	Year	Renewable Energy Source	Collectors surface (1000m²)	PVC capacity (kWp)	Electrical installed capacity (MWe)	Thermal installed capacity (MWth)	Fuel consumption (tonnes)	Fuel consumption /Heat input (TJ)	Autoconsumption (TJ)	RES electricity generation (GWh)	RES primary energy production (TJ)	RES primary energy production (ktoe)	RES heat production (TJ)	RES heat production (ktoe)	RES heat for domestic use (TJ)	Total primary production (ktoe)	Total inland consumption (ktoe)	Total electricity generation (GWh)
NL	1994	Hydro all			37.0					100.0	360	8.6		0.0				
NL	1994	Hydro -1 MW			0.2					1.0	4	0.1		0.0				
NL	1994	Hydro 1-10 MW			36.8					99.0	356	8.5		0.0				
NL	1994	Hydro 10+ MW			0.0					0.0	0	0.0		0.0				
NL	1994	Wind			157.0					238.0	857	20.5		0.0				
NL	1994	Solar pannels	142.1								118	2.8	118.0	2.8	51.0			
NL	1994	Photovoltaics		1999						2.3	8	0.2		0.0				
NL	1994	Geoth.electr			0.0			0.0		0.0	0	0.0		0.0				
NL	1994	Geoth.heat				0.0					0	0.0	0.0	0.0				
NL	1994	MSW			189.0		2580000	19786.0		1208.0	19786	472.6	1288.0	30.8				
NL	1994	Wood in h/holds						13400.0			13400	320.0	13400.0	320.0	13400.0			
NL	1994	District heating						0.0			0	0.0	0.0	0.0				
NL	1994	Wood in industry						1400.0			1400	33.4	1400.0	33.4				
NL	1994	Power stations			0.0	0.0		0.0		0.0	0	0.0		0.0				
NL	1994	Biofuels						0.0			0	0.0		0.0				
NL	1994	Landfill gas						2036.0	629.0	120.0	2036	48.6	143.0	3.4				
NL	1994	Sewage sludge						1908.0	511.0	104.0	1908	45.6	809.0	19.3				
NL	1994	Farm slurries						0.0		0.0	0	0.0	0.0	0.0				
NL	1994	A-F industry						544.0	509.0	1.5	544	13.0	29.0	0.7				
NL	1994	Total biomass						39074.0		1433.5	39074	933.2	17069.0	407.7				
NL	1994	Total primary energy									40417	965.3		0.0		66262	70741	
NL	1994	Total electricity gener.								1773.8				0.0				79677
NL	1994	Total heat production											17187.0	410.5				

(Source: Eurostat)

RENEWABLE ENERGY PRODUCTION IN PORTUGAL

	Year	Renewable Energy Source	Collectors surface (1000m²)	PVC capacity (kWp)	Electrical installed capacity (MWe)	Thermal installed capacity (MWth)	Fuel consumption (tonnes)	Fuel consumption /Heat input (TJ)	Autoconsumption (TJ)	RES electricity generation (GWh)	RES primary energy production (TJ)	RES primary energy production (ktoe)	RES heat production (TJ)	RES heat production (ktoe)	RES heat for domestic use (TJ)	Total primary production (ktoe)	Total inland consumption (ktoe)	Total electricity generation (GWh)
P	1994	Hydro all			3982.0					10704.7	38537	920.4		0.0				
P	1994	Hydro -1 MW			29.3					52.7	190	4.5		0.0				
P	1994	Hydro 1-10 MW			205.6					528.1	1901	45.4		0.0				
P	1994	Hydro 10+ MW			3747.5					10124.9	36450	870.5		0.0				
P	1994	Wind			8.3					17.0	61	1.5		0.0				
P	1994	Solar pannels	194.0								607	14.5	607.0	14.5	406.7			
P	1994	Photovoltaics		120						0.5	2	0.0		0.0				
P	1994	Geoth.electr			5.8			185.0		33.4	185	4.4		0.0				
P	1994	Geoth.heat				0.0					42	1.0	42.0	1.0				
P	1994	MSW			0.0			0.0		0.0	0	0.0	0.0	0.0				
P	1994	Wood in h/holds						61340.0			61340	1465.0	61340.0	1465.0	61340.0			
P	1994	District heating						0.0			0	0.0	0.0	0.0				
P	1994	Wood in industry						24829.0			24829	593.0	3359.0	80.2				
P	1994	Power stations						7063.0		933.0	7063	168.7	0.0	0.0				
P	1994	Biofuels					0	0.0			0	0.0		0.0				
P	1994	Landfill gas						0.0	0.0	0.0	0	0.0	0.0	0.0				
P	1994	Sewage sludge						0.0		0.0	0	0.0	0.0	0.0				
P	1994	Farm slurries						0.0		0.0	0	0.0	0.0	0.0				
P	1994	A-F industry						113.0		1.3	113	2.7	92.0	2.2				
P	1994	Total biomass						93345.0		933.0	93345	2229.4	64791.0	1547.4				
P	1994	Total primary energy									132778	3171.2		0.0		3259	19024	
P	1994	Total electricity gener.								11689.9				0.0				31380
P	1994	Total heat production											65440.0	1562.9				

