Renewable Energy Sector in the EU: its Employment and Export Potential

A Final Report to DG Environment

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C1961

Ref: 08/03/02 F:\EG\Current Contracts\C1961 Eco-Industries\Reporting\Final-sent\Re_final.doc

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EXECUTIVE SUMMARY

This report provides a brief overview of the current status of renewable energy developments in the EU, together with an assessment of employment, manufacturing activity and export markets. It also gives an overview of the current status of renewable energy exploitation in Candidate Countries.

Renewable energy in the EU

EU energy policy places a high priority on the increasing use of renewable energy, because of the important contribution that renewable energy can make towards improving security and diversification of energy supply, environmental protection and social and economic cohesion.

In 1997 the EU agreed a strategy and target to double the share of renewable energies in gross domestic energy consumption, from 6% to 12% by 2010. In 2001, member states agreed national (non-binding) targets for electricity production from renewable sources, to expand the aggregate proportion of electricity from renewable sources in the EU from 13.9% in 1997 (3.2% excluding large hydro) to 22.1% by 2010 (12.5% excluding large hydro).

Individual member states have widely different current levels of renewable energy use, and therefore have different national targets to 2010. There are a wide range of different support mechanisms being used to stimulate renewable energy uptake, including quota systems, feed-in tariffs, green certificates or a combination.

Most member states now recognise that political support is necessary to overcome the barriers that prevent a more rapid uptake of renewable technologies. These include: provision of fair and guaranteed access to electricity markets; financial measures to stimulate investment in renewable energy projects; fiscal measures that reflect the external costs and benefits of energy from renewable sources (particularly through carbon or energy taxes); and practical support from local public authorities in the siting and implementation of projects.

To achieve these targets by 2010 requires considerable investment from both public and private sector sources. The European Commission is currently promoting a short term stimulus for renewables, the “Campaign for Take-Off, 1999-2003”. This estimates that investment required to meet the 2003 targets for new capacity amounts to about 20 Bn Euro, of which 20% or 4 Bn Euro is public funding. Total investment needed to achieve the 2010 target amounts to some 165 Bn Euro, between 1997 and 2010.

These investments are seen across all of the renewable technologies, including wind, hydro, photovoltaics, geothermal, solar collectors, and biomass. More than half (84 Bn Euro) of the total investment is predicted to be targeted towards biomass projects, with a target to increase biomass capacity in the EU by 90 Mtoe by 2010. Other important technologies include wind, with a target of 36 GW additional capacity (29 Bn Euro investment) and photovoltaics (3 GWp target, 9 Bn Euro investment). Already however, these predictions are being modified with new developments: wind energy in particular is expanding more rapidly that the EU predictions, with the wind industry’s latest target for wind capacity in the EU by 2010 now revised upwards to 60 GW. Offshore wind will also make an increasing contribution to this target.

Employment from renewables

Studies into the impact of renewable energy on employment demonstrate that renewable energy has the potential to generate employment opportunities. Renewable energy production is more labour intensive than conventional energy production, in delivering the same amount of energy output. It also uses less imported goods and services, particularly during operation, since renewable energy sources are by their nature indigenous, local energy sources. A higher use of renewable energy can therefore benefit not only the national economy but is also a valuable industry at the local or regional level, where it can stimulate local investment and employment. Job gains are greatest in the agriculture and manufacturing industrial sectors. Biomass technologies in particular stimulate employment both in the biomass energy industry and in fuel supply, including planting, harvesting, transport etc.

Opportunities for employment are provided in a range of sectors, including manufacturing, project development, construction and installation, operation and maintenance. Strong indigenous manufacturing capabilities can be further strengthened by exporting goods and services worldwide.

An EU-wide study carried out in 1999 estimated that renewable energy has the potential to create over 900,000 new jobs by 2020, including 515,000 jobs in agriculture and biomass fuel supply. Industry estimates endorse these levels of job creation. Already a number of countries are achieving high employment levels from renewable energy activities, particularly in the wind energy industry. Germany, for example, estimates that the turnover of the Germany wind energy industry reached 1.7 Bn Euro, providing 25,000 direct and indirect jobs.

Export markets

Today, EU companies are amongst the world leaders in developing new renewable energy technologies, both for domestic markets and worldwide. The strong and expanding domestic markets provide the basis for many EU companies to be active in worldwide markets.

The main drivers for encouraging renewable energy in developed countries (including the EU) lie in environmental protection, particularly the role that renewable energy can play towards meeting greenhouse gas reduction targets. However, in developing countries it is the shortage of energy that it the main driver. Renewable energy can provide off-grid power in rural regions currently without access to power. Its use can also reduce the need for importing costly fossil fuels.

Wind: The EU is the largest market for wind energy developments, with 75% of the total world installed capacity of 18.5 GW. The EU's wind energy capacity is predicted to grow from 12 GW in 2000 to 60 GW by 2010. International wind markets are predicted to continue to grow at an average of 25% per year to at least 2006. Outside of the EU, the US is expanding its wind energy developments, while emerging world markets include India, China and South America.

Market leaders in the EU are Danish companies, which have a world market share f 40-50%. Other countries, particularly Germany and Spain, have expanding domestic markets which are helping to underpin their export activities. Offshore wind developments in the EU are increasing in importance, particularly for Denmark, which is establishing itself as a leader in this new technology, building on its indigenous onshore capabilities.

Photovoltaics: The main market applications for photovoltaics are for off-grid systems and increasingly for grid-connected systems, particularly in developed countries. World annual shipments of photovoltaic modules have expanded by more than 30% annually since 1998, reaching 278 MWp in 2000. Japanese and US companies dominate photovoltaic manufacturing capacity, although the EU's capacity is expanding, reaching 85 MWp by 2000.

More than 75% of the total PV installed in the EU in the 1990s occurred in Germany, mainly because of its active market support programmes. Other EU countries are now initiating similar initiatives, including Italy and the UK. Principal manufacturing capacity in the EU occurs in Germany, Spain, the Netherlands and France, totalling 85 MWp in 2000. As well as the inter-EU market, EU PV companies achieve exports worldwide.

Despite these indigenous manufacturing capabilities, trade code analysis indicates that the EU has a negative trade balance in the import/export of photovoltaic products, including semiconductor devices and related products of relevance to the renewable photovoltaic industry. In 1999, this trade deficit was approximately 200 M Euro (imports totalling approximately 600 M Euro against exports of about 400 M Euro).

Biomass: Biomass is a diverse resource which includes in addition to biomass and the residues of the wood working industry, energy crops, agricultural residues and agrofood effluents, manure as well as the organic fraction of municipal solid waste, source, separated household waste and sewage sludge.

Biomass resources make up by far the most important contribution towards total renewable energy production in the EU. Biomass use covers a wide spectrum from producing heat and generating electricity to producing fuels for the transport sector. Biomass resources are proposed to produce more than 80% (90.2 out of 107.6 Mtoe, according to the Commission White Paper) of the total additional contribution of renewables by 2010 in EU countries. These resources are predicted to add a further 230 TWh electricity production and 75 Mtoe heat production by 2010.

The EU biomass sector has increased by 13.5% between 1995-98, although some countries have shown a much greater increase - particularly Germany (57%) and Italy (94%). Germany, Finland and Sweden in particular have strong indigenous biomass industries, with thriving export market activities based around combustion technologies for heat and power production. France is the leading EU country producing biofuels (particularly biodiesel and bioethanol), a resource that is likely to expand as taxation policies are changed in favour of biofuels as a transport fuel.

Developments in Candidate Countries

To date, biomass resources have been one of the main renewable energy resources exploited in Candidate Countries, along with large scale hydro. This is because of the large natural biomass resource available in many of the Candidate Countries, and its widespread use as a non-commercial heating fuel resource. There is now an increasing interest to exploit biomass more widely both for heating and power applications.

There is an increasing activity in assessing the potential resources available from non-biomass renewable resources in most Candidate Countries. These resources include wind, hydro, and solar thermal, as well as newer technologies such as photovoltaics. Foreign companies are already starting to work within many of the Candidate Countries to assist in the development of the renewable resources, whilst indigenous capabilities are also being deployed to maximise the potential of renewable resources to stimulate employment and to reduce imports of fossil fuels.

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1.0 INTRODUCTION

1.1 What are renewable energy sources?

EUROSTAT definitions recognise the following renewable energy (RE) sources:

Solar technologies	Solar photovoltaics Solar panels
Wind energy	Onshore wind energy Offshore wind energy[1]
Hydro	Three scales of hydro plant are defined separately, namely <1MW (micro hydro), 1-10MW (small hydro), <10MW (large hydro)
Biomass	There are a wide range of biomass resources currently exploited for both power and heat, including: • Solid biomass fuels - forestry residues and other wood wastes, energy crops, etc. • Liquid biomass resources - agro-food industries, farm slurries, sewage sludge • Landfill gas and municipal solid wastes • Liquid biofuels - biodiesel, bioethanol, derived from a range of energy crops or waste oils
Geothermal energy	For electricity or heat

Emerging technologies not currently identified separately in EUROSTAT data compilation include various marine technologies, particularly tidal, wave and marine current technologies.

1.2 Renewable energy plant

The OECD defines renewable energy plant as:

"Any activity that produces equipment, technology or specific materials, designs, constructs or installs, manages or provides other services for the generation, collection or transmission of energy from renewable sources…"[2]

Renewable energy plant in the OECD definition are included as a component of the "Resources Management" group, which also covers recycled materials, sustainable forestry and agriculture, eco-tourism etc.

[1] Offshore wind energy resources are starting to be exploited in a number of sites, although EU-level statistics currently do not distinguish between offshore or onshore wind resources.
[2] OECD Environmental Goods and Services Manual, 1999, COM/TD/ENV(98)37/FINAL

For the purposes of this overview, special attention has been given to wind, solar, hydro, and biomass. Implications of new and emerging technologies will be considered where appropriate.

1.3 This report

The objectives of this report are as follows:

- Review the political and legislative conditions for development of renewable energy sources in Member States.
- Review the existing capacity and future prediction of development of renewable energy sources in Europe.
- Highlight the current and predicted expenditure on renewable energy technologies in Europe.
- Describe the impact of development of renewable energy technologies on employment
- Review European domestic markets and exports of renewable energy technologies.
- Describe the current state of development of renewable energy technologies markets in the Candidate countries.

2.0 POLICY AND LEGISLATION OVERVIEW

2.1 EU policy

The promotion of renewable sources of energy is a high priority across the EU, for reasons of

- security and diversification of energy supply
- environmental protection and
- social and economic cohesion.

Renewable energy policy at EU level is based on the European Commission's *White Paper for a Community Strategy and Action Plan*[3]. This strategy aims to double the share of renewable energies in gross domestic energy consumption across the EU from the present 6% to 12% by 2010, and includes a timetable of actions to achieve this objective.

Subsequent legislation now focuses on overcoming the various barriers to a greater level of uptake of RE, and creating a more favourable climate for RE implementation.

In the past, national legislation tended to inhibit the uptake of RE technologies because energy supply was provided through single national energy utilities. Third parties (for example, independent electricity producers) had only limited access to power supply markets. The EU is now moving rapidly forward with the liberalisation of gas and electricity markets both within and between Member States, and this is creating a climate within which there is not only greater competition but also freer access to independent producers including those exploiting RE technologies. The 1996 *Directive on the internal market for electricity*[4] obliges Member States to progressively open up an increasing proportion of their national electricity markets to competition. As a result, electricity prices for consumers have reduced, but the consequence of this makes it more difficult for renewable electricity to compete with conventional fossil energy without some form of financial support mechanism.

In order to address this problem, a proposal for an EU Directive on the *promotion of electricity from renewable energy sources in the internal electricity market*[5]*,* presented to the Energy Council in May 2000, was voted through its second reading by Members of the European Parliament on 3 July 2001. This Directive creates a common framework that will promote an increased contribution of renewable energy sources to electricity production in the internal electricity market. All Member States are required to set national (although non-binding) targets for renewables that are consistent with the objective of achieving a RE contribution of 12% of gross energy consumption (22.1% of electricity) across the EU by

[3] "White Paper for a Community Strategy and Action Plan, Energy for the Future: Renewable Sources of Energy" (COM(97)599, 23.11.97).
[4] Directive 96/92/EC of the European Parliament and of the Council of 19 December 1996 concerning common rules for the internal market in electricity.
[5] Proposal for a Directive of the European Parliament and of the Council on the promotion of electricity from renewable energy sources in the internal electricity market COM(2000)279. Amended proposal COM(2000) 884, 28.12.2000.

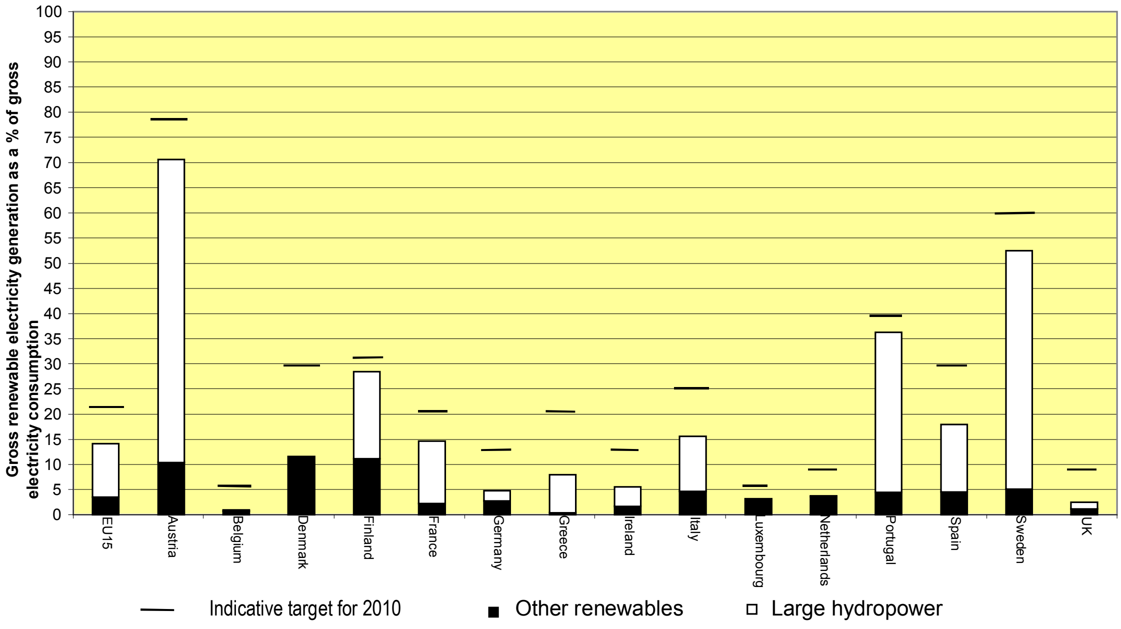
2010 (12.5% excluding large hydro). This compares with the 1997 contribution of RE electricity of 13.9% of electricity (3.2% excluding large hydro). Each member state is free to use its chosen means of achieving its targets, particularly its method of providing financial support to RE development, for example through quota systems, feed-in tariffs, green certificates, or a combination of these.

In addition the Commission adopted the Green Paper *Towards a European strategy for the security of energy supply*[6] in November 2000. This discussion document aims to provoke a wide-ranging and innovating debate on Europe's energy policy. It analyses the current energy situation and trends, and identifies the principal questions involved in deciding on a new common policy. In this context, it states that the EU must be prepared to place greater emphasis on the development of new and renewable energy sources.

2.2 National policies

The renewables Directive has established the overall structure, objectives and targets for RE development throughout the EU. Individual member states have widely different current levels of RE use, and therefore have widely different national targets to 2010, which have been agreed through a burden-sharing process. Figure 1 illustrates the levels of deployment of renewable electricity generation across the 15 member states in 1998, together with the agreed (non-binding) national targets necessary in order to meet the overall 2010 indicative target.

Figure 1: Renewable energy contribution to gross electricity consumption, 1998



Source: Eurostat

[6] COM(2000)769, 29 November 2000

Every member state now has a set of targets to increase the level of use of RE (see Table 1 below).

Table 1: Member States targets

Country	Target
Austria	Obligation on operators of distribution networks to ensure that by 2007 4% of electricity comes from RES-E[7] (excluding all forms of hydro). In addition, end-users or electricity traders located in Austria must ensure that 8% of their supply comes from small-scale hydro installations (up to 10 MW) located in Austria. Fulfilment of the 8% obligation must be documented by means of specific certificates for small-scale hydro.
Belgium	Flanders: RES-E to account for 1% of energy production in 2001, 3% in 2004 and 5% in 2010.
Denmark	Aim of 12-14% RE contribution to primary energy consumption by 2005 and long-term goal of 35% RE share of total primary energy consumption by 2030. Separate target of 20% RES-E share of electricity consumption by 2003.
Finland	Increase of RE contribution to energy demand with 50% (3 Mtoe) by 2010 and a doubling by 2025. Increase of RES-E with 8.35 TWh between 1995-2010 leading to a 31% share of electricity consumption by 2010.
France	No overall RE targets, but various sectoral strategies and targets for example 250-500 MW wind capacity by 2005.
Germany	At least a doubling of RE share of total energy consumption by 2010.
Greece	Increase of RE share in national energy balance from 5.4% in 1996 to 8.2-8.5% in 2010, mainly via wind and biomass.
Ireland	500 MW target for installed electricity capacity for the period 2000-2005. Increase in RES-E production from 6% in 1998 to 12.4% in 2005 - a 3.75% RE share in total primary energy requirement.
Italy	RE production forecast suggesting an increase from 11.7 Mtoe in 1997 to 20.3 Mtoe by 2008-2012. Installed capacity for RES-E forecasted to increase from 17,104 MWe (1997) to 24,700 (2008-2012).
Luxembourg	10% of total electricity consumption should be covered by RES-E in 2010.
Netherlands	5% RE share of total energy demand in 2010 and 10% by 2020. 1000 MW wind capacity on onshore locations by 2000, but not separate policy target for RES-E.
Portugal	No overall RE targets, but some specific technology targets established under financial support schemes (for example 180 MW RES-E by the end of 1999)
Spain	Comprehensive plan for development of RE setting as overall target that 12% of energy demand should be covered by RE in 2010. Specific RES-E target aiming at 29.4% RES-E share of total electricity generation by 2010.
Sweden	Additional 1.5 TWh electricity from RES-E be end of 2002 from 3 sources: - CHP based on biofuels: 0.75 TWh - Wind power: 0.5 TWh, - Small scale hydropower: 0.25 TWh
UK	Government proposal for 5% RES-E by 2003 and 10% by 2010 to be achieved by means of a Renewables Obligation imposed upon licensed electricity suppliers.

