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PENETRATION OF RENEWABLE ENERGY IN THE ELECTRICITY SECTOR

Annex I Expert Group on the United Nations Framework Convention on Climate Change
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FOREWORD

This Working Paper is one of a series of eighteen studies carried out under the project: "Policies and Measures for Possible Common Action". The project was carried out by the OECD, together with the International Energy Agency, in 1996 and 1997 for the Annex I Expert Group on the United Nations Framework Convention on Climate Change (UNFCCC). The goal of the project was to assess a range of cost-effective greenhouse gas mitigation policies and measures for countries and Parties listed in Annex I to the UNFCCC. The eighteen working papers have been made widely available as analytical input to negotiations under the UNFCCC Ad hoc Group on the Berlin Mandate. The working papers may also provide input to national decision making processes on greenhouse gas mitigation policies. The measures analysed do not necessarily represent policy preferences of Annex I Parties.

The project benefited greatly from substantial input from delegates. Three successive chairmen of the Annex I Expert Group provided outstanding leadership for the project: Doug Russell (Canada); Ross Glasgow (Canada); and Ian Pickard (United Kingdom). The work was supervised by Jan Corfee Morlot (OECD). Fiona Mullins (OECD) drafted the initial framework which was used to structure the eighteen working papers.

The Annex I Parties or countries referred to in this document refer to those listed in Annex I to the UNFCCC: Australia, Austria, Belarus, Belgium, Bulgaria, Canada, Czechoslovakia (now Czech Republic and Slovakia), Denmark, the European Community, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Latvia, Lithuania, Luxembourg, Netherlands, New Zealand, Norway, Poland, Portugal, Romania, Russian Federation, Spain, Sweden, Switzerland, Turkey, Ukraine, United Kingdom and United States. Where this document refers to "countries" or "governments" it is also intended to include "regional economic organisations," if appropriate.

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EXECUTIVE SUMMARY

Context

Most renewable energy technologies suffer a significant cost disadvantage relative to major fossil fuel based technologies in base load electricity, except in certain niche markets. However, the costs for renewables are likely to decrease more quickly relative to fossil fuel technologies.

Renewable energy sources are generally promoted by most Annex I Member countries, though not solely in the context of climate change. The promotion of the uptake of renewable energy technologies can be undertaken in order to contribute to secure, sustainable energy supplies, to meet global and national environmental objectives, and to provide additional benefits such as increased employment and export opportunities.

The current trend toward liberalisation of electricity markets has created a dynamic environment that promises to deliver multiple benefits - more efficient resource allocation, better productivity, more innovation, and reduced costs to consumers. It is unsure how this will affect the penetration of renewables.

Recent trends indicate that where renewable promotion takes place, renewables are given special status - often for a limited period of time. However, the potential for renewables is generally poorly exploited due to a combination of technical, economic and market impediments.

Renewables are defined in this study as solar, wind, small hydro-electricity, bioenergy and geothermal.

Description of Measures and their Policy Objectives

The aim of the study was to identify measures to support the market penetration of electricity-generating renewable energy technologies, which could be undertaken by countries which are Annex I signatories of the UN Framework Convention on Climate Change (UNFCCC).

The paper reveals that for renewables to become more generally commercially competitive and widespread, continued support by governments, industry and by international organisations is needed.

Approach and Methodology

The study draws upon existing studies, such as those undertaken by the International Energy Agency (IEA), to provide a brief review of the main impediments and obstacles affecting the uptake of renewable energy technologies, including the differences between impediments within Economies in Transition and the member countries of the Organisation for Economic Co-operation and Development (OECD). The report assesses the success and replicability of policies and measures that have been used by governments of Annex I countries to overcome impediments to renewable energy. Impediments refer to any technical, economic, market or other factor impeding the deployment of renewable technologies.

From these, a list of possible policies and measures for common action to enhance the penetration of renewables is provided for further consideration. (An appendix to the report lists examples of Annex I countries' measures to support renewable energy.)

Impediments to the deployment of renewable energy technologies

Different types of impediments are encountered as a technology progresses towards the marketplace. In the initial stages of development, technical impediments usually predominate. Later, in order for a technology to become cost-effective, market impediments such as inconsistent pricing structures may need to be overcome. Next there are institutional, political and legislative impediments which hinder the market penetration of technologies, including problems arising from a lack of awareness of, and experience with new technologies and lack of a suitable institutional and regulatory structure. Finally, there are social and environmental impediments, which result mainly from a lack of experience with planning regulations which hinder the public acceptance of a technology. It is clear that a strategy which aims to maximise the market penetration of renewable energy technologies should address the full spectrum of impediments.