(Source: Eurostat)

RENEWABLE ENERGY PRODUCTION IN FINLAND

	Year	Renewable Energy Source	Collectors surface (1000m²)	PVC capacity (kWp)	Electrical installed capacity (MWe)	Thermal installed capacity (MWth)	Fuel consumption (tonnes)	Fuel consumption /Heat input (TJ)	Autoconsumption (TJ)	RES electricity generation (GWh)	RES primary energy production (TJ)	RES primary energy production (ktoe)	RES heat production (TJ)	RES heat production (ktoe)	RES heat for domestic use (TJ)	Total primary production (ktoe)	Total inland consumption (ktoe)	Total electricity generation (GWh)
FIN	1994	Hydro all			2736.0					11837	42613	1017.8		0.0				
FIN	1994	Hydro -1 MW			27.0					102.0	367	8.8		0.0				
FIN	1994	Hydro 1-10 MW			278.0					1061.0	3820	91.2		0.0				
FIN	1994	Hydro 10+ MW			2431.0					10674.0	38426	917.8		0.0				
FIN	1994	Wind			5.0					7.0	25	0.6		0.0				
FIN	1994	Solar pannels									0	0.0		0.0				
FIN	1994	Photovoltaics									0	0.0		0.0				
FIN	1994	Geoth.electr									0	0.0		0.0				
FIN	1994	Geoth.heat									0	0.0		0.0				
FIN	1994	MSW									0	0.0		0.0				
FIN	1994	Wood in h/holds									0	0.0	0.0	0.0				
FIN	1994	District heating									0	0.0	0.0	0.0				
FIN	1994	Wood in industry									0	0.0	0.0	0.0				
FIN	1994	Power stations									0	0.0		0.0				
FIN	1994	Biofuels									0	0.0		0.0				
FIN	1994	Landfill gas									0	0.0		0.0				
FIN	1994	Sewage sludge									0	0.0		0.0				
FIN	1994	Farm slurries									0	0.0		0.0				
FIN	1994	A-F industry									0	0.0		0.0				
FIN	1994	Total biomass								6740.0	189934	4536.3	0.0	0.0				
FIN	1994	Total primary energy									232547.2	5554.0		0.0		12721	30356	
FIN	1994	Total electricity gener.								18584.0				0.0				65546
FIN	1994	Total heat production											0.0	0.0				

* Figures for specific energy sources are not available

(Source: Eurostat)