[7] RES-E : electricity from renewable sources

National emphases on the rationale for promoting RE differ. These reasons are often related to national interests, levels of fuel security, or environmental protection considerations (see Box 1).

Box 1 : Examples of national drivers influencing support for RE

- In **Austria** energy policy places a strong emphasis on improving the country's security of energy supply and reducing the amount of energy imports
- **German** energy policy is closely linked with national policies to support climate protection. Renewable energy plays an important part in this policy, and the government has actively supported financial provision towards renewables, both at national and regional level.
- The overall objective of **Sweden's** energy policy is to secure short and long term energy supply on economically competitive terms, with the emphasis on sustainable development.
- **Danish** policy seeks to replace electricity from coal with that from combined heat and power, natural gas and renewable energy. Throughout the 1990s, a series of energy strategies have progressively raised the targets of renewable energy use.
- **Irish** energy policy focuses on increasing its use of indigenous energy sources and reduce its level of fossil fuel imports.
- **Italian** energy policy aims to reduce import dependency and to reduce greenhouse gas emissions.

2.3 Future development of RE sources in the EU

The principal drivers influencing the development of RE technologies and hence the implementation of RE plant, focus on both technical and non-technical issues.

The RE industry is now recognised as a dynamic and expanding industry, with expanding capabilities in a range of technologies. Research and development is helping to achieve progressive improvements in technological capabilities, and to raise standards of plant performance, availability, reliability, availability, etc. Demonstration projects are able to improve confidence in plant performance by demonstrating these technological improvements and encouraging replication. As a result, these improvements help to reduce unit costs, and help to make RE more cost-competitive with fossil plant.

There are a number of non-technical barriers that can limit the uptake of RE, although many of these limitations are increasingly being overcome as RE is more widely implemented. The principal non-technical support measures that need to be taken in order to achieve successful implementation of RE schemes can be summarised as follows:

- Political - providing strong political support, through adoption of policies in favour of RE

- Legislative - ensuring that the energy market is accessible to independent electricity producers, particularly through providing support for a guaranteed market and power sales for RE electricity
- Financial - providing access to financial support for investment in RE projects, through grants, loans, subsidies, etc.
- Fiscal - reflecting external costs and benefits of energy from RE sources compared with energy from fossil or nuclear sources, particularly through use of carbon or energy taxes
- Role of public authorities - providing active support in the siting and implementation of RE projects, including awareness raising and information campaigns, targeted towards promoting the benefits of RE to the community

EU member states that have seen the greatest level of increase in RE deployment are those that have been most successful in implementing these support measures.

3.0 EXPENDITURE

Achieving the EU's agreed targets to achieve a doubling of the share of renewables in EU energy use by 2010 requires considerable investment both from public sector and private sector sources.

To stimulate a rapid uptake of RE in the early years after the RE White Paper, the EC is supporting a *"Campaign for Take-Off",* targeted at providing initial support and implementation activities to 2003 (see Table 2).

Public funding from all possible sources (European, national, regional, local) to stimulate the Campaign is anticipated to be in the order of 4 billion EURO.

Table 2: Targets for the Campaign for Take Off (1993-2003)

Campaign Action	Proposed new installed capacity	Estimated total investment cost (Bn Euro)	Suggested public funding (Bn Euro)
1,000,000 PV systems	1,000 MW	3	1
10,000 MW wind farms	10,000 MW	10	1.5
10,000 MW biomass	10,000 MW	5	1
100 communities with "100% renewables"	1,500 MW	2.5	0.5
Total		20.5	4

In its 1997 White Paper on renewables (see section 2.1), the European Commission made an assessment of the total investment needed to achieve the 2010 target. In total, the investment required was estimated to be 165 billion EURO, between 1997 and 2010. This analysis included the anticipated cost reductions as technological improvements and a greater uptake of technologies lead to a reduction in unit costs for renewable energy installations. (See Table 3).

Table 3: **Estimated Investment Costs/Benefits by Sector to meet the 2010 target of doubling proportion of RE use in the EU**

Type of Energy	Additional Capacity 1997 - 2010	Unit Cost 1997 EURO	Unit Cost 2010 EURO	Average Unit Cost EURO	Total Investment 1997–2010 Bn Euro	Additional Annual Business 2010 Bn Euro	Benefit of Annual Avoided Fuel Costs 2010 Bn Euro	Total Benefit of Avoided Fuel Costs 1997 – 2010 Bn Euro
Wind	36 GW	1,000/kW	700/kW	800/kW	28.8	4	1.43	10
Hydro	13GW	1,200/kW	1,000/kW	1,100/kW	14.3	2	0.91	6.4
Photovoltaics	3 GWp	5,000/kWp	2,500/kWp	3,000/kWp	9	1.5	0.06	0.4
Biomass	90 Mtoe				84	24.1	-	-
Geothermal (+ heat pumps)	2.5 GW	2,500/kW	1,500/kW	2,000/kW	5	0.5	-	-
Solar Collectors	94 M m^2	400/m^2	200/m^2	250/m^2	24	4.5	0.6	4.2
Total for EU market					**165.1**	**36.6**	**3**	**21**

From: Communication from the Commission: Energy for the future: Renewable Sources of Energy. White paper for a Community Strategy and Action Plan.

At the national level, member states are providing a wide range of public sector financial support initiatives to stimulate uptake of RE. Some examples include the following:

- **Germany's** Feed-In Law was established in 1991 and expanded in 2000. It provides support for RE electricity by providing a guaranteed market and fixed price for electricity from RE sources. Wind energy schemes benefited considerably during the late 1990s from very favourable tariffs available, such that Germany is the world leader in wind energy capacity. More recently, photovoltaics installations also now benefit from generous tariffs (0.99 DM/kWh, 0.51 EURO/kWh) through the Feed-In Law. In addition, the "100,000 Roofs programme", started in 1999, provides 560 M Euro towards supporting individuals and small and medium-sized companies to install grid-connected PV systems. As a result, the 100,000 roofs target is predicted to be achieved by 2003.

- **Denmark** has led the way in exploiting wind energy since the late 1980s, and is now working towards a target of providing 45% of Danish electricity consumption from wind power (on- and off-shore) by 2030. This success was achieved by a combination of premium tariffs for electricity from wind power, together with generous subsidies towards early research, development and demonstration initiatives, particularly in the late 1980s and early 1990s. As a result, Danish wind energy companies are now world leaders. The importance of wind energy to the rural economy has long been recognised in Denmark, where the majority of turbines are privately owned (see Box).

- **Finland** has some of the highest use of RE, particularly of biomass, in the EU. The government has supported extensive research and development into the biomass technology industry, which has helped to create a strong indigenous market and export industry.

- **Spain** has rapidly expanded its use of wind energy in recent years, achieved through the provision of generous tariffs for RE electricity, combined with active political support at regional level for new wind power installations. In particular the regions supported the development of indigenous wind manufacturing industries, in order to stimulate the regional economy. Spain now has a solid core of three totally home-based turbine manufacturers - MADE, Ecotecnia and Desarrollos Eolicas - these have now been joined by others which use Danish technology or are jointly owned with Danish companies. These include Gamesa Eolica, NEG Micon, Bazan-Bonus and Nordex. Rules laid down by regional governments like Galicia have kept turbine imports to a minimum.

Box 2: Wind energy in the local economy

Wind energy can provide an important boost to the economies of rural areas. In countries such as Denmark and Germany, where there is a high proportion of individual turbines, turbine ownership can bring wealth to individuals or communities.

Larger wind farms also generate wealth. The investment required for a typical 30-turbine wind farm is around 20 million EURO. Around one quarter of this is usually spent with local contractors, bringing 5 million EURO into the local economy. Once the wind farm is up and running, it generates income through land rental and rates. Some companies also establish community funds, providing additional income to local schools, community centres or other local projects.

4.0 EMPLOYMENT

4.1 Impacts of RE on employment at EU level

A study[8] carried out during 1998-9 for DG XVII (Energy) of the European Commission aimed to provide a comprehensive analysis of the impacts of renewable energy deployment on employment from the present day to 2020. Key findings from the study were as follows:

- Energy produced from renewable sources is predicted to increase by a factor of about 2.4, from a base of 440 TWh in 1995 to 1,066 TWh by 2020. The modelling predicts increases in the capacity and output of all the renewable energy technologies studied, and in all Member States. These predictions also represent an increase in the overall proportion of final energy consumption in the EU provided by renewables[9] from 4.3% in 1995 to 8.2% by 2020.

- The modelling predictions estimate that this increase in energy provided from renewable sources can result in the creation of over 900,000 new jobs by 2020. 385,000 jobs are predicted to be created by 2020 from provision of renewable energy, and a further 515,000 jobs from biomass fuel production. This increase takes account of the direct, indirect and subsidy effects on employment, and jobs displaced in conventional energy technologies.

- Jobs gains are greatest from biomass technologies - both in the biomass energy industry and in fuel supply - however all technologies show long-term net job creation.

- Renewable energy technologies are in general more labour intensive than conventional energy technologies, in delivering the same amount of energy output.

- Jobs displaced as a result of subsidies to support renewable energy deployment are significantly less than corresponding job gains (both direct and indirect impacts) elsewhere in the economy.

- Job gains are greatest in the agriculture and manufacturing industrial sectors. The conventional energy supply industry is predicted to lose less than 2% of its work force by 2020 as a consequence of the shift to a greater use of energy from renewable sources.

- All technologies generate a net increase in jobs during the construction phase. For some technologies however there are net employment losses during the operational phase.

- Employment creation occurs in all Member States. Germany, France and Italy have the greatest absolute employment increases, whilst Denmark, Greece and Austria achieve the highest proportional increase relative to the size of their labour force.

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8 The impact of renewables on employment and economic growth. ALTENER project 4.1030/E/97-009
9 Excluding large hydro, geothermal, wave and tidal energy, which were not included in the analysis.

The results from the study are of practical benefit to many different groups, including policy makers, the renewable energy industry, regional and local authorities, investors, and will help raise general awareness about the employment benefits from renewable energy technologies.

This net employment increase occurs because:

- renewable energy production is more labour intensive than conventional energy production, in delivering the same amount of energy output;
- renewable energy production uses less imported goods and services, especially during the operational phase, and therefore results in a slightly higher multiplier effect;
- the analysis has assumed that expansion of biological fuel sources occurs *without* displacing employment in conventional agriculture and forestry [10].

To an extent, and more so in the earlier years, subsidies are required to enable renewables to compete in the market with conventional energy sources. However, even when allowance is made for jobs that would have been created from alternate deployment of these subsidies (consumers buying other goods, governments investing in alternative public services) renewables were still found to generate *net* jobs relative to conventional energy sources they displace.

4.2 Principal opportunities for employment

Opportunities for employment from the renewable energy sector occur in a wide range of areas:

- Manufacturing - design and fabrication, component manufacture and supply, assembly, refurbishment
- Project development - a wide range of sectors contribute to the development of a RE project, including planners, surveyors, financiers, insurance, project design and developers, architects, etc.
- Construction and installation of the plant includes site operations, electrical and mechanical engineering, fabrications, etc.
- Operation and maintenance of the plant requires a range of specialist and non-specialist skills, including management, servicing, fuel collection and supply (for biomass plant).

[10] The rationale for this is that there is still widespread overproduction of many agricultural products due to price subsidies from consumers and export subsidies from the CAP even though significant areas of land are in set-aside. The political reality of how an increase in energy crop production can be brought about within the framework of CAP and international trade agreements has not been considered within this study.

4.3 Estimates from trade associations

A number of EU trade associations have made estimates of the potential employment impacts of increased deployment of individual RE technologies in the EU. These estimates are presented in Table 4. An assessment of current employment in the wind industry, provided by the EU's wind energy trade association, is given in Box 3, and a similar assessment by the PV trade association is given in Box 4.

Table 4: Job creation estimates from Trade Associations

Sector	Employment	Trade Association
Wind	190,000-320,000 by 2010 if 40GW wind power installed	(EWEA) European Wind Energy Association
Solar PV	100,000 by 2010, if 3 GW of solar PV installed	(EPIA) The European Photovoltaic Industry Association
Biomass	1,000,000 by 2010, if biomass potential is fully exploited.	(AEBIOM) The European biomass Association
Solar	250,000	(ESIF) The European Solar Industry Federation

Sources: Various, as reported in the EC White Paper for a Community Strategy and Action Plan, 1997

Box 3: Employment in the wind energy industry

Over 20,000 Europeans are directly employed in the wind energy industry, many of these employed in SMEs. Manufacture and installation of wind turbines employs, on average, around six people per year for every MW of newly manufactured turbines. For operation and maintenance, between 100 and 450 people are employed per year for every TWh of electricity produced. The number varies according to the age and type of turbines.

For every job in wind turbine and component manufacture, installation and operation and maintenance, there is at least one more in associated sectors of the industry. This includes consultancy, legal work, planning, research, finance, sales, marketing, publishing, and education.
Source: European Wind Energy Association

In Germany, manufacturers of complete wind turbines and components directly employ more than 3000 people. Just under a third of these started employment during 1998. If activities such as planning, construction, operation, servicing, licensing and financing are taken into account, then almost 15,000 jobs have been created, many in the economically weak areas of northern Germany. In 2000, the turnover of the German wind industry reached 1.7 billion EURO, providing 25,000 direct and indirect jobs.
Source: Wind Force 10. Edition 2000

Box 4 : Employment in the PV industry

The opening of new PV production facilities result in the creation of about 20 jobs per MWp of capacity. In addition, wholesale, retail and installation services associated with each MWp of systems sold provide for about 30 jobs. Most of these jobs are at the regional or local level since they must be located close to the end-customer. Maintenance of installed systems provides for on average 1 job per MWp of cumulated installed systems. In addition, employment opportunities are also created in associated sectors such as universities and research institutes, and in the construction industry. Most of these jobs will be realised at the local level through a need for new retailing and installation services close to the customer.

It is estimated that PV technology would provide in the European Union in the year 2010 about 59,000 jobs to meet the EU target of 3 GWp by 2010. Taking into account export opportunities and associated service industries, e.g. the construction section, a level of 100,000 jobs is 2010 is realistic.
Source: European PV Industry Association

5.0 MARKETS

5.1 World RE markets

5.1.1 Overview

Today, EU companies are amongst the world leaders in developing new RE technologies, both for domestic markets and worldwide. The EU's RE industry will continue to expand, in particular to meet the challenging target set by the recent EC Directive to double RE's share of electricity in the EU by 2010. As a result, RE companies have increasing confidence in the future of the market, which will help them to maintain and improve their competitive edge. The initiative will especially have significant effects on SMEs, as they constitute an important part of the sector.

As a result of the strong and expanding market for RE technologies in the EU, many EU RE companies are also active in the worldwide RE market. EU hydro and PV industries, for example, are already well established in growing markets as Latin America and Asia.

5.1.2 Market drivers and trends

The main drivers for encouraging RE in developed countries (including the EU) lie in environmental protection, particularly the role that RE can play towards meeting Kyoto targets to reduce greenhouse gas emissions.

However, in developing countries, it is the shortage of energy that is the main driver. In many developing countries, RE is one of the main opportunities for providing off-grid electricity to the many millions of rural communities that currently do not have any power. RE also plays an important role in the overall energy mix for developing countries, by reducing the need for costly imports of fossil fuels, and instead exploiting indigenous energy resources.

Aid agencies and other large public and private sector investment programmes, are increasingly considering RE as a secure and cost-effective opportunity for energy provision in developing countries. New financing initiatives, particularly through Clean Development Mechanism and Joint Implementation, will increasingly be used by developed countries as a means of implementing RE in developing countries.

5.2 Technology overviews

5.2.1 Wind

World wind developments

Average growth rates for wind energy installations for the five years to 1998 were approximately 40%, and the total capacity installed world-wide by 2000 was over 18,000 MW (see Figure 2[11]). 75% of this capacity is in the EU, with a further 15% in North America (particularly the US). It is estimated that international wind markets will continue to grow at an average rate of 25% up to 2006.[12]

Emerging wind energy markets world-wide include:

- India, which currently ranks fifth in global capacity, installing a further 55 MW in 2000, bringing its total capacity up to over 1,100 MW.
- Egypt, which had 50MW come on line in 2000, backed by foreign aid and overseas investments.
- China, which is starting to develop a large portfolio of wind energy projects based around its renewable energy strategy, particularly relating to rural energy provision.
- Argentina, with planned expansion of 3,000MW of wind energy, with a first phase in 2001 installing 280MW at a total investment cost of 640 M Euro.

Recent forecasts for global wind power developments to 2005 indicate that a further 40,000 MW can be anticipated, with major markets being Europe and America, but with rapid expansion occurring, particularly in Asia (Figure 3).

[11] Data source for Figures 2,3 and 4: BTM Consult ApS, April 2001, International Wind Energy Development, World Market Update 2001. As reported in Renewable Energy World, July/August 2001
[12] Power Generation in the 21st Century- Renewables Gaining Ground (January 2001) Dresdner Kleinwort Wasserstein.