Existing measures to support renewable energy in Annex I countries

A wide variety of measures are employed by Annex I governments to overcome the impediments mentioned above. These measures can be roughly grouped according to the type of impediment as follows:

- measures to address technical impediments and maximise technical potential - principally through research, development and demonstration;
- measures to address market impediments and maximise economic potential - through ensuring a consistent pricing basis. These can be achieved both through the removal of subsidies for competing energy sources, such as fossil fuels, and through ensuring the full cost pricing of all forms of energy to reflect their social and environmental costs as well as their short term production costs. Full cost pricing is problematic due to uncertainties in the magnitude of external costs, and gives rise to political problems;
- measures to address other impediments - these include a wide variety of market stimulation measures, such as guaranteed purchase for renewable electricity (with price support); "green electricity" schemes; investment grants; tax breaks; promotional measures; large scale demonstration and market stimulation schemes; government targets for renewable energy deployment; voluntary agreements with utilities to increase deployment; and modification of legislation or restructuring to allow market access to renewables. These measures encourage investment in renewable energy, allow realisation of economies of scale, and help to build up a track record for successful commercial operation.

The application of different types of measure varies significantly across the Annex I countries. In general, the countries which have been most successful in stimulating deployment and encouraging the growth of renewable energy industries are those which have adopted an integrated package of market stimulation and promotion measures, coupled with strong government support for research and development.

In the Economies in Transition (EITs) of Central and Eastern Europe and the Commonwealth of Independent States, the potential for renewable energy is often significant, but the level of support is generally restricted by three factors:

- EITs often have more urgent short term priorities, such as improving energy efficiency and installing environmental controls on existing coal or oil-fired plant;
- severe economic problems, leading to a lack of both domestic and foreign investment capital.;
- artificially low primary fossil energy prices due to government subsidies. (This is being addressed through energy price reform in most EITs, but the pace of change is restricted by the need to minimise social and economic hardship).

Some EITs are introducing legislation to allow grid access by independent power producers, and a few are starting to offer financial incentives such as low interest loans, tax breaks or preferential buy-back rates.

Possible policies and measures for common action to support the penetration of renewable energy

Based on the preceding discussion of impediments and the measures which can be adopted to overcome these, it is postulated that the most successful strategy for support of renewable energy will be via a “chain of support” to address all the impediments which face technologies at different stages of their progression to the marketplace. Such a chain is illustrated on the following page. Based on this chain, a number of possible policies and measures for common action have been identified:

<u>Actions Directed at Technical Impediments</u>

Support technical development through improved, strengthened and extended international collaboration on research, development and design in the renewables area.

<u>Actions Directed at Market Impediments</u>

Full cost pricing of competing energy technologies, through:

a) co-operation and sharing of experience on removal of subsidies, particularly for EITs;

b) common agreement on incorporation of external costs (politically difficult) or wider dissemination of experience with partial measures such as carbon taxes and pollution permits, to encourage wider uptake and better design of such measures.

Ensure a full value price for renewable electricity in order to take into account the full social, environmental and economic benefits, through:

a) Co-ordinated research on full valuation of renewable electricity;

b) Dissemination of experience with pioneering approaches such as net metering schemes;

c) Exploration of voluntary agreements between regulators and supply utilities for full value pricing of renewable electricity supplies.

Table 1. The Chain of Support for Renewable Energy Technologies

Technical Impediments	**Support technical development** (R&D to reduce costs and improve efficiently)
Market Impediments	Full cost pricing of competing technologies (remove subsidies, incorporate external costs)
	Ensure a full value price for renewable energy (valuing renewables - socio-economic factors)
Institutional, political and legislative impediments	**Market stimulation** (guaranteed purchase, premium prices, investment support, tax breaks, low interest loans)
	Awareness of opportunity (awareness for industry, utilities, developers, via dissemination, methodologies for assessment of markets and resources)
	Harnessing commercial finance (assurance of technical performance via standards and certification, establishing long-term confidence, joint implementation)
	Reduce transaction costs (grid connection, regional energy centres, standardised assessment techniques)
	Ensure availability of skilled personnel (training, awareness, dissemination, demonstrations, qualifications)
	Overcome planning impediments (minimise environmental impact, raise awareness of benefits and opportunities by planners)

Actions at Institutional, Political and Legislative Impediments

Market stimulation:

a) wide dissemination of the results of market support measures or policies to all Annex I countries, with the aim of encouraging the replication of successful measures and avoiding the pitfalls of less successful schemes;

b) financing assistance, e.g. common funds targeted specifically at investment in renewable energy technologies perhaps utilising the existing support mechanisms of the World Bank and EBRD;

c) the agreement of common objectives for renewable energy deployment.