RENEWABLE ENERGY PRODUCTION IN SWEDEN

	Year	Renewable Energy Source	Collectors surface (1000m²)	PVC capacity (kWp)	Electrical installed capacity (MWe)	Thermal installed capacity (MWth)	Fuel consumption (tonnes)	Fuel consumption /Heat input (TJ)	Autoconsumption (TJ)	RES electricity generation (GWh)	RES primary energy production (TJ)	RES primary energy production (ktoe)	RES heat production (TJ)	RES heat production (ktoe)	RES heat for domestic use (TJ)	Total primary production (ktoe)	Total inland consumption (ktoe)	Total electricity generation (GWh)
S	1994	Hydro all			16448.0					59039	212540	5076.2		0.0				
S	1994	Hydro -1 MW										0.0		0.0				
S	1994	Hydro 1-10 MW										0.0		0.0				
S	1994	Hydro 10+ MW								72	259	6.2		0.0				
S	1994	Wind			45.0						0	0.0		0.0				
S	1994	Solar pannels									0	0.0		0.0				
S	1994	Photovoltaics									0	0.0		0.0				
S	1994	Geoth.electr									0	0.0		0.0				
S	1994	Geoth.heat									0	0.0		0.0				
S	1994	MSW									0	0.0	0.0	0.0				
S	1994	Wood in h/holds									0	0.0	0.0	0.0				
S	1994	District heating									0	0.0	0.0	0.0				
S	1994	Wood in industry									0	0.0		0.0				
S	1994	Power stations									0	0.0		0.0				
S	1994	Biofuels									0	0.0		0.0				
S	1994	Landfill gas									0	0.0		0.0				
S	1994	Sewage sludge									0	0.0		0.0				
S	1994	Farm slurries									0	0.0		0.0				
S	1994	A-F industry						0.0		1693.0	275775	6586.5	0.0	0.0				
S	1994	Total biomass									488575	11668.8		0.0		30813	48550	
S	1994	Total primary energy								60804.0				0.0				142850
S	1994	Total electricity gener.											0.0	0.0				
S	1994	Total heat production																

* Figures for specific energy sources are not available

(Source: Eurostat)

RENEWABLE ENERGY PRODUCTION IN THE UNITED KINGDOM

	Year	Renewable Energy Source	Collectors surface (1000m²)	PVC capacity (kWp)	Electrical installed capacity (MWe)	Thermal installed capacity (MWth)	Fuel consumption (tonnes)	Fuel consumption /Heat input (TJ)	Autoconsumption (TJ)	RES electricity generation (GWh)	RES primary energy production (TJ)	RES primary energy production (ktoe)	RES heat production (TJ)	RES heat production (ktoe)	RES heat for domestic use (TJ)	Total primary production (ktoe)	Total inland consumption (ktoe)	Total electricity generation (GWh)
UK	1994	Hydro all			1463.6					5076.0	18274	436.4		0.0				
UK	1994	Hydro -1 MW			29.3					141.0	508	12.1		0.0				
UK	1994	Hydro 1-10 MW			0.0					0.0	0	0.0		0.0				
UK	1994	Hydro 10+ MW			1434.3					4935.0	17766	424.3		0.0				
UK	1994	Wind			148.5					337.0	1213	29.0		0.0				
UK	1994	Solar panneis	286.3								266	6.4	266.0	6.4	152.0			
UK	1994	Photovoltaics		0						0.0	0	0.0		0.0				
UK	1994	Geoth.electr			0.0			0.0		0.0	0	0.0		0.0				
UK	1994	Geoth.heat				2.2					35	0.8	34.7	0.8				
UK	1994	MSW			112.0	49.9		14412.0		716.5	14412	344.2	1927.0	46.0				
UK	1994	Wood in h/holds						7290.0			7290	174.1	7290.0	174.1	7290.0			
UK	1994	District heating						0.0			0	0.0	0.0	0.0				
UK	1994	Wood in industry						4166.0			4166	99.5	4166.0	99.5				
UK	1994	Power stations			0.0	0.0		0.0		0.0	0	0.0	0.0	0.0				
UK	1994	Biofuels						0.0			0	0.0		0.0				
UK	1994	Landfill gas						7400.0		517.0	7400	176.7	792.0	18.9				
UK	1994	Sewage sludge			91.4			6820.0		360.8	6820	162.9	2181.0	52.1				
UK	1994	Farm slurries						15.0		0.4	15	0.4	9.0	0.2				
UK	1994	A-F industry						0.0		0.0	0	0.0	0.0	0.0				
UK	1994	Total biomass						40103.0		1594.7	40103	957.8	16365.0	390.9				
UK	1994	Total primary energy									59891	1430.4		0.0		239134	219812	
UK	1994	Total electricity gener.								7007.3				0.0				325046
UK	1994	Total heat production											16665.7	398.0				

(Source: Eurostat)