Figure 2 : Total installed wind energy capacity worldwide (2000)

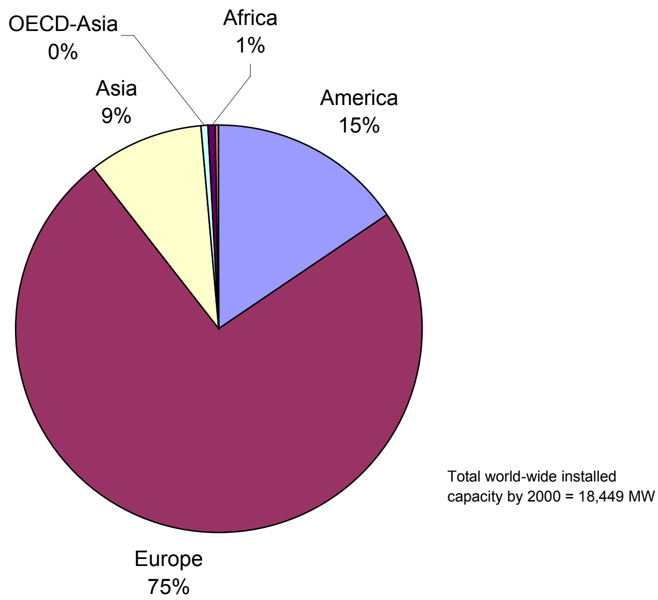
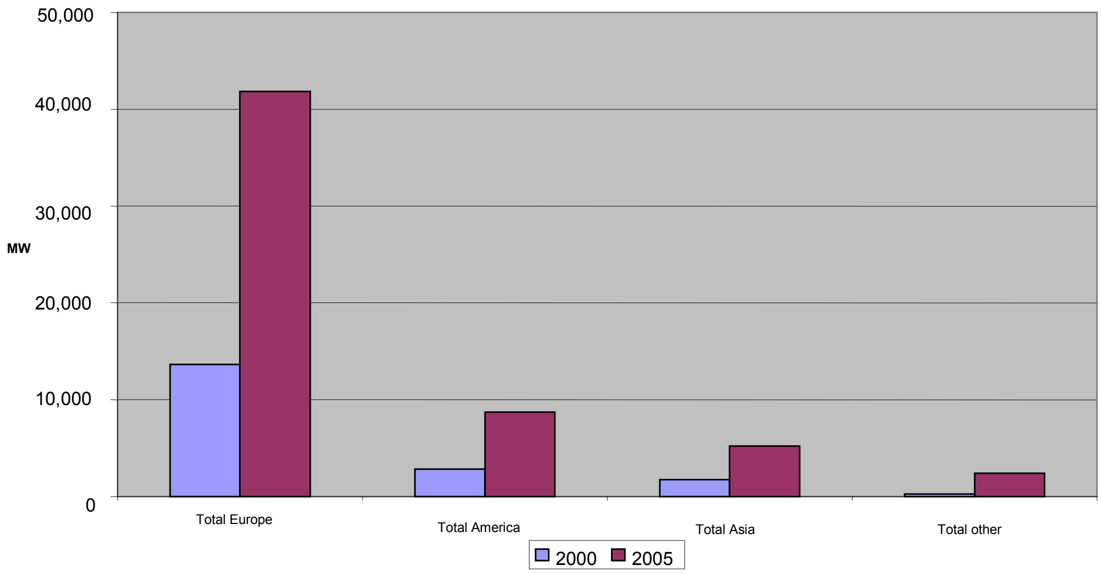


Figure 3 : Forecast for global wind energy development to 2005

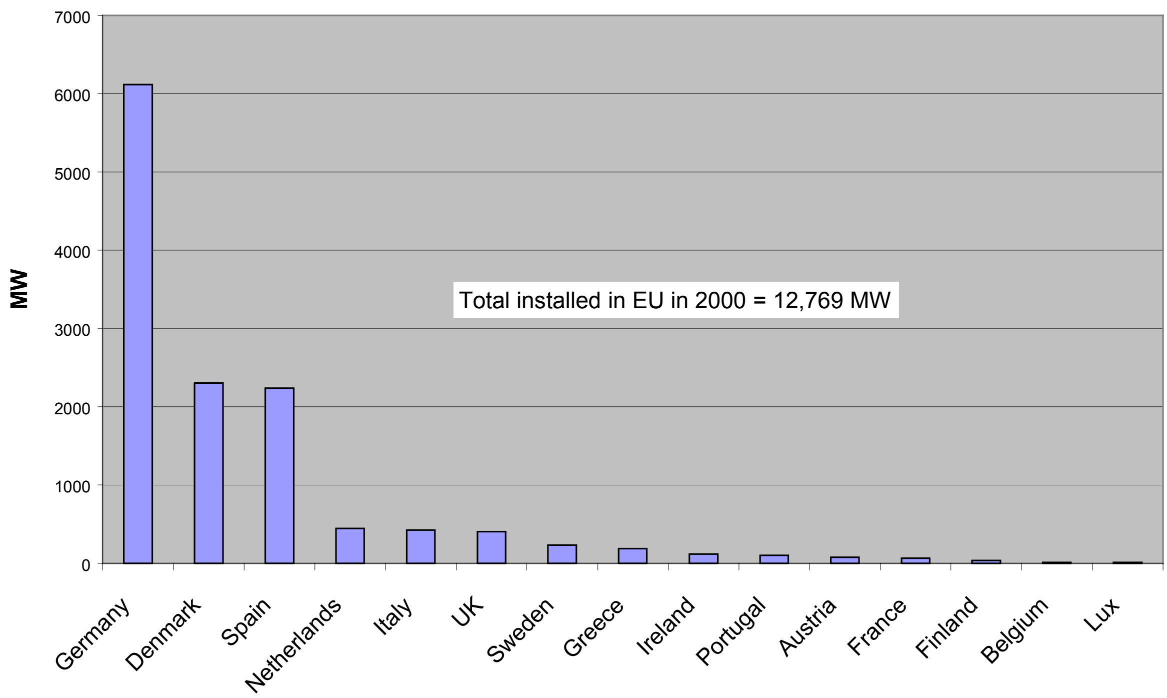


EU wind energy developments

The European Wind Energy Association's target of 40,000 MW wind capacity in the EU by 2010 has recently been revised upwards to 60,000 MW, in the light of the continued expansion in wind energy developments throughout the EU.

By 2000 there was more than 12,000 MW capacity installed, with the market leaders Germany, Denmark and Spain accounting for more than 80% of this capacity (Figure 4).

Figure 4 : EU wind energy capacity, 2000



Market leaders

Eleven wind turbine manufacturers supply more than 95% of the world market. Of these, nine are European. The market leaders are Danish companies, which operate worldwide, typically exporting 60-90% of their total production. The leading company is Vestas, which had export sales of nearly 700 MW in 2000.

Other countries, notably Germany and Spain, have expanding domestic markets which are helping to establish their indigenous wind companies and underpin export activities. Enercon (Germany) exported about one quarter of its sales in 2000, while the Spanish companies Gamesa and MADE are also active in export markets.

There is a growing trend towards joint ventures between wind energy companies, and for companies to establish subsidiaries in new wind markets. Vestas, for example, has established a wind factory in Scotland (UK), while the major wind energy companies in Spain were established through joint venture activities with various Danish companies.

Offshore wind

In 2000 the first offshore wind plants were commissioned in Europe. Projects are now operating in the UK, Sweden and Denmark, with more planned in other countries including Ireland, Germany, France. The European Wind Energy Association (EWEA) has estimated that 5 GW of the 60 GW predicted for 2010 will be coming from the offshore sector.

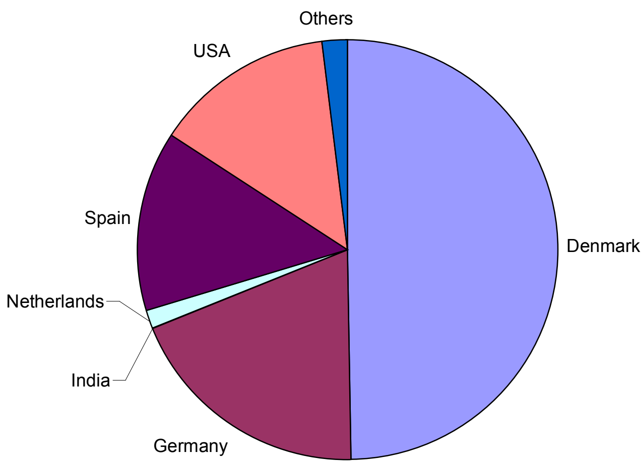
Box 5 : The Danish wind energy industry

The Danish wind turbine industry has developed into the flagship of Danish exports of energy-related equipment. In 1998 wind turbine exports accounted for 25% of all Denmark's energy-sector exports.

The main markets for Danish wind turbines at present are Germany, Spain and the USA (Figure 5). Danish manufacturers are expected to be able to maintain a world market share of 40-50% for the next few years.

The construction of large offshore wind parks in Denmark has increased in importance. The Danish government has set a capacity target of 750 MW, spread over five projects, for implementation before 2008. The indigenous capabilities built up in the development of Denmark’s onshore wind industry is helping to ensure that Denmark is also a leading developer in offshore wind technology.

Figure 5 : Export destinations for Danish wind turbines (%)



Source: BTM Consult Aps-April 2000

5.2.2 Photovoltaics

World PV markets

The world market for photovoltaics (PV) is estimated to be worth in excess of £1 billion per annum, and the potential market is enormous.

There are already more than 1.4 GWp of PV deployed worldwide. During 1998-2000, annual growth rates in PV manufacturing of greater than 31% were achieved, with PV shipments reaching 278 MWp in 2000 (Table 5).

Table 5 : Annual shipments of photovoltaic modules

Region	Annual Shipments (MWp)					
	1991	1996	1997	1998	1999	2000
Rest of world	5.4	9.4	9.4	18.7	20.5	29.0
USA	16.8	39.4	51.7	53.7	63.3	80.0
Japan	19.3	21.0	35.0	49.1	80.0	110.0
Europe	13.0	19.3	30.0	31.2	37.6	59.0
Total (MWp)	54.5	89.1	126.1	152.8	201.4	278.0
Cumulative (MWp)	313.5	669.2	795.3	948.1	1,149.5	1,427.5
Annual Growth	5.1%	13.5%	41.6%	21.1%	31.9%	38.0%

The main market applications for photovoltaics are for off-grid systems (e.g. telecommunications, small consumer products) and, increasingly, grid connected systems (e.g. building integrated power supplies). In 2000, new grid-connected systems dominated 50% of installed PV power applications globally.

Japan, the US and the EU are still the principal market regions:

- The US has a target to achieve over 2 GWp of PV capacity by 2010, rising to 3 GWp by 2020.
- Japan, the world leader, has a target of 5 GWp by 2010, to be achieved through its ongoing Sunshine Programme.
- The EU's target, as described in more detail in section 2.1, is for an additional 3 MWp of capacity by 2010.

The EPIA estimates that the rest of the world, under a "business as usual" scenario, could represent capacity demand of about 1.2 GWp by 2010, although the off-grid market potential in unelectrified countries alone is estimated at more than 15 GWp.

EU PV markets

More than 75% of the total PV installed in the EU during the 1990s occurred in Germany, mainly as a result of its market support initiatives, including the ongoing 100,000 Roofs

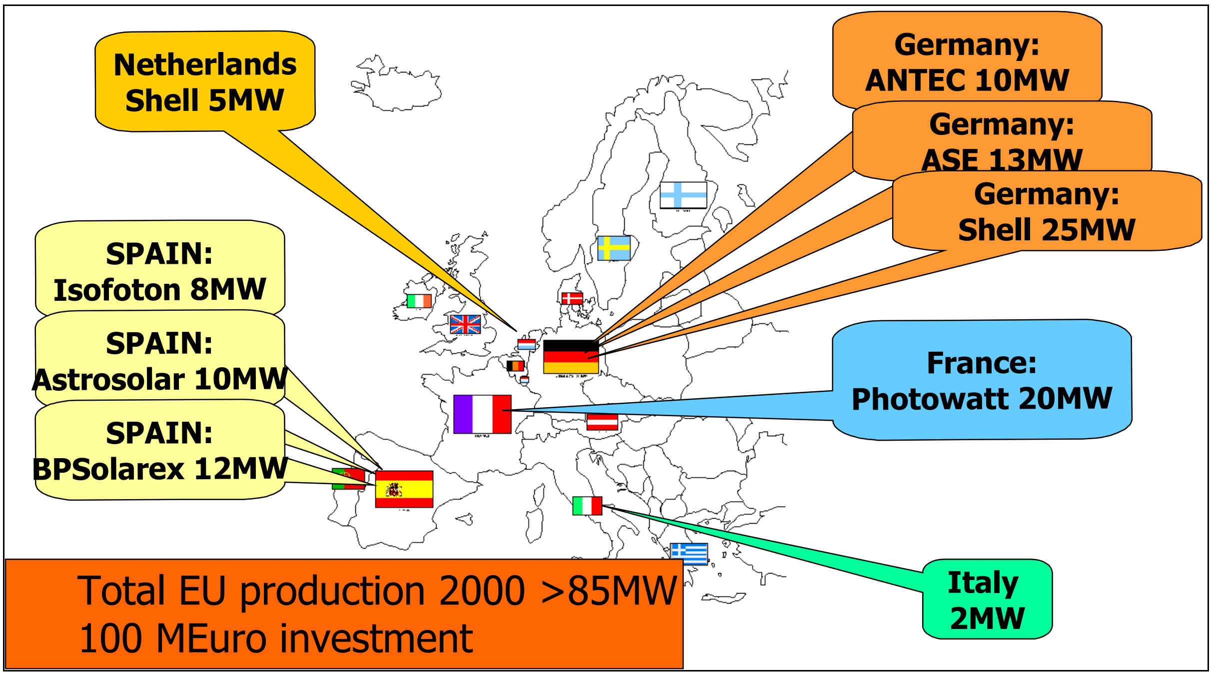
Programme (see section 2.2). Other EU countries are now following similar initiatives to provide financial and technical support to establish PV installation programmes, particularly Italy, which started a PV roof programme in 2001, and the UK, which has recently established a series of demonstration projects on both domestic and industrial installations.

Market leaders

The top eight producers of PV cells/modules in 2000 produced 82% (235 MW) of total world production. Japanese companies dominate (Sharp, Kyocera, Astro Power, Sanyo, Mitsubishi), and the US also has strong industry presence (AstroPower, Siemens Solar, BP Solar (Solarex)).

However, the manufacturing capacity in the EU is expanding, reaching 85 MWp by 2000. Most of the manufacturing capacity is established in EU member states that have strong domestic support programmes for PV - particularly Germany, as well as Spain and the Netherlands (see Figure 6).

Figure 6 : PV manufacturing capacity in the EU, 2000



5.2.3 Biomass

Biomass resources

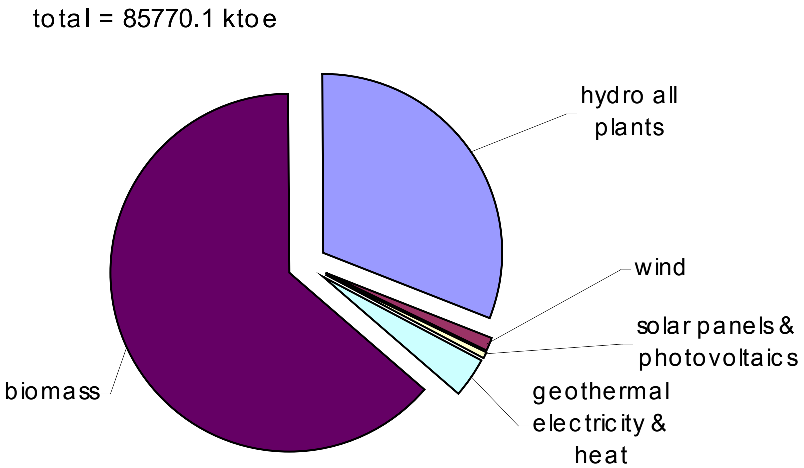
Biomass is a diverse resource which includes in addition to biomass and the residues of the wood working industry, energy crops, agricultural residues and agrofood effluents, manure as well as the organic fraction of municipal solid waste, source, separated household waste and sewage sludge.

Biomass use covers a wide spectrum from producing heat and generating electricity to producing fuels for the transport sector.

In some regions of the world, biomass is the major source of heating and cooking and represents about 14 percent of final global energy demand.[13] It is very difficult to measure the use of biomass because of the diversity of its applications and the fact that much of the biomass use is non-commercial.

In the EU, biomass provides the largest single source of renewable energy (see Figure 7 and Figure 8).

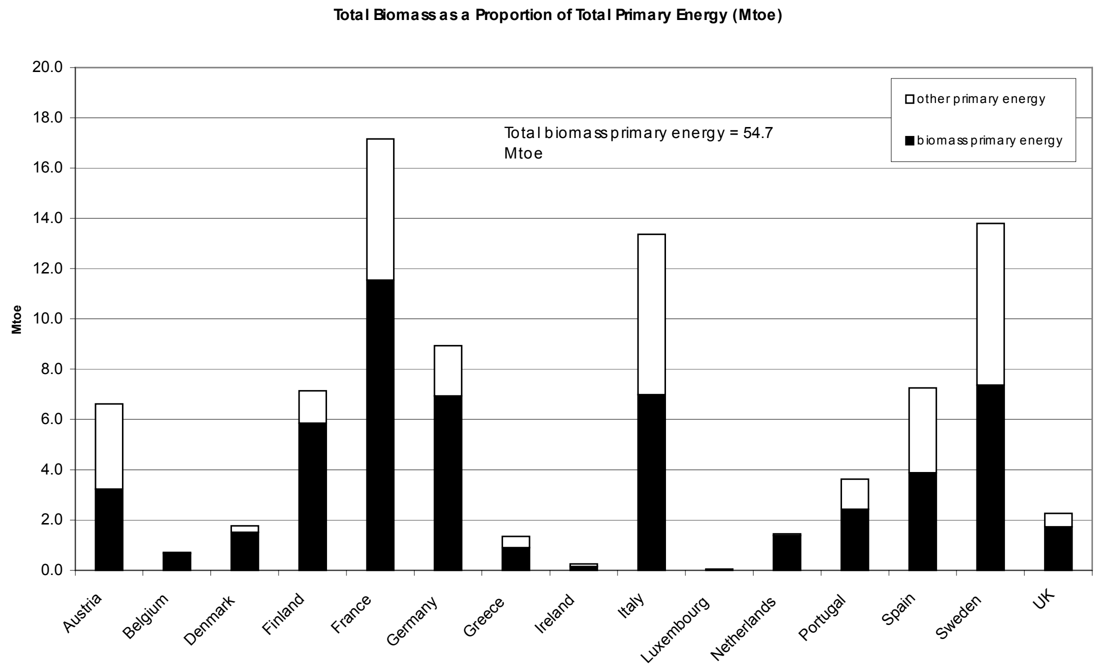
Figure 7 : Biomass contribution to total RE production in the EU in 1998 (%).



Source: Eurostat

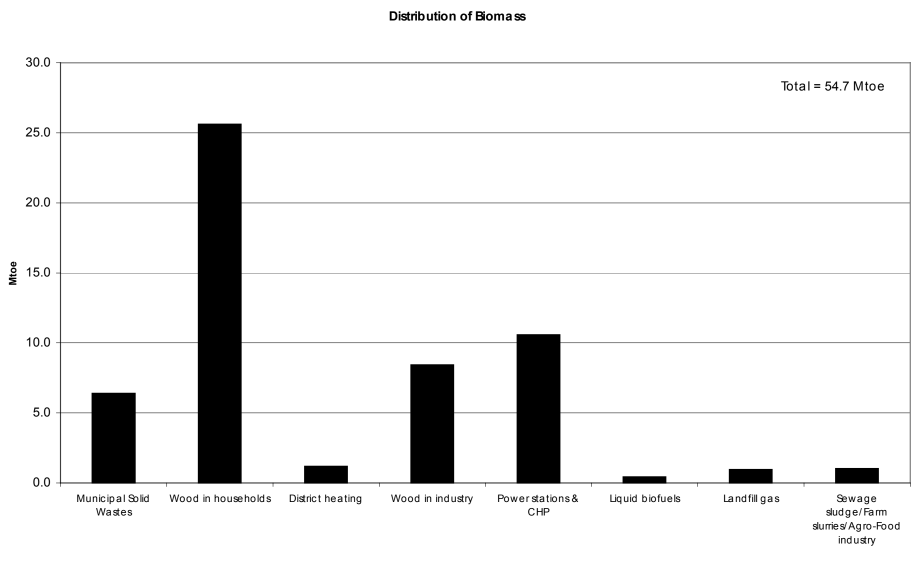
[13] The Evolving Renewable Energy Market, IEA Renewable Energy Working Party

Figure 8: Total biomass as a portion of total primary energy in EU countries.