Awareness of opportunities:

a) aggregate and publish information on niche markets world-wide to enhance awareness of them and their attractiveness to investors and consumers;

b) dissemination of case histories of successful deployment of renewable electricity technologies; and

c) development and dissemination of standard certified methodologies for assessment of renewables resources to assist with project planning and the development of project financing plans.

Harnessing commercial finance:

a) development of technical standards to increase the confidence of investors and developers in renewable energy technologies;

b) standard certified methodologies for assessing resources;

c) provision of a “brokerage service” or insurance instrument to bring the renewables industry together with the financial community to develop suitable finance packages;

d) support for “Green electricity” schemes, through dissemination of experience so far; development of guidelines on marketing and pricing green power; public education; and development of a certification scheme to build credibility;

e) integration of “green electricity” into a future single European market.

Minimise transaction costs, via:

a) establishment of regional energy centres;

b) international consensus on the desirability of removing impediments to new entrants to the energy market.

Ensure availability of skilled personnel, via:

a) creation of internationally recognised academic and vocational qualifications in renewable energy technology design, installation and maintenance.

b) provision of specialised courses on renewable energy technologies at international centres.

c) consensus with academic organisations to include a stronger coverage of renewable energy technologies in traditional academic courses.

Actions Directed at Social and Environmental Impediments

Reduce environmental impacts, via co-ordinated research, development and design and dissemination of results.

Improve awareness of planners, via common action on:

a) development of planning guidelines which outline a framework for taking into account the benefits as well as the possible adverse impacts of renewable energy schemes;

b) wide dissemination of profiles of successful renewable energy developments;

c) organise training courses for representatives from local authorities which would enable them to identify opportunities for renewable energy;

d) establishment of technical advisory centres.

Maximise planning opportunities by consideration of the potential for utilising renewable energy technologies at an earlier stage in the planning process, e.g. through:

a) common voluntary adoption of planning guidelines which recommend including an assessment of the potential for utilisation of renewable energy technologies for every new development;

b) common agreement to disseminate the methodology and the benefits of Strategic Environmental Assessment (SEA) and promote its use in the power sector by governments, funding agencies and planners

Benefits of the Penetration of Renewables

Commercially competitive renewables can contribute to the achievement of environmental targets (particularly reduction of CO_2, SO_2 and NO_x), a more diverse, secure and sustainable energy supply, increased employment, and enhancement of national economies through the development of strong renewable energy industries with the potential to compete in export markets. The measures outlined above could help to achieve increased deployment through supporting renewables at all stages of their development. Increased market penetration will in turn feedback into reducing costs via the "learning by doing" process.

Rationales for common action include:

i) sharing the costs and benefits, and hence the risks, of various programmes;

ii) allowing cross-fertilisation of ideas and approaches to occur among countries, improving the chances of finding successful and cost-effective solutions;

iii) enlarging the potential market for new renewable energy technologies, allowing economies of scale to be achieved more easily;

iv) giving clearer market signals to manufacturers and suppliers operating in an international market; and

v) enabling countries to implement measures that could not be implemented on an individual basis.

It is extremely difficult to quantify the effects of the common actions for the penetration of renewables, because this requires separation of these effects from the effects of other national policies. However, a crude analysis suggests that several hundred Mt of CO_2 could be saved by vigorous implementation of the whole chain of possible common actions proposed. (The study did not address the costs of possible common action to enhance the penetration of renewables in general, or the implementation aspects of any specific measure.)

Given different national circumstances, possible common actions might be based on, *inter alia*, geographic regions, trading ties, common interests, industrial structures or policies already in place. Existing institutions and vehicles, such as the Climate Technology Initiative and other regional or multilateral collaborative networks, could be exploited in this regard.

Conclusions

An attempt was made to assess the political sensitivity of the possible common actions. The assessment is indicated in the table on the next page.

Because of the uncertainty of the effect of restructuring on the increased penetration of renewable energy technologies, the most feasible common actions to consider in the short term are those measures to capture the full benefit of existing market stimulation activities, such as awareness of opportunities, overcoming planning impediments, research, development and design collaboration, and training of skilled personnel.

Summary of Potential Common Actions to Support Electricity Generating Renewables

Impediment Type	**Common Action**	**Political Sensitivity**[1]
Technical	Collaboration on RD&D	Low
Market	Removal of subsidies to other supply options	High
	Incorporation of external costs	High
	Research into the full value of renewables electricity	Low
	Dissemination of net metering approaches	Low
	Exploration of voluntary approaches for full value pricing	Medium
Institutional, political and legislative	Dissemination of experience of market support measures	Low
	Establish a common investment fund to support renewables	High
	Agree common objectives for renewables deployment	High
	Disseminated information on niche markets world wide	Low
	Dissemination of deployment case histories	Medium
	Develop and disseminate standard certification methodologies for resource assessment	Medium
	Develop technical standards for technologies	Medium
	Establish a brokerage service between the renewables industry and financial services	Medium
	Encourage Green Consumerism	Medium
	Establishment of regional energy centres to assist renewables developers	Medium?
	International consensus on the removal of rules for grid access to new entrants to the power generation market	High
	Create internationally recognised qualifications in renewable energy	Medium
	Provision of specialised personnel training centres	Medium
	Promotion of stronger coverage of renewables in traditional academic courses	Medium
Social/Environmental	RD&D to reduce environmental impacts	Low
and planning	Development of planning guidance	Medium
	Consideration of potential for RE at the planning stage of new developments	Medium

1 The Political Sensitivity rating is purely subjective. It is meant to indicate the complexity of decision making required on the action, the timeframe likely needed and the complexity of implementation.

INTRODUCTION

Most Annex I country governments have a policy of promoting the uptake of renewable energy technologies in order to contribute to secure, sustainable energy supplies, to meet global and national environmental targets, and to provide additional benefits such as increased employment and export opportunities. The current penetration of renewable energy technologies varies significantly. Most renewable energy technologies suffer a significant cost disadvantage relative to the major fossil fuel-based technologies in base load electricity generation. Certain more recently developed renewable technologies are competitive in niche markets, particularly for the provision of electric power in remote locations. In some countries, such as Sweden and Finland, renewables account for some 20 per cent of energy supply. However, more generally, the potential for renewables is poorly exploited due to a combination of technical, economic and market impediments.

Studies by the International Energy Agency (IEA) predict that even if renewable energy from new technologies such as wind, solar power, and advanced biomass technologies, continues to grow faster than all other fuels, as predicted by the World Energy Outlook[1], non-hydro renewable energy will still only account for 2 per cent of total primary energy supply in IEA countries by 2010.

The current trend toward liberalisation of electricity markets has created a dynamic environment that promises to deliver multiple benefits - more efficient resource allocation, better productivity, more innovation, and reduced costs to consumers.

It may be too early to say whether market liberalisation will act in aggregate to encourage increased market penetration of renewable energy technology or whether market uncertainties and cost-cutting pressures will effectively decrease the replacement rate of capital stock by encouraging the use of old, depreciated generating plants for as long as possible, reducing the rate at which new renewable technologies enter the market. Market liberalisation may expedite the economic deployment of some renewable energy technologies through the opening of electricity markets to new suppliers, the introduction of customer choice, and the removal of subsidized prices, for example, in remote areas where renewables would otherwise be competitive. However, energy market deregulation and increased competition could result in lower prices for energy consumers that would be beneficial economically but may make it even more difficult to convince them to invest in renewable energy technology.

For renewables to become more generally commercially competitive, an evolutionary process is required in which their deployment stimulates improvements in cost, performance and operational experience, which in turn stimulates further deployment.

This report aims to identify possible policies and measures for countries listed in Annex I of the United Nations Framework Convention on Climate Change (UNFCCC) which could be undertaken in support of the market penetration of electricity generating renewable energy technologies.[2] The study has been commissioned by the Annex I Expert Group on the UN FCCC.

There are a number of possible types of common action which have been defined by the Annex I Expert Group as follows:[2]

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2 Annex I countries include OECD countries excluding Korea, Mexico and Turkey, plus the transitional economies of Central and Eastern Europe and the Commonwealth of Independent States.