Wood in households is the largest use of biomass in the EU (26 Mtoe or 48%), followed by power stations & CHP (11 Mtoe or 20%). Together with wood in industry and municipal solid wastes these four make up the large part of biomass usage (see Figure 9).

Figure 9: Biomass resources in the EU (1998)



Source: Eurostat

The biomass sector has shown an increase of 13.5% in the EU-15 during the period 1995-1998, although some MS have achieved much greater increases of 57% (Germany) and 94% (Italy) in the same period of time.[14]

The principal biomass resources currently utilised are forest residues, wood industry residues, as well as municipal wastes. Crops grown for energy use (e.g. coppice) are increasingly being developed as an agricultural fuel resource. These range of solid biofuels are used for traditional uses (fuel wood for domestic heating etc.), and at a larger scale to provide heat for industrial processes or district heating systems. Increasingly, wood and other biomass resources are being used for power generation, using conventional combustion systems or via new technologies such as gasification or pyrolysis.

Liquid biofuels are increasingly being used for transport fuels in some EU countries. The two primary types of biodiesel and bioethanol, derived from oilseed rape, sunflower oil, wheat, sorghum. Waste oils are also an important source of biofuels.

Energy is also recovered from landfill gas, and from biogas, which is produced through anaerobic digestion of sewage, agricultural slurries and the organic component of industrial and urban wastes. Biogas plants can become centres for the management of agricultural manure in rural areas. Biogas plants also play a role in the recycling of organic waste products from households in cities. It is predicted that the production of biogas under controlled conditions from organic residues will increase, the collection and use of landfill gas to produce energy remains only a second option. Landfill gas production is expected to become less important in the future as legislation limits the amount of biodegradable material that can be disposed of to landfill sites. However, the emission of gases will continue for more than 10 years after the closing of disposal sites. Only 2% of the potential of animal manure is used for biogas production in Europe. A big gap exists between the available technologies and the existing market.

Future developments

Biomass resources are proposed to produce more than 80% (90.2 out of 107.6 Mtoe, according to the Commission White Paper) of the total additional contribution of renewables by 2010 in EU countries:

- Biogas (livestock production, sewage treatment, landfills) - 15 Mtoe
- Agricultural and forest Residues - 30 Mtoe
- Energy crops - 45 Mtoe

Projections by the Commission[15] relating to the uptake of biomass include the following:

[14] Communication from the Commission to the Council, The European Parliament, The Economic and Social committee and The Committee of the Regions on the implementation of the Community Strategy and Action plan on Renewable Energy Sources (1998-2000), Brussels, 16.02.2001
[15] Communication from the Commission Energy for the Future: Renewable Sources of Energy White Paper for a Community Strategy and Action Plan.

- By 2010, electricity production from biomass resources will reach 230 TWh, while heat production from biomass will be 75 Mtoe.

- A stronger exploitation of the biogas resource in EU will take place, because it is in line with the Commission's strategy for reducing methane emissions on environmental grounds. This has been expressed in the preparation of a global agreement on greenhouse gas emissions. On the other hand the Landfill Directive is going to limit the production of biogas from landfills.

- There is an un-exploited potential in the form of wood and agricultural residues (straw etc.) which exceeds 150 Mtoe per year. It is estimated that 30 Mtoe can be mobilised annually by 2010 for power, heating and the industrial process heat market.

- Energy crops might be the significant resource in the future. The contribution for bioenergy production from crops is estimated at 45 Mtoe by 2010.

- Future development of biofuels will be based mostly on production in Europe. Liquid biofuels may contribute 18 Mtoe of biofuels production however liquid biofuels are the least competitive product from biomass in the market place. The anticipated potential of 27 Mtoe is expected from solid biofuels. The material can be diverted from short rotation forestry, or non-wood, energy crops, good combustion and gasification.

Country Trends

The following table briefly summarises the current and future trends in biomass use in each of the EU 15.

Austria	Extensive forestry, and paper and pulp industries operate biomass fired CHP plants using waste from the industry, which provide the industry's own heat and power demands. The use of biomass for district heating is becoming increasingly common especially in rural areas (fuelwood, sawdust, bark and woodchips). There is a well-established local industry that developed to meet demand for new biomass district heating plants and equipment. Due to the increasing prices for heating oil and natural gas, the interest in using biofuels in increasing rapidly. In recent years there have been some organisations promoting the marketing and trade of woody biofuels for private customers. Biofuels and biogas play a less important role. In the future small plants for heating of single or double houses are to be introduced, these do exist but need some improvements in technology for broad market penetration. In universities and in association with industry there is support for new technological developments in biomass power production processes
Belgium	The most important biomass resources in Belgium are solid industrial by-products, most of this capacity is in solid biomass fuelled boilers used in the pulp and paper industry, sawmills, and other industries. The second most important biomass fuel is industrial black liquors, and there is a small

	proportion of domestic firewood used. The heating market will be the most important area of development in the future. The current import and export markets are not significant due to the poor utilisation of biomass in Belgium.
Denmark	Denmark has considerable straw biomass resources. The production of this resource is a by-product of agricultural activity, and thus depends on financial matters affecting the management of agricultural areas. The greatest number of biomass fuelled boilers are used in district heating plants and municipal CHP plants. Over 75% of forest residues are already utilised, and in the light of the government's aim to increase forest area, Denmark's total wood fuel resources will increase in the future. Denmark has a past record of utilising its biomass resources for heating purposes, more recently, they are increasingly being used to generate power as well.
Germany	In Germany, energy crops and straw provide a large share of the biomass resources, with smaller amount of forestry residues, compared to other EU countries. A large proportion of biomass energy production is covered by residential use of firewood. The use of wood for heating purposes is common in Bavaria, with almost one third of homes using wood as an energy source. Renewable energy promotion is now shifting towards promotion of the direct use of biomass for heat production. Good performance levels and expertise are required to obtain state investment subsidies, thus ensuring the overall quality of installations is high. Recently there has been an increase in the development of wood-fuelled CHP plants, particularly in the southern forested regions (e.g. Bavaria).
Finland	Finland is a leading EU country in making effective use of its extensive biomass resources. The most important biomass resources are wood biomass and peat. Forest residues and the industry by-products (from Finland's extensive forests and large forest industry) are also an important biomass resource, though the amount available is heavily dependent on production in the forest industry. CHP plants, using a range of biomass resources (wood waste, agricultural biomass, peat and black liquor) are used extensively to provide heat and electricity for domestic and industrial purposes. Only a small share of the forest residue resources are currently used, but this will increase rapidly in the near future, as several CHP plants for forest residues are under discussion (in industry and municipalities). District heating systems are common with about half the population connected, and these are increasingly using biomass as a fuel. The Finnish government provided a high level of subsidy and support to R&D to develop an indigenous biomass technology industry, helping to create a strong market, and consequently a thriving export industry, in particular in combustion technology, boilers and emissions control. Currently about 10% of the refined wood fuels are used inside Finland, the rest is exported, mainly to Denmark and Sweden.
France	France has a high biomass resource of straw compared to other EU levels, but very little is used in energy production. Residential firewood is the second most important biomass resource in France, and is by far the highest

	energy use of biomass. Most biomass boilers are in district heating plants, with some in the pulp and paper industry or sawmills, (mainly using black liquors, bark and sawdust). France is the largest producer of biodiesel in Europe and one of few countries to give a relatively high priority to its development, mainly to support the agricultural sector and for research.
Greece	The domestic sector in Greece uses large quantities of forest wood fuel, charcoal and agricultural residues from tree pruning. A large amount of waste residue is produced by the Greek wood and pulp industry, only a small amount of which is used for heat or steam production. There are many opportunities to develop wood residue usage for energy purposes in this industry. Several attempts have been made at a national level to enhance the energy exploitation of forest residues, however barriers remain; lack of mechanisation, land relief problems, the absence of a biomass energy output market and an unfavourable legal framework. In the Community Support Framework, proposals are formed to promote the energy use of forestry and agricultural residues by developing an infrastructure for harvesting and handling biomass chains.
Ireland	By far the largest biomass resource in Ireland is peat, however, peat is not now generally considered as a renewable resource. Excluding peat, industrial by-products represent about 42% of biomass energy use, and firewood covers the other 58%. Together these two areas account for about 1% of total primary energy requirement. Most domestic firewood is used unseasoned in open fires, and there is potential to increase the amount used and its efficiency by introducing the use of seasoned wood in enclosed stoves. Most of the sawmill residues are used for heat production in the four wood panel mills in Ireland. Potential is recognised to develop CHP units in this area. There is also significant potential to introduce refined wood fuels, and to develop energy crops and forestry residues as sources of energy.
Italy	The most important biomass resource is domestic firewood. Other resources include fruit, wine, and olive prunings. There are many very small biomass fuelled plants used countrywide in pulp & paper, sawmills, and other industries. As the Italian bioenergy market is relatively new, biomass import and export are nearly non-existent and hard to quantify. In Italy the production of renewable energy from biomass was underdeveloped until the end of the 90's. This was mainly due to an unsettled bioenergy strategy, unwillingness of the population to accept new power plants (especially those using 'waste' biomass feedstocks) and an inability to establish supply chain agreements. The situation is currently changing. Innovative know-how is available for industrial development, employment impacts of biomass energy are being realised, and the possibility of planting or extending forests to increase the biomass energy sector is being explored.
Spain	Spain has large and varied resources of biomass (about 20 Mtoe), but the energy use of these resources involves less than about 20% of the potential, with most resources used in domestic applications. All of the industrial black liquors produced by wood industries and domestic firewood resources available are utilised. Olive wastes, woody agricultural wastes, some

	charcoal and some almond shells are also used for energy production. Biomass fuels are mainly used in the municipal sector for CHP, and in the pulp and paper industry. By far the largest number of biomass fuelled boilers can be found in areas such as the olive industry. There is a lack of infrastructure in the Spanish biomass market, which makes import and export trading difficult. The Spanish Promotion Plan on RES puts special importance on the generation of electricity through biomass resources, owing to its high development potential, and the rapid expansion in this sector. It also includes aid for investment in biomass treating equipment.
Portugal	The use of firewood as fuel is very significant in Portugal. There is a high utilisation rate of the solid industrial by-products and black liquors for energy production. Current users of biomass are mainly domestic and social (schools, swimming pools) and industrial (pulp and paper mills, sawmills, panels, ceramic industry). In these cases, biomass is usually used in conjunction with fossil fuels in co-combustion processes. Portugal imports a large amount of woodchips (5,5 mill Euro) information on the destination of Portuguese exports and the origin of imports is not available. Currently the internal biomass market is relatively new, with a small number of biomass users. Expansion and growth in the future is likely, particularly in the case of forest residues, where there are large productions and demands, with a solid supply chain connection yet to develop between the two.
Netherlands	The most important biofuel is the biomass fraction fed into waste incinerators. The Netherlands has a relatively large resource of wood waste, while other sources of biomass are quite small. Almost all the domestic resources are already used in energy production, and an additional 10 PJ of firewood is imported (mostly from Germany) and used annually. From January 2000, the ban on landfilling combustible waste streams has had a strong impact on the availability of combustible waste for energy. Currently 74% of Dutch biomass utilisation is wood wastes. There are a large number of industrial biomass plants (less municipal ones). Most of the industrial plants are small, providing heat for a sawmill, using its own by-products. As a consequence of the ban on landfilling combustible wastes, a new industry has emerged that aims at pre-treatment of mixed industrial waste into RDF (refuse derived fuel) pellets, part of which is utilised in Germany and Belgium in cement ovens and Sweden in district heating. Currently the export trade is very strong, but as capacity for conversion in the Netherlands comes online, it is not clear for how long the export market will continue to be this strong.
UK	The most significant biomass resource is wood based waste with the packaging and paper waste fractions accounting for the largest portion. The other important biomass resource available in the UK is straw. The amount of SRC planted is increasing rapidly each year, (currently 1,500 ha). Provision of grant support is available for 25,000 ha of SRC or miscanthus over the next 5 to 6 years, but is dependent on heat and power plant developments to purchase the resource. In practice the only biomass type largely used in energy production is domestic firewood (90% of total

	biomass usage), this figure may be affected by a difficulty in estimating the amount of biomass wastes burned in smaller units to heat for heat in the woodworking industry (estimated at about 8% of total biomass usage). Wood wastes are not separated and sold separately as fuels, they are burned in waste incinerators mixed with other waste materials. Current biomass fuelled power stations using chicken litter, straw and wood fired projects have been recently commissioned. The biomass industry receives limited support from government energy programmes as it is seen as an expensive alternative to other renewable technologies. When available, support is in the form of the renewable obligation, capital grants (energy crops), and exemption from the climate change levy. The biomass market in the UK is underdeveloped and is not at a stage to consider importing fuel. The production side is also insufficiently developed to produce surpluses for export..
Sweden	During 1998 the use of biofuels, peat etc amounted to over 92 TWh (over 330 PJ). Fuels used include black liquors from pulp mills, wood fuels (logs, bark, sawdust and energy plantations), refuse, peat, and straw and energy grasses. As Sweden has a strong forest industry the quantity of black liquors both produced and used in unusually large (125 PJ/a). About 1 million tons per year of pellets and briquettes are produced. More than 80 biofuel production companies are operating in the Swedish market, with more than 80% of them associated with forest industries. The main areas of biofuels utilisation are; the forest products industry (many by-products used for process heat and electricity production), district heating plants, the single family house sector (mainly logs and wood chips for heating), and electricity production. There are 125 biomass district heating plants, and 24 biomass CHP plants. District heating plants use mainly wood fuel, and some refuse. The use of wood fuels in this sector has more than quadrupled since 1990. Biofuels accounted for 3.8 TWh of power production in 1998, wood fuels (1.2 TWh) and black liquors (1.3 TWh) were used for electricity production in industrial CHP plants, the remainder (1 TWh) was from wood fuels in CHP plants supplying district heating. There is relatively extensive commercial importation of biofuels during the last few years in the form of wood fuels, salvaged wood, tall oil, crushed olive stones and peat. They are imported at prices lower than the home market. New burning capacities for solid biofuels are underway in the major export origin countries. This may mean that in the near future, Sweden becomes a net exporter of biofuels, particularly of densified fuels.

Source: AFB-net V, Targeted actions in bioenergy network, *Export & import possibilities and fuel prices –Task 2. (Individual country reports)*

6.0 RENEWABLE ENERGY – TRADE CODE ANALYSIS

This section examines the extent of trade between EU15 and non-EU export markets in a selection of renewable energy products, using a defined set of trade codes.

6.1 Background and approach

Official EU trade statistics, in value and in volume, contain data on the export of a large number of distinct products, each with its own "trade code". We have used these export data provided by EUROSTAT, for EU15, for the period 1995-1999, to provide an assessment of trade balances, imports and exports into and out of the EU, for various products relating to renewable energy. Such time series, or data for consecutive years, allow an analysis of developments and trends in the past, giving information on expected trends in the future.

A companion report[16] produced as part of this study provides a more detailed description of the approach taken to analyse trade code statistics, together with an assessment of data quality, advantages and disadvantages of using this approach. The current report uses the same approach and therefore the details are not reproduced here.

Data for the analysis were supplied from EUROSTAT, through its COMEX trade code database. Trade outside of the EU is analysed according to groups of countries, as follows:

Candidate countries	N America
Eastern Europe (non candidate)	Latin America
Mid East	Africa
S Asia	China
SE Asia (excluding China and Japan)	Australasia
Japan	

(For a full listing of countries within each country grouping, please see the companion report)

Table 6 below lists the codes identified for analysis. It is clear that at present, there are only a limited number of trade codes available relating to renewable energy sources. These focus particularly on solar sub-sectors, i.e. solar thermal water heaters and photovoltaics products. Trade codes relating to hydropower components are also included. Notable exceptions from this list include wind power and biomass. This is due to the apparent lack of a trade code at present that separately covers these industries.

[16] A Review of EU Eco Industries and Global Environmental Markets

Table 6 : Trade codes covering renewable energy sources

Sub-sector	Product Category	Trade code (Notes)
Solar Thermal	Instantaneous gas water heaters (excluding boilers or water heaters for central heating)	841911 OECD *(1)*
	Instantaneous or storage water heaters, non-electric (excluding instantaneous gas water heaters and boilers or water heaters for central heating)	841919 OECD *(1)*
Photovoltaics	Photosensitive semiconductor devices, including photovoltaic cells whether or not assembled in modules or made up into panels; light emitting diodes (excluding photovoltaic generators)	854140 OECD *(1)*
	Photosensitive semiconductor devices, incl. photovoltaic cells	85414090 (*2*)
	Solar cells whether or not assembled in modules or made up into panels (excluding photovoltaic generators)	85414091 *(3)*
Hydropower	Parts of hydraulic turbines, water wheels including regulators (excluding those of cast iron or cast steel)	84109090
	Hydraulic turbines, water wheels and regulators therefor (excluding hydraulic power engines and motors of heading no 8412)	8410
	Hydraulic turbines and water wheels of a power =< 1 000 kW (excluding hydraulic power engines and motors of heading no 8412)	841011
	Hydraulic turbines and water wheels of a power > 1 000 kW but =< 10 000 kW (excluding hydraulic power engines and motors of heading no 8412)	841012
	Hydraulic turbines and water wheels of a power > 10 000 kW (excluding hydraulic power engines and motors of heading no 8412)	841013

(1) The Environmental goods and Services Industry, Manual for data collection and analysis. OECD / Eurostat 1999.

(2) Code started in 1999

(3) Code ran from 1988 to 1998.

6.2 Pros and cons of using trade codes

The **advantages** of using trade codes analysis include the following:

- It offers updateable time series trade data, showing which markets are becoming more (or less) important, and allows a benchmark against which to compare performance.
- It offers both export and import data, comparability across Member States, and hence can demonstrate comparative advantages of countries across environmental goods.
- It provides wide-ranging analysis compared with supply side surveys, which can skew the importance of exports and markets.

However, there are a number of potential **disadvantages** of trade code analysis for renewable energy products:

- It is based on a limited set of product codes, some of which combine renewable energy products with products using conventional (fossil) energy sources.
- Some renewable energy product codes are not yet incorporated into the EUROSTAT reporting convention - particularly wind turbines and wind components, and any aspects of biomass technologies, including combustion equipment, fuel handling, etc.
- It is based on product codes only, so cannot consider exports or imports of services, nor can it consider combined technology and service packages.
- For biomass in particular, there is currently no measurement of biomass fuel trade exports/imports.
- It does not provide any details about the factors which drive the markets, nor detail the demand/preferences of the markets, which would be needed to develop appropriate market entry strategies.