- specific policies and measures that could be implemented by a group of countries together under some form of agreement to increase the effect of the measures (e.g. trade partners remove subsidies);

- co-ordination of action to implement the same or similar measures together (e.g. harmonise standards or test protocols for products);

- agreement to take actions in a sector towards a given aim or target leaving the means of reaching the agreed aim to each country (e.g. x per cent improvement in fuel efficiency); and

- successful policies and measures that could be replicated in other countries (e.g. countries might choose from a menu of measures).

This study reviews the impediments to greater market penetration of renewable energy (Section 3), reviews existing measures used to support renewable energy (Section 4), and assesses options and rationales for potential common action (Sections 5 and 6). Section 7 draws together the conclusions of the study.

There has been no attempt in this study to associate measures with specific renewable energy technologies. Renewable energy technologies are defined for this study as wind, solar, bioenergy, small hydro electricity, and geothermal technologies.

IMPEDIMENTS TO THE DEPLOYMENT OF RENEWABLE ENERGY TECHNOLOGIES

Introduction

The term "impediment" is often used to refer to factors that impede the adoption of a new technology.[3] Different types of impediments are encountered as a technology progresses towards the marketplace. In the initial stages of development, technical impediments usually predominate. Later, in order for a technology to become cost-effective, market impediments such as inconsistent pricing structures may need to be overcome. Next there are institutional, political and legislative impediments which hinder the market penetration of technologies that are economically competitive. Finally, there are social and environmental impediments linked to lack of experience with planning regulations and gaining public acceptance of a technology, which hinder cost-effective technologies from achieving their full market potential.

One sub-set of impediments may be referred to as "market failures" which result in the inefficient allocation of resources. Governments, particularly those which primarily rely on market forces to ensure efficient allocation of resources within their economies, may seek to take action to correct these. However, it should be acknowledged that some so called impediments may reflect the fair operation of the market or institutional system (e.g. safeguards against pollution, visual intrusion) and should be accepted as such.

In economies where market forces do not operate, or do not operate fully in all sectors (such as the transitional economies of Central and Eastern Europe and the Commonwealth of Independent States), other impediments may also be of importance, particularly those related to the political and institutional structure of the economy. In addition, the changes that have accompanied economic reform have often had a profound impact on energy demand and supply in these countries.

This section reviews the many different impediments that may impede the implementation of renewable energy technologies, and comments on the relative importance of these impediments in the context of OECD and other Annex I countries. Most of these impediments are applicable to all renewable energy technologies, but technology-specific impediments have been discussed by another recent IEA study.[4]

3 A broad definition of the term "impediment" is used. It refers to any technical, market economic or other factor impeding the deployment of renewable technologies. The purpose of the review of impediments is simply to provide a reference framework for the identification and discussion of Possible common actions in Section 4.

4. These difficulties are described in another working paper in this series: Mullins et al; Financing Energy Efficiency in Countries with Economies in Transition. Working Paper No. 10..

Impediments To The Implementation Of Renewables

External factors and impediments affecting the deployment of renewable energy may be of a technical, market, social/environmental, political or institutional nature, and all the factors tend to be interrelated as depicted in Figure 1. The relationship and relative importance of these different impediments will vary depending on the particular renewable technology and the circumstances under which it may be implemented. For example, within a niche market, such as the supply of solar electricity to remote, sunny regions not connected to the grid, renewable sources can be commercially viable (i.e. the market impediments are overcome), however, this may result in technical, informational and environmental factors becoming the main impediments to implementation. Thus the balance of importance of the impediments may shift - as one impediment is surmounted, others become apparent. The emphasis should therefore be placed on broader solutions, potentially incorporating several measures, which tackle a range of impediments.