Analysing renewable energy trade codes can therefore only give a limited and incomplete picture of the status of renewable energy exports and imports. Nevertheless, the fact that some renewable energy products are now represented in standard EUROSTAT statistical reporting procedures is a significant step towards standardising renewable energy products as part of the mainstream trade reporting.

6.3 Sub-sector trade code analysis

The following sections provide the results for each of the trade listed in Table 6 of four analyses:

- **Total EU15 trade balances** (1995-1998/9): summaries of the total imports, exports and net balances of trade for the EU15.
- **Sources of imports** from outside of the EU15 (1999): total value of imports into the EU15, and origin of these imports.
- **Destination of exports** to outside of the EU15 (1999): total value of exports from the EU15, and destination of these exports.
- **Member State trade balances** (1999): trade balances for each of the EU15 member states, showing total imports, exports and the resulting balance of trade. Imports and exports are reported for both intra-EU trade and extra-EU trade. In all of the trade balance figures, the first column relates to imports, the second to exports, and the third column to the trade balance.

6.3.1 Instantaneous Gas Water Heaters

These are included in Table 6 because of its inclusion in the OECD manual. However, there are doubts over the totally renewable nature of this technology, as it would seem to be focussed on gas fired domestic hot water heaters.

Figure 10 : Total EU-15 Trade Balance (Instantaneous gas waterheaters)

The EU15 has a net positive trade balance with non-EU countries, which has expanded from about 30 M Euro in 1995 to nearly 40 M Euro by 1999. Total exports have increased nearly 50% from 40 M Euro to nearly 60 M Euro by 1999.

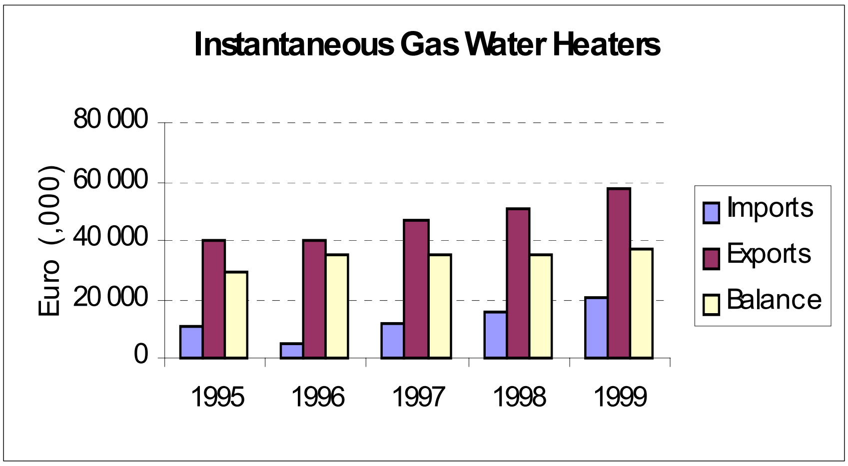


Figure 11 : Source of Imports (1999) (Instantaneous gas waterheaters)

Of the 20 M Euro imports in 1999, 85% are listed as being derived from Candidate countries. North America is the only other region providing any significant imports of these heaters.

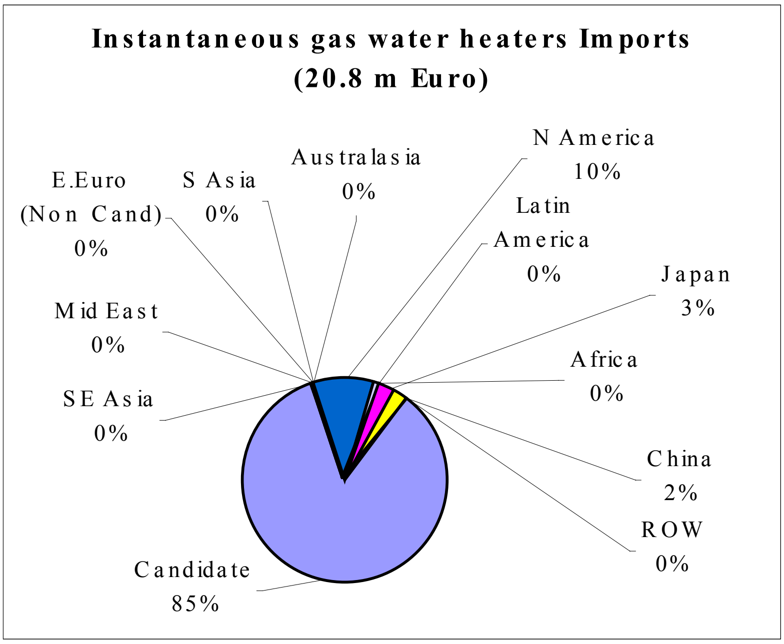


Figure 12 : Destination of Exports (1999) (Instantaneous gas waterheaters)

The market for exports of these water heaters is very diverse. The largest proportions are to Candidate countries, North America, Latin America and Africa. A collection of smaller export markets, combined, make up about 15% of the total export market.

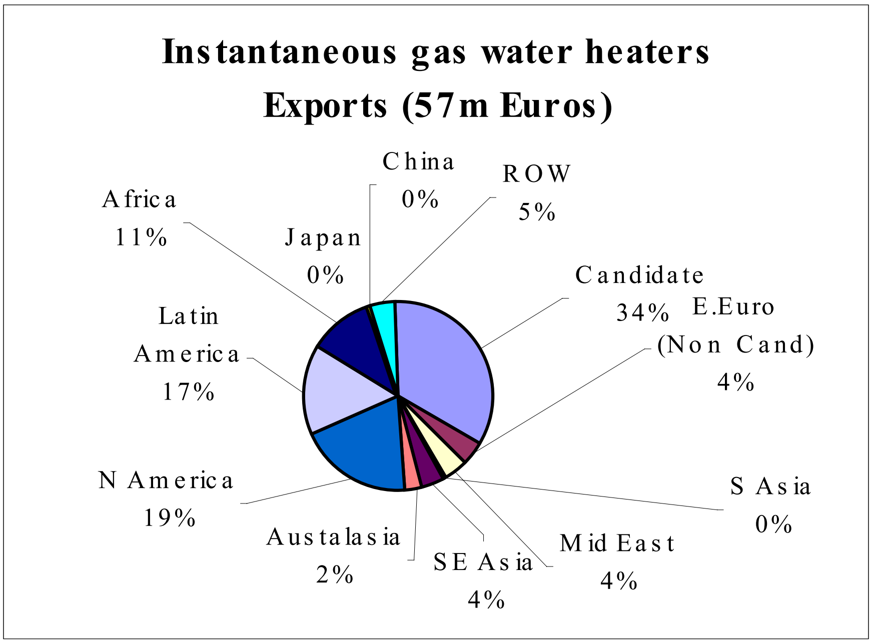
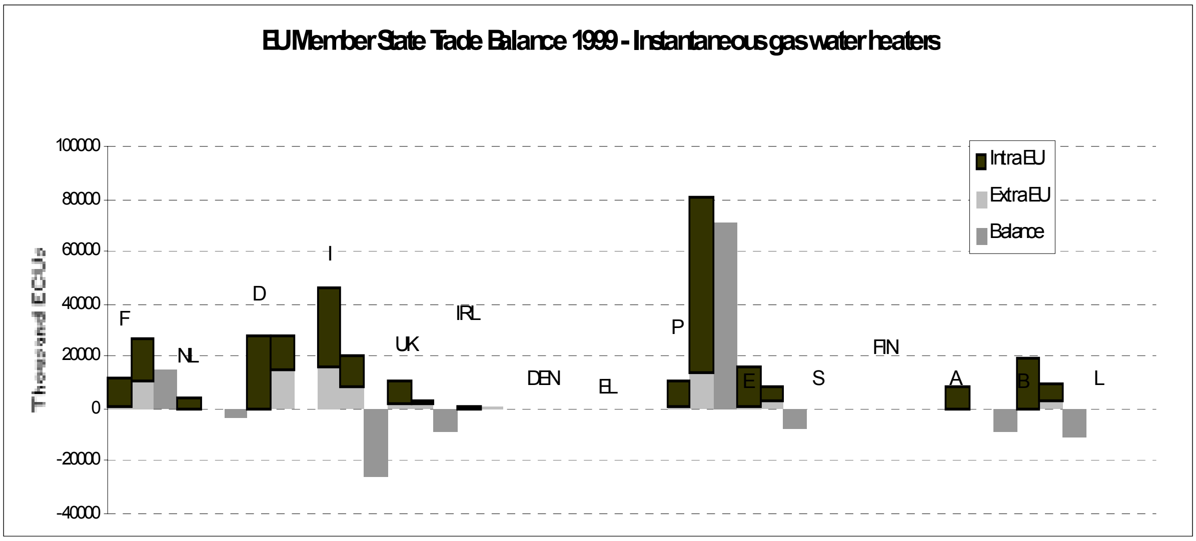


Figure 13 : Member State Balances (1999) (Instantaneous gas waterheaters)

Germany and Italy import the greatest value of these water heaters. France, Germany and Portugal are the principal sources for export, with Portugal reported to be the most active exporter with exports of 80 M Euro. The majority of exports are intra-EU. Italy, Spain, the UK, Austria and Belgium all have negative trade balances.



Note: 1st column relates to imports, 2nd column to exports, 3rd column to trade balance.

6.3.2 Instantaneous Non Gas or Electric Water Heaters

This category is used due to its inclusion in the OECD manual. The code is presumed to include solar thermal panels.

Figure 14 : Total EU-15 Trade Balance (Instantaneous non gas or electric waterheaters)

Both imports and exports have increased slightly over the period 1995-1999. Exports from the EU reached 80 M Euro in 1999, with a trade balance of nearly 40 M Euro.

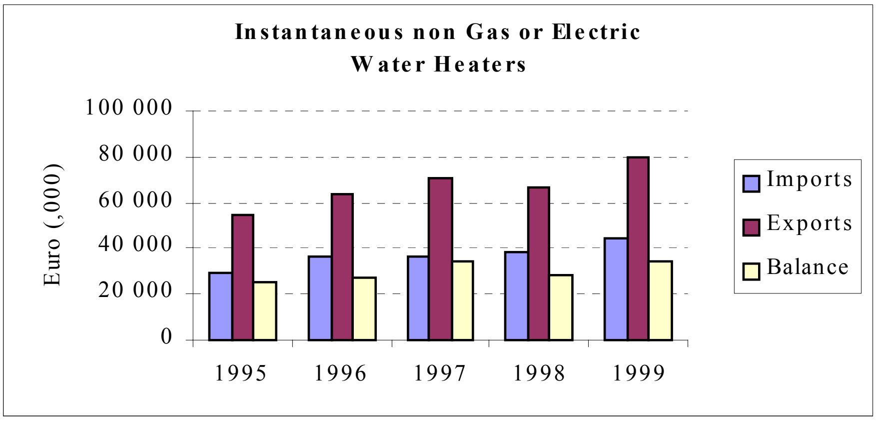


Figure 15: Source of Imports (1999) (Instantaneous non-gas or electric waterheaters)

A third of imports of these water heaters originate from Candidate Countries. Some imports also derive from North America and Australasia. The "ROW" category represents 26% of the total, this indicates that a large proportion of the reporting is presented as unaccounted trade.

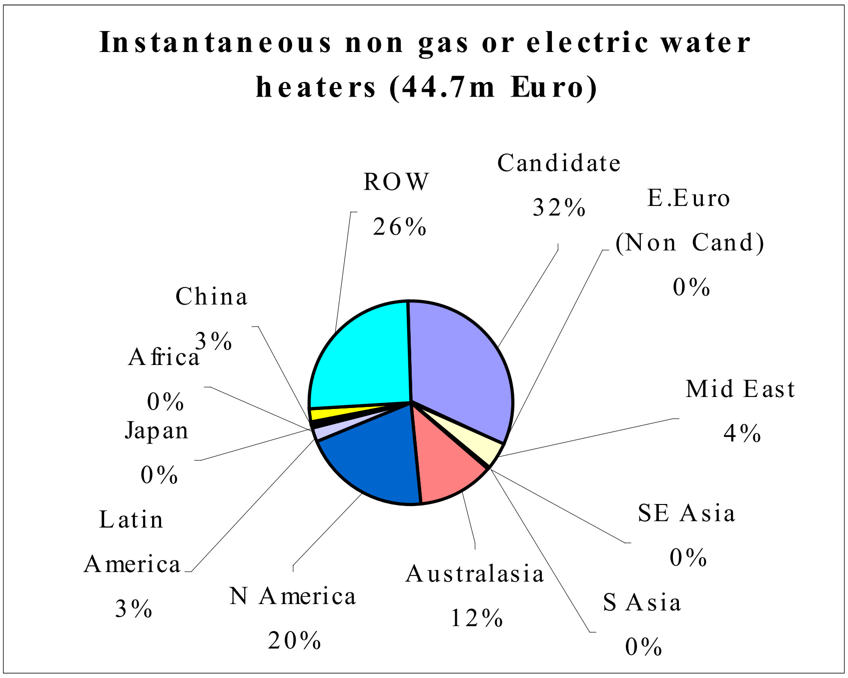


Figure 16 : Destination of Exports (Instantaneous non-gas or electric waterheaters)

The export markets for these water heaters is diverse. Candidate Countries receive a 34% market share, but as with the imports, there is a correspondingly significant ROW classification (25%), indicating that data reporting may not be complete.

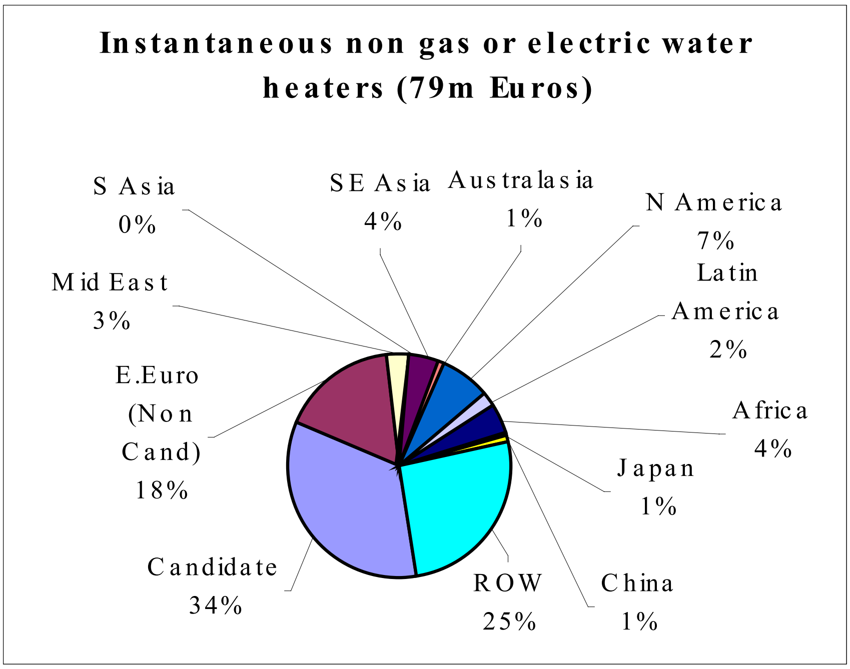
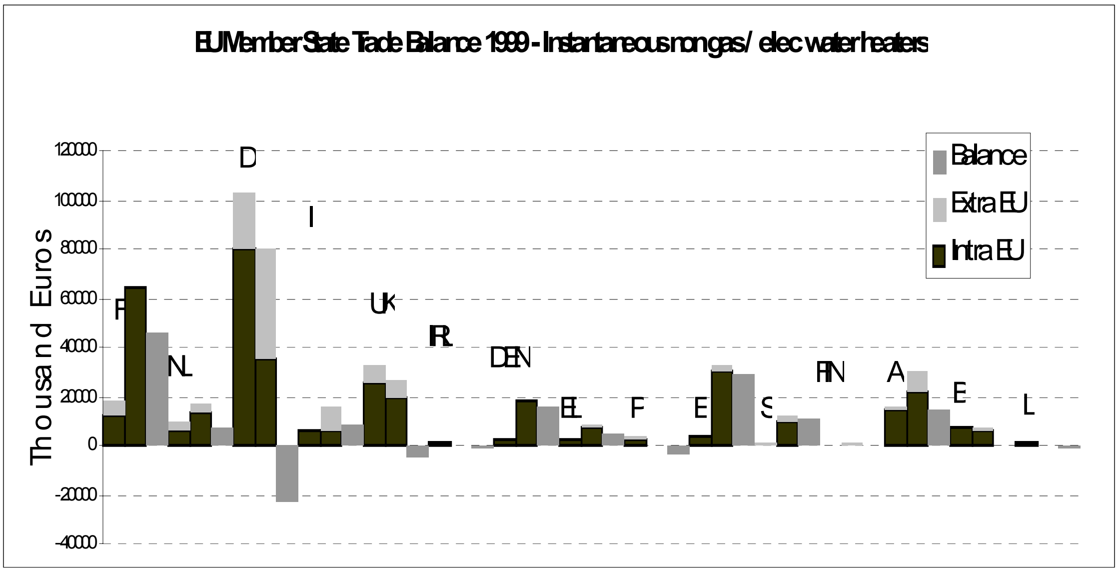


Figure 17 : Member State Balances (1999) (Instantaneous non-gas or electric waterheaters)

Germany and the UK import a large amount of these water heaters, and have an accompanying negative trade balance. Most other Member States have neutral or slightly positive trade balances. France, Germany, UK, Denmark, Spain and Austria all report exports, most of which are intra-EU (except for Germany, which also exports extra-EU).



Note: 1st column relates to imports, 2nd column to exports, 3rd column to trade balance.

6.3.3 Photovoltaics

This section is incorporated due to its inclusion in OECD manual. The fact that photovoltaic generators are specifically excluded is worthy of consideration.

Figure 18 : Total EU-15 Trade Balance (Photovoltaics)

Although both exports and imports have increased between 1995-1999, the EU's trade balance in photosensitive semiconductor devices overall is negative (nearly 500 M Euro).

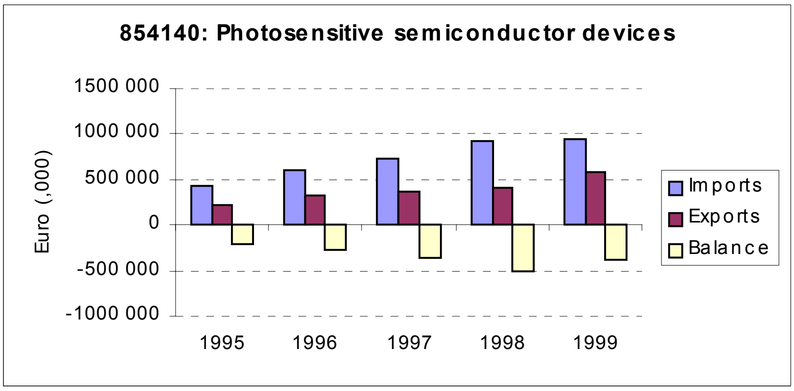


Figure 19 : Source of Imports (1999) (Photovoltaics)

Principal sources for import of photosensitive semiconductor devices are SE Asia (25%), Japan (24%), North America (20%). There is also a large (27%) ROW component of unallocated trade. Total value of imports was 949 M Euro in 1999.

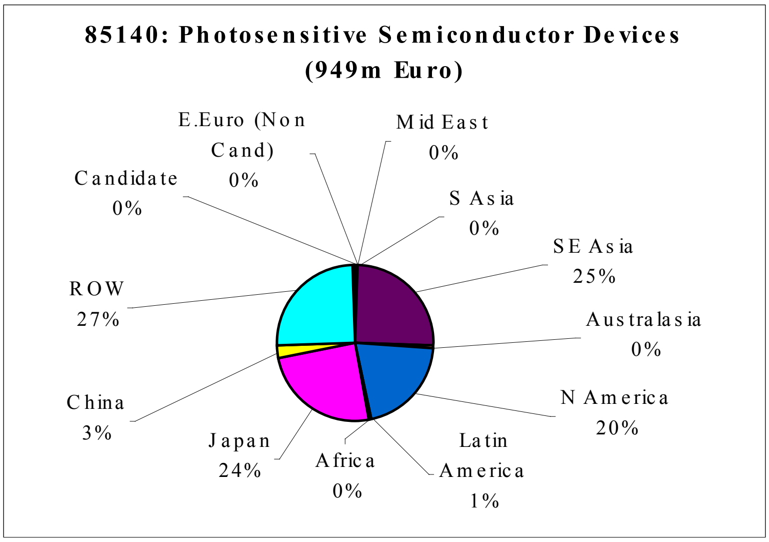


Figure 20 : Destination of Exports (1999) (Photovoltaics)

EU export destinations for photosensitive semiconductor devices are worldwide. Total value of exports was 575 M Euro in 1999 (374 M Euro less than imports). Principal markets are North America (25%) and SE Asia (16%). However, once again there is a very large ROW category which is not allocated to a specific region destination.

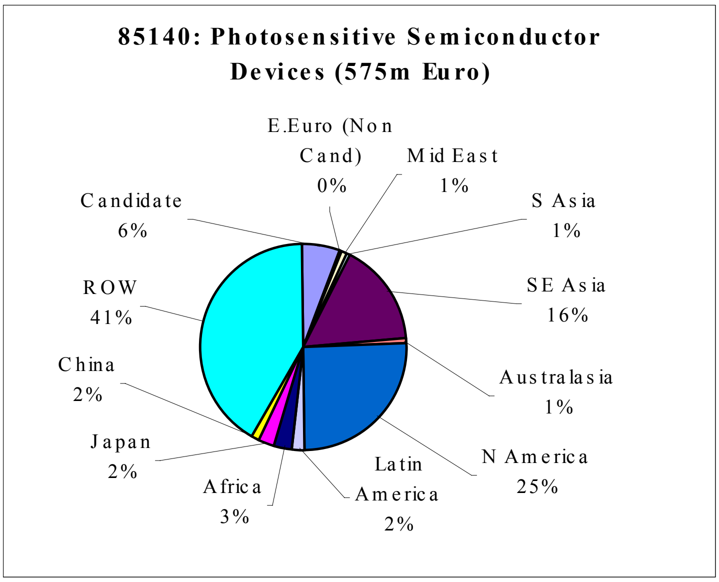
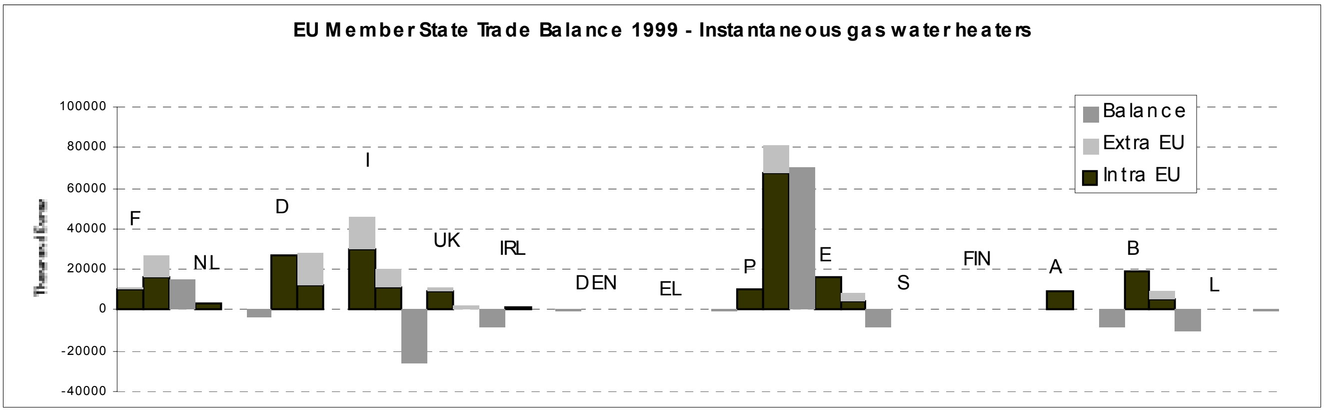


Figure 21 : Member State Balances (1999) (Photovoltaics)

Germany and Italy report large imports. France, Germany, Italy, Portugal all report large exports, both intra- and extra-EU. Italy, UK, Spain and Belgium all report negative trade balances. Notably, however, the total size of the negative trade balances does not correspond with the total EU-15 surplus reported.



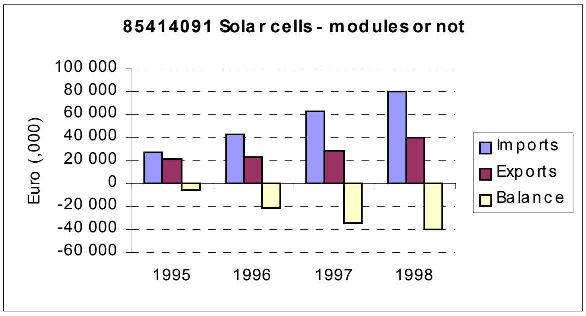
Note: 1st column relates to imports, 2nd column to exports, 3rd column to trade balance.

6.3.4 Photovoltaics Continued

Codes covered are;
85414091 .88-98 Solar Cells Whether Or Not Assembled In Modules Or Made Up Into Panels (Excl. Photovoltaic Generators) (Stopped in 1998)
85414090 .99- Photosensitive semiconductor devices, incl. photovoltaic cells. (started in 1999)
The date overlap on these two codes indicates that the one that started in 1999 is a refinement/expansion of the earlier code. The description of the new code has a good correlation with renewable energy applications. However, closer examination indicate that the amount of trade included in the new code is considerably greater than in the earlier one, therefore it is not possible to use the two in a time series evaluation.

Figure 22 : Total EU-15 Trade Balance (Photovoltaics)

Both the old and the new codes show the EU-15 with a large negative trade balance. The new code from 1999 records about a ten-fold greater volume of trade compared with the earlier code. The new code covers a significantly higher quantity (value) of trade (40 M Euro exports in 1998, nearly 400 M Euro in 1999). Balance in 1998 was 40 M Euro deficit; in the 1999 accounting this expanded to 200 M Euro deficit.



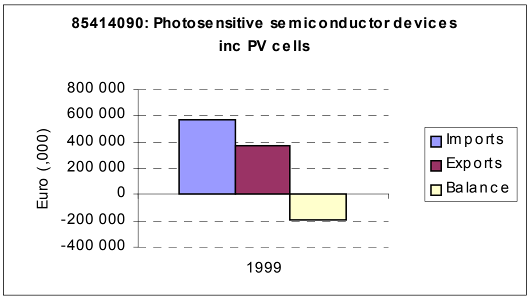
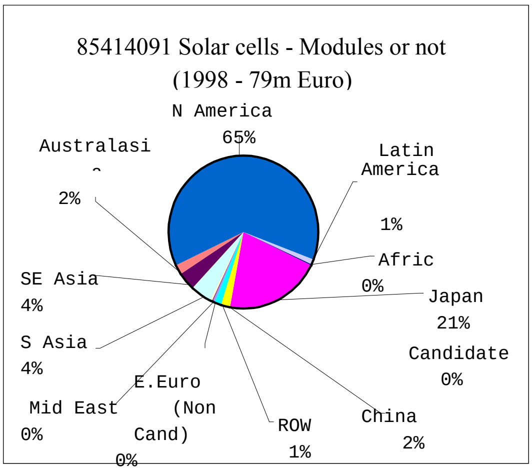


Figure 23 : Source of Imports (1999 / 1998) (Photovoltaics)

Again, the new code incorporates a far higher value of trade. The old code indicates imports dominated by North America (65%), but this drops to 20% in the new 1999 code. Japan is a high source of imports for both codes (21% in 1998, 23% in 1999). The new code has 38% of imports accounted for under the 'rest of world' category, i.e. unallocated trade.



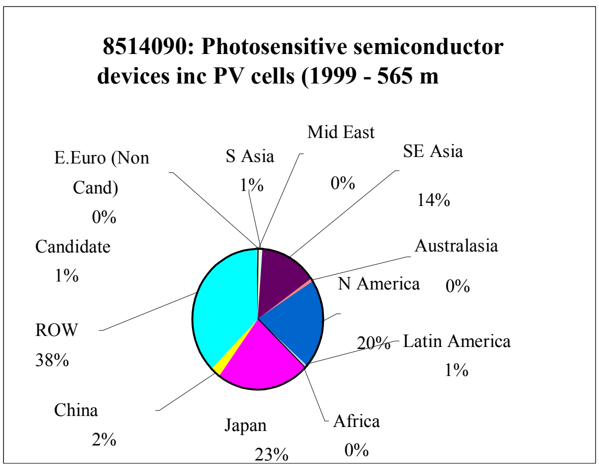
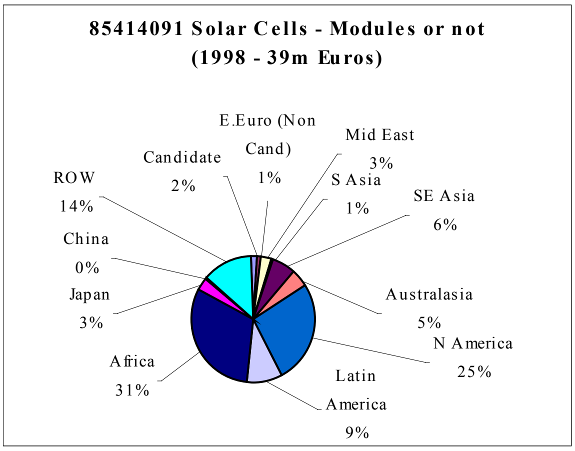


Figure 24 : Destination of Exports (1998 / 1999) (Photovoltaics)

The new code captures a larger amount of trade (370 M Euro compared with 39 M Euro in 1998), but the destination of the majority of it is unaccounted for. The old code has a diverse export market where Africa and N America feature prominently. The new code still shows North America and Africa as significant (Africa less so), while SE Asia has increased its proportion of the trade.



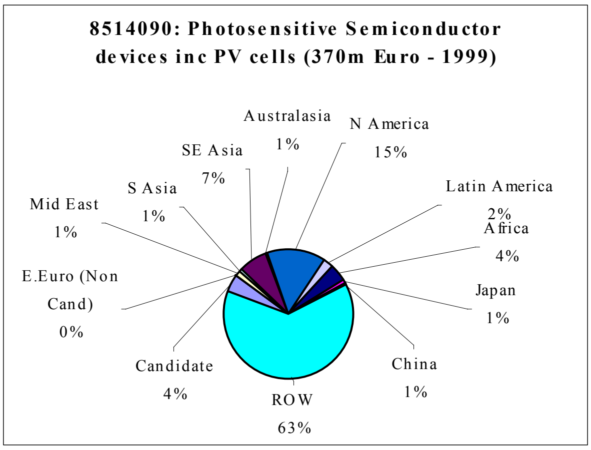
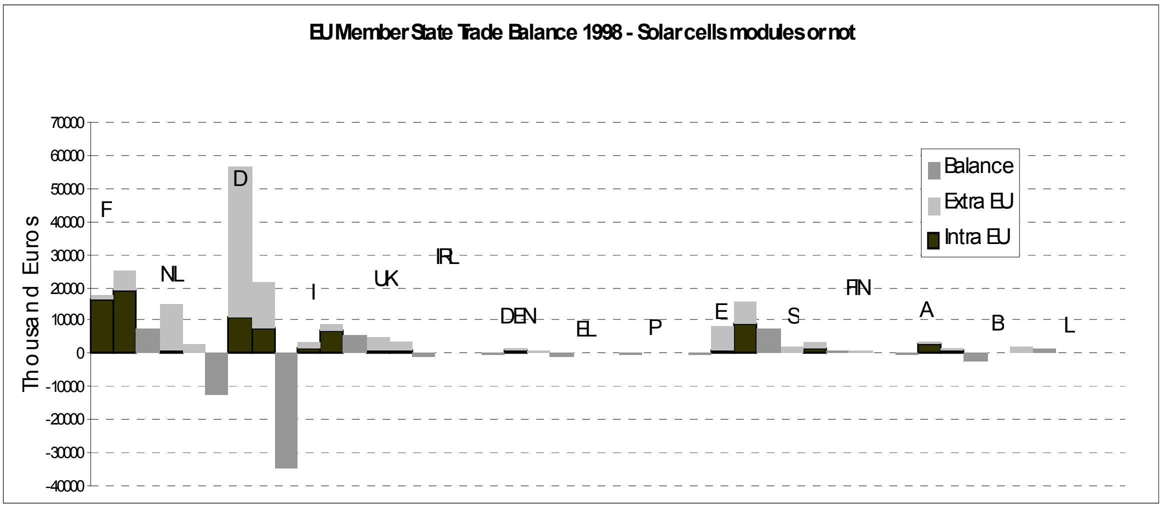
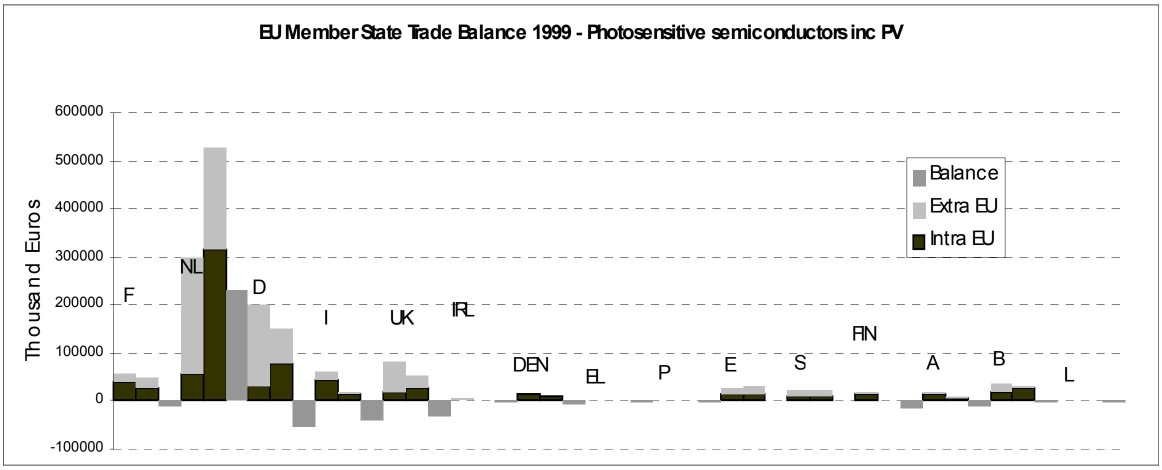


Figure 25 : Member State Balances (Photovoltaics)

The previous Figures indicates a negative balance of trade totalling about 200 M Euro. However, this does not correspond directly with the data presented for individual member state balances, indicating some data quality or completeness issues.

The Netherlands and Germany had negative trade balances in 1998, but under the new 1999 reporting, the Dutch trade balance was positive (200 M Euro), with Germany, Italy and the UK having the principal trade deficits. In 1999, the principal member states with imports and exports of photosensitive semiconductor devices were the Netherlands and Germany, and, to a smaller extent, Spain. The UK also indicated a small positive export activity.
The Netherlands is reported as the largest exporter (500 M Euro) and importer (300 M Euro) in 1999, with a large proportion of intra EU imports. Germany reports both imports and exports of about 200 M Euro in 1999.





Note: 1st column relates to imports, 2nd column to exports, 3rd column to trade balance.

6.3.5 Hydropower

Hydropower differs from the other renewable technologies, in that it is a much longer established industry. The trade codes analysed are given in Table 7.

Table 7 : Trade codes analysed under Hydropower.

84109090 .90- Parts Of Hydraulic Turbines, Water Wheels Including Regulators (Excl. Of Cast Iron Or Cast Steel)
8410 .88- Hydraulic Turbines, Water Wheels And Regulators Therefor (Excl. Hydraulic Power Engines And Motors Of Heading No 8412)
841011 .88- Hydraulic Turbines And Water Wheels Of A Power =< 1 000 kW (Excl. Hydraulic Power Engines And Motors Of Heading No 8412)
841012 .88- Hydraulic Turbines And Water Wheels Of A Power > 1 000 kW But =< 10 000 kW (Excl. Hydraulic Power Engines And Motors Of Heading No 8412)
841013 .88- Hydraulic Turbines And Water Wheels Of A Power > 10 000 kW (Excl. Hydraulic Power Engines And Motors Of Heading No 8412)

Figure 26 : Total EU-15 Trade Balance (Hydropower)

The hydropower sector has a positive balance in all aspects. The largest value of trade is in large capacity units, this is unsurprising due to the high capital costs involved.

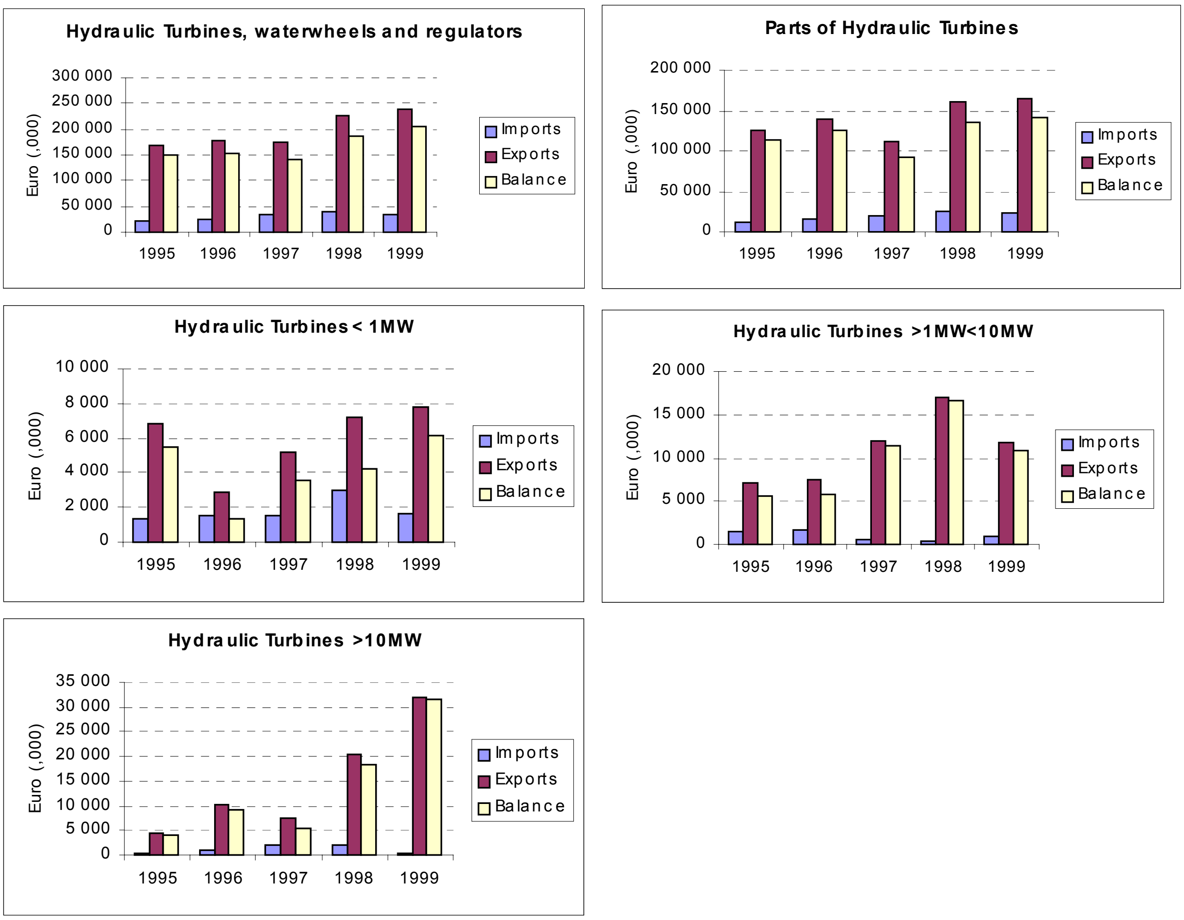
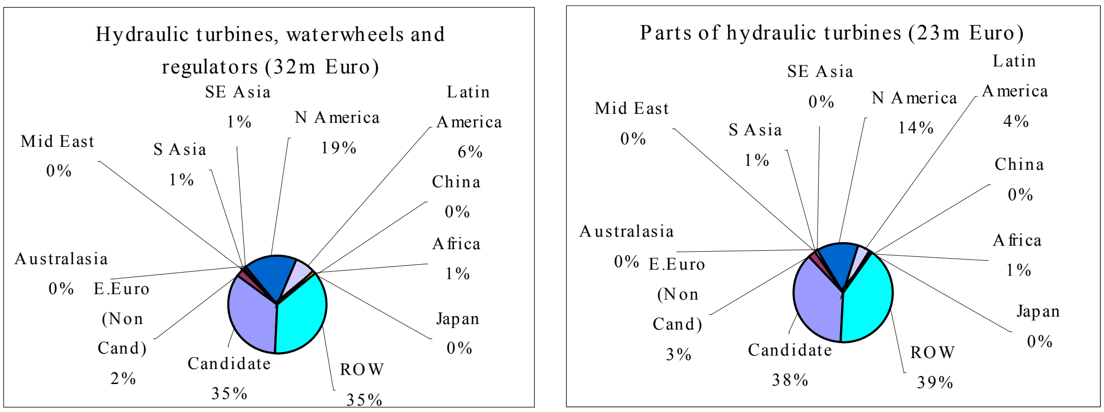
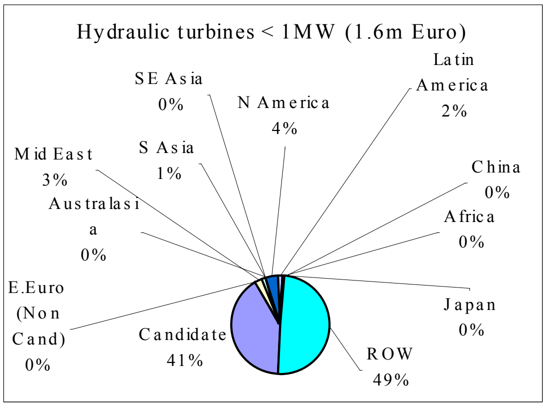
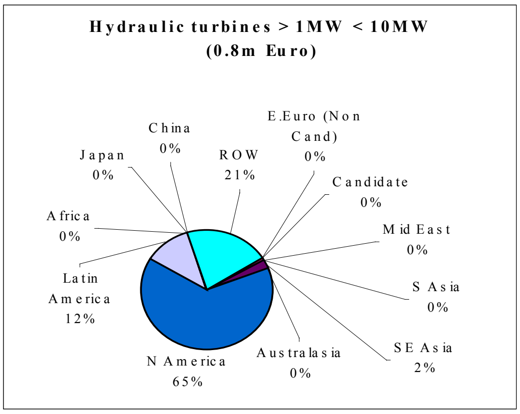


Figure 27 : Source of Imports (1999) (Hydropower)

There are relatively small value of imports in this sector. The import of parts is by far the most significant area. The size of figures for larger turbines (>1MW) would suggest that this section refers to parts only rather than to whole sets. The Candidate countries have mainly minor exports of small turbines.







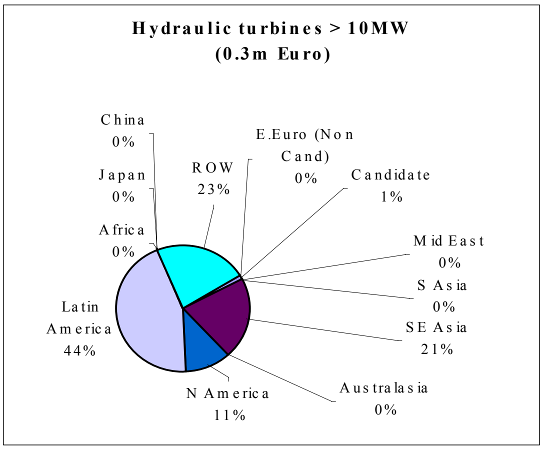
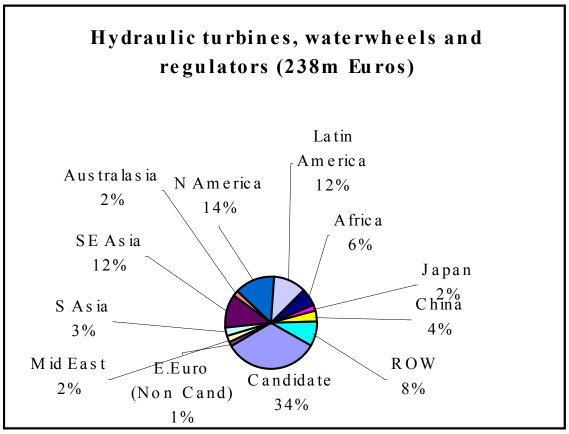
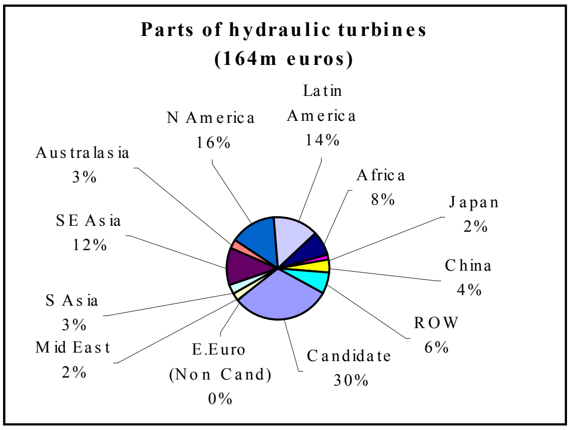
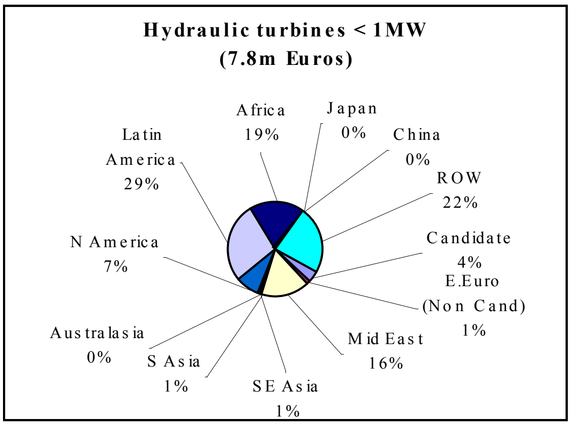


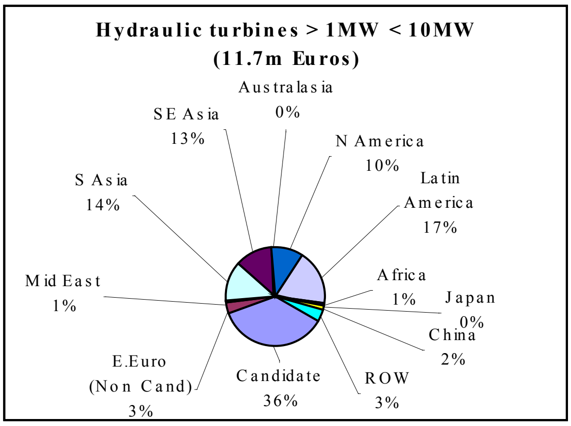
Figure 28 : Destination of Exports (1999) (Hydropower)

EU countries have a diverse hydropower export market. The Candidate countries represent a major market and there are also considerable exports to Latin America and Africa in the small hydropower sectors.









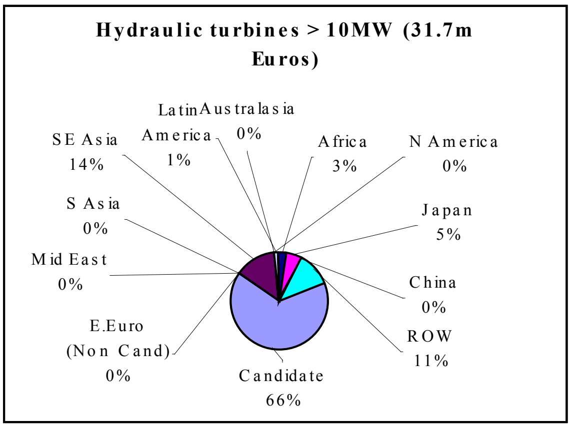
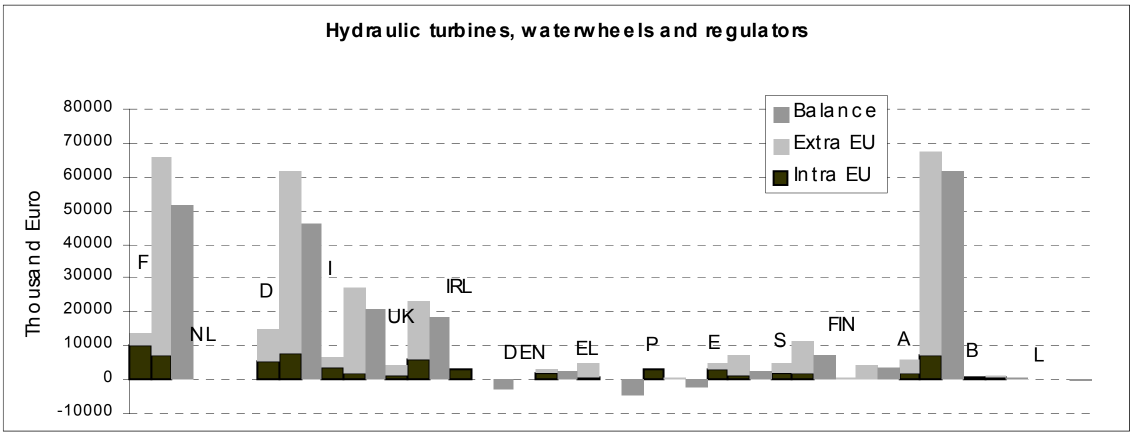
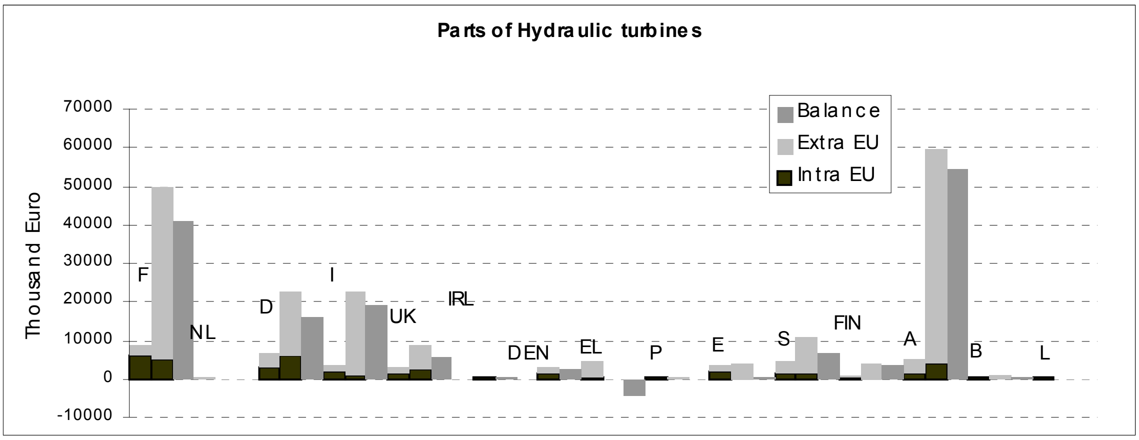


Figure 29 : Member State Balances (1999) (Hydropower - parts)

France, Germany, Italy, UK and Austria dominate hydropower exports, showing a link to states which have a large hydro capacity of their own (e.g. Austria). The majority of exports are to extra-EU locations. This could be a consequence of a mature EU market.

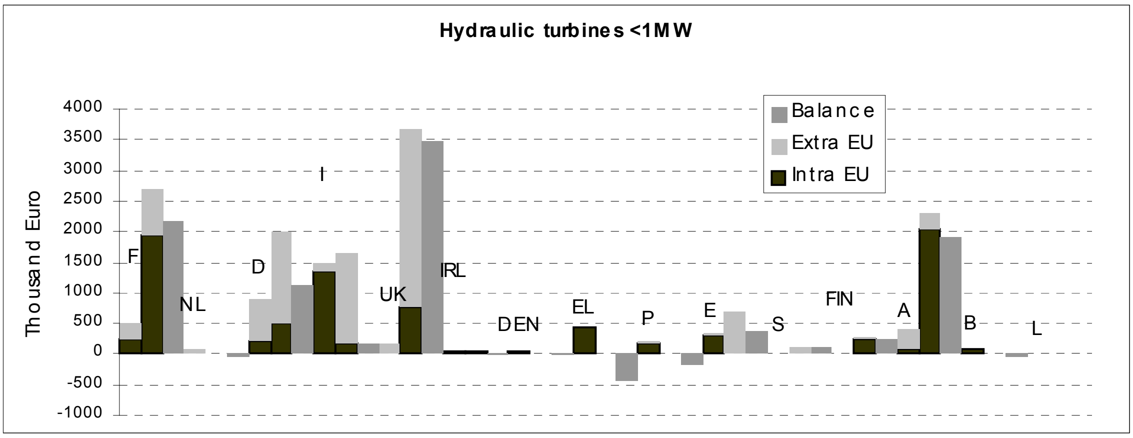


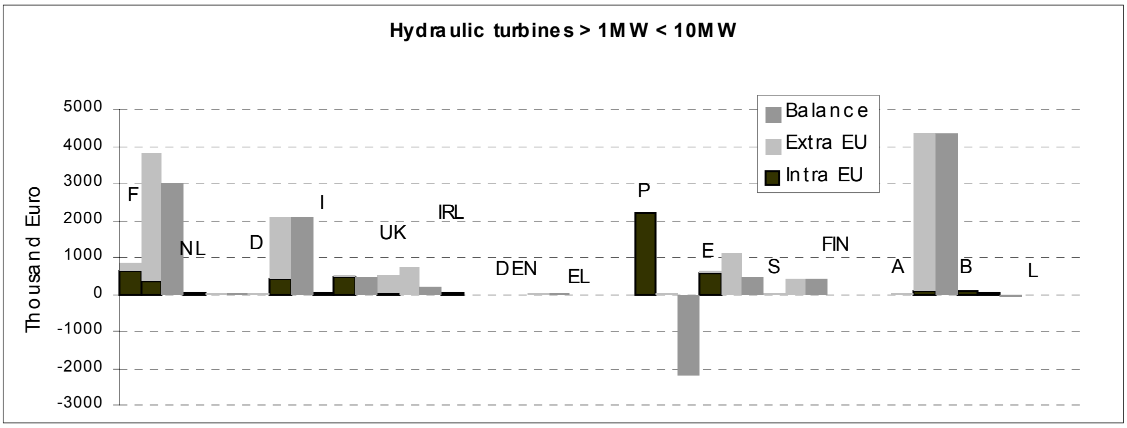


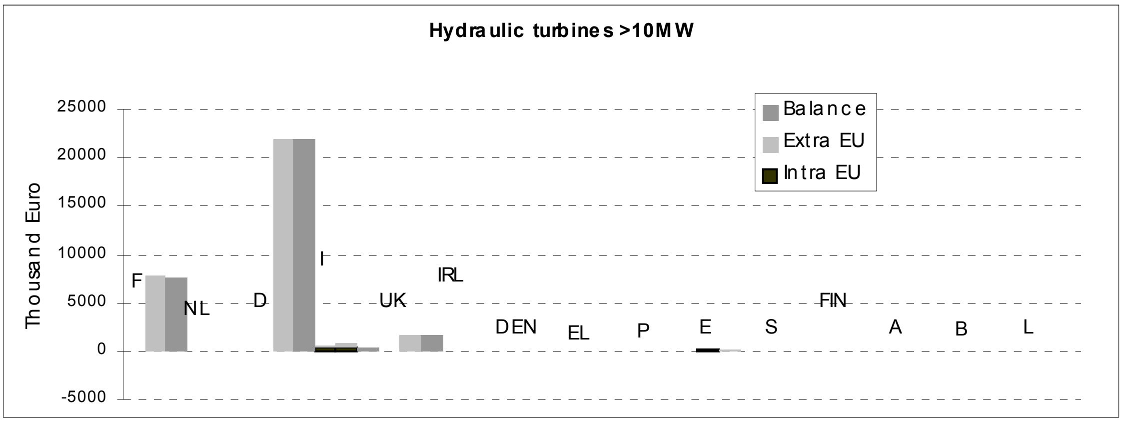
Note: 1st column relates to imports, 2nd column to exports, 3rd column to trade balance.

Figure 30: Member State Balances (1999) (Hydropower - small/larger scale)

Many member states are active in exporting and importing small hydro turbines. There is evidence of the presence of an intra EU market. Concerning the mid size hydro, Portugal imports, while France Germany, and Austria all export. In large scale hydro, France and Germany are major exporters, with the UK also having some exports. This indicates a mature market in the EU.







Note: 1st column relates to imports, 2nd column to exports, 3rd column to trade balance.

6.4 Conclusions

This is the first time that trade codes for renewable energy products have been included in an Eco-industries assessment. The use of trade code analysis gives an indication of the size of trade in renewable energy products, both intra- and extra- EU15 member states.

The analysis has identified the following:

- The EU15 has a positive trade balance in waterheaters, with exports of 60 M Euro exceeding imports of about 20 M Euro. Although not all of the products included in this trade code will be solar water heaters, nevertheless it indicates that the EU has a healthy domestic water heating industry, and this has the potential to diversify into renewable products.

- The EU15 has a negative trade balance in photovoltaic products, including semiconductor devices and related products of relevance to the renewable photovoltaic industry. In 1999, this trade deficit was approximately 200 M Euro.

- The EU15 has a strong but generally steady positive trade balance in hydropower activities, including large and small scale turbines and parts. Exports are achieved worldwide, particularly to candidate countries and Latin America.

Limitations of the analysis include the following:

- There is at present no trade codes for two major renewable energy areas, namely wind and biomass. Other emerging technologies with good export potential are wave, tidal, fuel cells, none of which can be identified through trade codes as yet either.

- Under the present trade codes, these renewable energy products are mixed with non-renewable products as well. This is particularly significant for water heaters and for photovoltaic semiconductor devices.

- Data reporting is not always consistent, particularly with relating total EU trade with individual member states trade flows. Thus in some instances the reported trade deficit for the EU15 is greater than the sum of individual member states trade balances (e.g. for photovoltaics).

- Country destinations are not always stated, which results in a large proportion of the destinations reported as ROW “rest of the world”.

Despite these limitations, the use of trade codes could be a useful tool in monitoring the expansion of trade in renewable energy in the future. A fuller set of trade codes would need to be established (particularly for wind etc.), with detailed descriptions of the content of each, to ensure that only renewable energy products were included in the code. Member states would also need to be encouraged to provide complete reporting of trade quantities and country destinations.

The renewable energy industry is one of the fastest growing sectors in the EU. The results presented here demonstrate that it is a strong and expanding industry that has now reached a sufficient state of maturity for it to warrant comprehensive monitoring and reporting of its trade flows. Use of trade code analysis, combined with qualitative trade surveys and evaluations, can help to identify and target the most appropriate measures and activities to ensure that the industry continues to expand into a world-class sector.

7.0 CANDIDATE COUNTRIES

This section briefly draws together information about the current status of renewable energy use in Candidate Countries, resources and future potential.

7.1 Renewable energy consumption

According to EUROSTAT data from 1998, gross inland renewable energy consumption (GIC) in the Candidate Countries was as follows:

Table 8: Gross Inland Consumption of renewable energy in selected Candidate Countries (1998)

Country	GIC in ktoe	% of total GIC
Bulgaria	678	3.30
Czech Republic	327	0.81
Estonia	507	9.86
Hungary	407	1.62
Latvia	1047	24.29
Lithuania	591	6.35
Poland	3870	3.99
Romania	4660	11.42
Slovakia	662	3.59
Slovenia	521	8.01

Source: Eurostat

To date, biomass resources have been one of the main renewable energy resources exploited in Candidate Countries, along with large scale hydro. This is because of the large natural biomass resource available in many of the Candidate Countries, and its widespread use as a non-commercial heating fuel resource. There is now an increasing interest to exploit biomass more widely both for heating and power applications.

Table 9 shows the promising biomass resources available to candidate countries in the future. Table 10 shows the amount of biomass resource potential already utilised in the candidate countries. Table 11 gives the value of potential biomass resources, available for energy use in the short term (defined as 2000 to 2005) The information is taken from a study completed for the FAIR programme in 1999[17].

[17] Development of a bioenergy market development plan for Central Europe. FAIR-CT98-3826.

Table 9 : Promising biomass resources in the candidate countries

Table 10 : Biomass potential already utilised in the candidate countries (PJ).

Table 11 Biomass potential (currently not utilised), available for energy use, short term (2000-2005) (PJ)

Key trends

- Forest residues and wood waste from wood processing units are the main sources of biomass already used in many of the Candidate Countries, particularly in Hungary, Latvia and Poland. Both of these resources are almost entirely used in heat production, particularly as firewood.

- Straw and other field crops are also used to a lesser extent, in Hungary, the Czech Republic, Latvia and Poland.

- The greatest potential use of biomass resources in the short term (to 2005) lies in a greater use of wood wastes from processing units, from forest and other biomass resources, and from agricultural residues. These are seen mainly as heat production resources, although there is some potential for power applications in the Czech Republic from straw resources.

- The study indicates that biomass use from forestry resources has the potential to more than double in many countries by 2005, particularly countries with high levels of existing use such as Poland and Hungary. Straw use is predicted to expand considerably in many countries, compared with its current very low levels of use. The Czech Republic, Poland and Hungary indicate that this resource may be exploited rapidly in the short term.

- Major CHP opportunities in the short term lie in the use of sewage sludge (biogas) and landfill gas, with some possibilities for power production alone.

- Energy crops (either as solid or liquid fuels) are not predicted to be exploited to any great extent in the short term. The only exception is the possibility of biodiesel development in the Czech Republic, and a small amount of short rotation forestry (SRF) in Hungary.

- In the longer term (to 2020 and beyond), energy crops as solid fuels (SRF) are predicted to provide an increasing resource for both heat and power production in a selection of countries, including in Poland, Romania and Slovakia. The study indicated that liquid fuels (bioethanol and biodiesel) may also be developed in some countries, although to a lesser extent.

- Wood wastes from wood processing units, fire wood, and felling residues from forestry have promising potential to shift from short term emphasis on heat production to a longer term emphasis on CHP in many countries.

- Farm animal wastes (biogas) in the mid to long term can become more widely utilised in both heating and CHP sectors. This also applies to biogas derived from agro-industrial liquid wastes.

7.2 Candidate Country Summaries

7.2.1 Czech Republic

In 1994, the share of renewable energy sources (comprising solar, wind, water, and biomass) represented 1-2% of the total power generated.[i] Installed capacity in renewable sources is still very small and the 1998 figures did not exceeded 20 MW[ii]. A renewable sources energy market share of 6% is expected by 2010.[iii] CEZ (the main Czech generator) has been operating a wind generator (0.315 MW) since 1993 and operation of another (1.165 MW) was expected to commence soon. Independent producers operate wind generators with installed capacity of approximately 14 MW[iv]. Operation of a 0.010 MW photovoltaic source by CEZ began in 1997. Installed capacity in hydro plants is covered mainly by three large pumped storage hydro plants (of total capacity of 1,145 MW), and a number of smaller hydro plants with total capacity of 727 MW, operated by CEZ. Independent producers operate hydro plants with total installed capacity of about 60 MW.[v]

7.2.2 Estonia

Around 8 percent of the energy production is based on using biomass. This figure is expected to grow to 11% by 2005 due to Estonia's abundant peat and forestry reserves, and the lesser impact of biomass use on the environment in comparison with the use of either oil shale or oil fuel.

7.2.3 Hungary

Hungary has large biomass resources that are not used commercially. Wind energy in Hungary is well studied, but as yet there is little commercial experience with this technology. Small scale hydro is restricted to a small number of projects in the north and east. Geothermal energy has little current application but some existing opportunities. Waste to energy has limited opportunities for future development in the district heating systems.
The 1999 energy plan points to increased use of renewable resources,[vi] and the government is looking into alternative, renewable sources of energy (solar, wind, water) for the future.
A significant part of the Hungarian electricity sector was privatised in 1995 and 1996 German, French, Italian, Belgian and Finnish strategic investors acquired majority stakes in key power utilities.[vii] The World Bank has had a number of environmental projects in Hungary recently including a project on the use of renewable energy. Projects in this scheme include one applicable to straw (Szekesfehervar) and another applicable to wood (Szombathely) to increase the use of available biomass resources.

7.2.4 Latvia

To become more independent from imported electricity to meet local needs, the Latvian government supports private initiatives for construction and commercial activity of small-scale hydropower, wind generators and co-generation equipment. Electrical power produced by small generators benefits from higher tariffs compared with the larger scale generation. [viii]
The Public Investment Program for the development of energy sector (1999) includes 25 projects with a total cost of LVL 21.2 million (36 million Euro). The Energy Efficiency Fund,

which began in 1998, provides loans to smaller plants, basically for replacement of present equipment with more efficient equipment.[ix]

7.2.5 Romania

In 1999, hydro and nuclear together comprised 15% of the Romanian energy use (8% in 1990). The share of renewable energy sources (RES) in the primary energy consumption is 5.3 %; excluding large hydro, RES account for only 2.9%..[x]

Major emphasis is put on the regeneration of the hydro sector which currently stands at 6000 MW in installed hydro electric power stations, yet only 40% of the hydro potential is currently used. The restructuring and promotion of hydroelectric power in Romania will involve rehabilitation of the large power plants (providing 85% of the national energy system), Investment for providing new technologies for 42 hydro aggregates is estimated at 350 M USD (318 M Euro) and for completing the unfinished HPPs, for an estimated 110 M USD (100 M Euro) [xi] Plus there is an additional investment in building new capacities (900 MW) of an estimated 1.6 billion USD (1.5 billion Euro).
Much of the equipment and technologies now in place in the Romanian factories is European origin, purchased in sixties and seventies. The Romanian import market for equipment related to the energy sector is dominated by German, French and Italian companies. [xii]

7.2.6 Slovakia

Electricity production in Slovakia remains a state-controlled industry. There are up to 100 companies dealing directly with renewable energy sources (RES) in Slovakia. RES represent about 3% of annual primary energy sources consumption. Almost no subsidies and transforming legislation exist to support this market. Planned privatisation of the energy utilities, where foreign strategic partners and investors are expected to enter energy market on a large scale, will lead to larger utilisation of the potential of RES in the country. It is expected the number of companies will increase (double) after action plans for energy efficiency and RES will be approved in Parliament (2003). Commitments from the IPCC (Kyoto protocol), hold biomass resources as the most important sources of CO2 reduction in the Slovak conditions.

The most active and represented countries within the Slovak energy sector are Austria, Denmark, The Netherlands, Germany, Czech Republic and USA.

Box 6 : The job creation potential of new energy technology investments in Slovakia, (study conducted by Energy Centre Bratislava, May 2001)

In the sector of renewable energy sources and efficient energy use the following figures are applicable for Slovakia:[xiii]

- Thermal insulation of all residential buildings that do not comply with present technical requirements by the year 2015 would create around 24,200 jobs per year. Present employment rate for thermal insulation is of 3,600 jobs per year.
- Complete utilisation of economic potential of small and medium sized combined heat and power (CHP) by the year 2010 would create some 1,100 jobs per year.
- Complete utilisation of potential of energy production from biomass (30 PJ) by the year 2010 would bring approximately 3,800 new jobs.

7.2.7 Slovenia

The government document "Strategy of Efficient Use and Supply of Slovenia" (1995) discusses renovation of hydro power plants and phasing out and substitution of thermal power plants.[xiv] Estimated investments into renewable energy sources are US$1, 505 M (1,370 M Euro) (1993-2010). Hydropower accounted for 25% of the 2,514 MW of installed electric capacity in 1994. A counselling network had been implemented by the Slovenian Building Centre (Gradbeni centre Sloveinje), stimulating the take up of solar thermal energy, mostly used for heating household water. To replace old capacity and cover growing demand, up to 1,500 MW of new capacity will have to be constructed to the year 2020, including investments in automatisation of hydropower stations. [xv] [xvi]

7.2.8 Turkey

Turkey's production of solar energy is only about 377 TJ (compared with Spain which produces about 1,663 TJ per year). The greatest potential is in the South Eastern Anatolia region. Of the geothermal resources, only 200 MW of a potential 4,500 MW capacity for energy generation and only 1,000 MW of a 31,100 MW heating capacity is currently being exploited. At present there is only one (7 MW) unit that produces wind energy.

The production of solar energy has increased in the period 1991-1996; the annual increase is about 18%. Geothermal energy production increased by 1700% from 1989 to 1996. For the years 1996-2000, geothermal energy production increased at an annual average rate of 45%. There are many new projects for the construction of wind energy plants in Turkey that are likely to increase the demand for wind energy equipment.

7.3 Case Study: Poland[xvii]

It is extremely difficult to evaluate the volume of renewable energy utilised in Poland, as information may only become available through special fact-finding research techniques. The share of renewable energy in the fuel and energy balance has been estimated by various national institutions, such as the Main Statistical Office, Ministry of the Economy, EC Baltic Renewable Energy Centre. The figures given by the institutions vary, a fact which is a source of difficulties in the correct estimation of the actual utilisation of renewable energy in Poland. At the moment, the basic sources of renewable energy in Poland are biomass and hydro. Geothermal energy, wind power and solar energy are of lower significance. The potential renewable energy resources in Poland are presented in **Error! Reference source not found.**.

Table 12 : Annual technical potential of RE in Poland

Source of energy	**EC BREC's expert appraisal 'Economic & Legal Aspects of Utilisation. . .' (EC BREC, 2000) [PJ]**	**'Reduction Strategies of Greenhouse Gas Emissions' [PJ]**	**Report prepared for the World Bank (Hauff,1996) [PJ]**
Biomass	895	128	810
Water	43	50	30
Geothermal resources	200	100	ca. 200
Wind	36	4	4 - 5
Solar radiation	1340	55	370
Total	2514	337	ca. 1414
Total primary energy consumption in Poland in 1998	4069.6		

Estimated figures for the current levels of utilisation of renewable energy in Poland are given in Table 13.

Table 13 : Renewable energy use in Poland, 1999

	Energy production from renewable sources in 1999	
	PJ	**%**
Biomass	101.8	98.05
Water energy	1.9	1.83
Geothermal energy	0.1	0.1
Wind energy	0.01	0.01
Solar energy	0.01	0.01
Total	103.82	100

There is therefore a considerable opportunity to exploit Poland's renewable energy resources, particularly from biomass.

The current status of renewable energy exploitation in Poland is summarised briefly below.

Wind power only began to develop in Poland at the beginning of the 1990's, and that was mainly on the Baltic seaside. The most privileged areas in terms of availability of wind power resource are the Baltic coast, Suwaki area and Mazovian lowland plain. By the end of 1999, 14 wind farms with the total power over 3.5 MW had been connected to the grid and placed in service. Added to this, there are around 50 small independent wind turbines in operation in Poland now. Investors take keen interest in wind power installations, especially in north-western Poland, where over 10 projects with total power exceeding 600 kW each are currently prepared.

Biomass is the most promising renewable source of energy. The share of biomass in the balance of renewable energy in Poland is growing. Biomass may be utilised in direct combustion processes in a solid (wood, straw) and gaseous form (biogas) as well as processed into liquid fuels (oil, alcohol).

In Polish conditions, one may expect considerable growth of interest in the utilisation of solid biofuels - wood and straw - in the coming years. Polish farms produce around 25 million tonnes of straw (mainly cereal and rape) and hay every year.

The Polish biomass market offers quite a large number of wood-fired boilers as there are some 20 manufacturers and importers of such boilers at the market. There are around 10 manufacturers of low-temperature wood-fired boilers, and around 10 manufacturers and suppliers of straw-fired boilers currently active on the Polish market.

Hydropower: Among the various methods of energy generation, **hydropower** has the longest tradition in Poland. Polish hydropower resource is small due to the limited and unfavourably distributed precipitation, high soil permeability and relative flatness of the country. The total installed capacity of large hydro-electric power stations (excluding pumped-storage plants) is around 630 MW, and of the small ones 160 MW. It must be mentioned that the power output of existing hydroelectric power stations may be increased by 20-30% through the modernisation of their generators. There are around 800-1,000 sites around the country that are estimated to be economically viable for micro hydropower. [xviii] [xix]In view of the small-scale utilisation of the existing technical potential, hydropower engineering in Poland has a chance of further development.

Solar energy has had only limited application to date. The total number of solar collectors is estimated at 50-60 units, and their surface area at 6,000 m^2. They are operated for 300-600 hours per year on average. Photovoltaics are virtually not used in Poland.

Geothermal energy: WHO is interested in developing the geothermal power. This interest is based on the local need to reduce atmospheric emissions from domestic and industrial coal burning. .[xx] [xxi]

Foreign companies in the Polish renewable energy sector. [xxii]

Companies from Denmark, Finland and Sweden that are present in Poland include:

- Ansaldo Volund (waste-to-energy)
- NEG-Micron (wind energy),
- Babcock Entreprise,
- Energieconsulting Heidelberg and
- Polytechnik

Renewable energy market drivers

The European Union strongly supports Poland's efforts to attain European levels of alternative energy production sources. The EU has already opened the following aid programs: Joule-Therme, Altener, Synergy and Phare for Poland's renewable energy development. EcoFund, a foundation managing funds from the conversion of part of the Polish foreign debt into a benefit fund to support environmental protection-related endeavours (so-called debt- for-environment swaps), has listed "renewable energy sources" as its top priority beside "water management".[xxiii]

The Polish Ministry of Economy recently passed an ordinance that makes it mandatory for the Polish Power Grid companies to purchase a certain percentage of energy produced from renewable sources. This and other legal acts pave the way for the creation of renewable power industries.[xxiv]

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