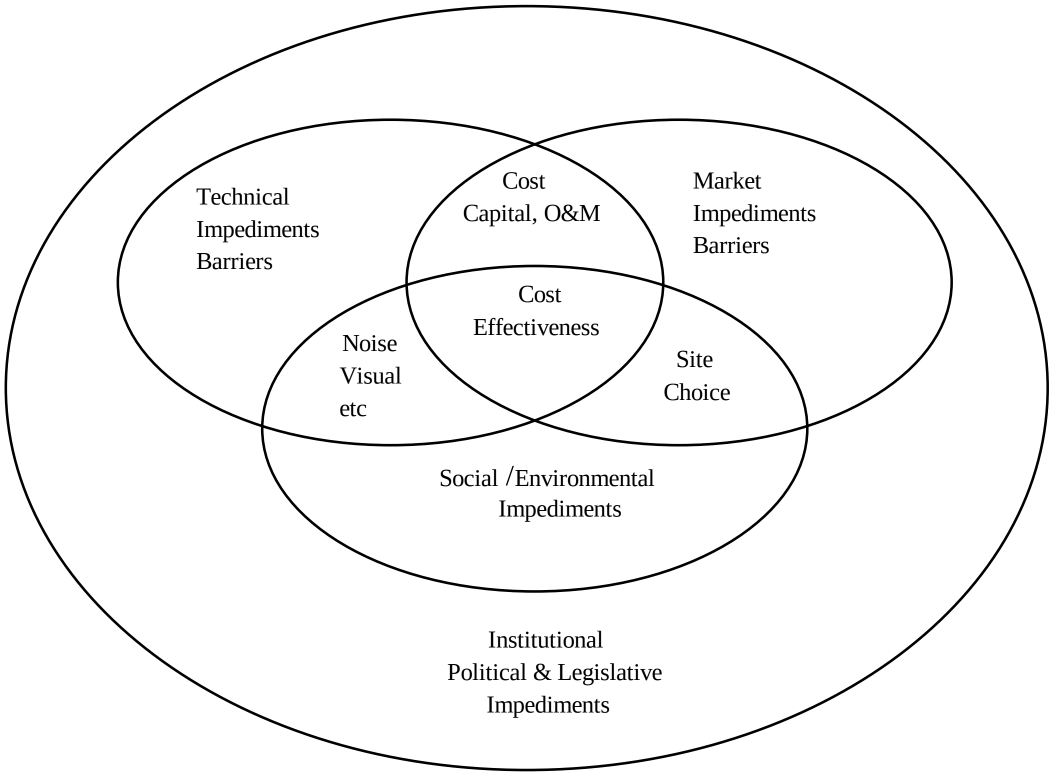
Technical and Market Impediments

These two sets of impediments are discussed together because of their strong inter-relationship. They relate to the technical and market performance of renewable electricity generation technologies. Albeit that not all renewables are close to being commercially competitive, there are two main factors affecting the cost- effectiveness of those renewables that have a fighting chance in the current market: firstly, the failure to fully internalise the social and environmental costs of the conventional technologies which compete with renewable energy, and secondly, a combination of technical factors which result in capital-intensive investment profiles which can deter investors. Direct comparisons between conventional and renewable technologies, in terms of the financial return on investment, do not yet favour renewables.

Most renewable technologies have investment profiles in which capital costs are very high compared to operating costs. In addition, the intermittent nature of some renewable sources of electricity means that utilisation of capital equipment may be low. The assessment of the rate of return on investment in such capital-intensive technologies is highly dependent on the investment criteria used. Investments in renewable technologies appear less attractive when high discount rates are used (i.e. when short payback periods are required). Short-term contracts between energy suppliers and distributors also tend to discourage investment in renewables, because investors need to ensure that their high initial investment will be recovered via realisation of the benefits of the future low operating costs. These problems are exacerbated by the impediments which renewables face in obtaining competitive forms of finance, which arise from factors such as lack of familiarity with, and awareness of, the technology in the financial community, high levels of perceived risk, uncertainties over resource assessment methods, and the small size of the renewables industry and of many individual projects.

However, it is important to note that the current high levels of capital costs are based on relatively new technologies, low-volume production runs, and current manufacturing practices. Costs have halved over the last ten years, and are expected to halve again over the next decade due to technical advances and economies of scale resulting from greater market penetration of renewables[2]. “Learning by doing” is, and will continue to be, a significant contributor to lowering costs.

Figure 1. External Factors and Impediments



Technical and economic factors which hinder the deployment of renewables are summarised below:

Capital cost

a) Relatively high capital costs per unit of output, often either because further technological development is needed or because the system is too small to benefit from economies of scale. This makes it difficult for renewables to realise a satisfactory rate of return on investment, even though they may be cost-competitive on a life cycle basis.

b) Grid connection costs may also be high.

c) Because of the small size of many renewable energy projects, project planning and development costs are also often disproportionately high.

Value of output

a) The low value given to the electricity/heat output is a constraint, as the value does not reflect external costs of other fuel sources or the long-term marginal cost of energy supply.

b) In transitional economies, the price of electricity may be maintained at an artificially low level, reducing the value of the product.

Location versus demand

a) Unlike other fuels like oil and coal, which can be transported to central generating facilities, renewables are best converted into electricity where the resource is located. Because many renewable resources are relatively dispersed and are often located in remote areas, transmission and connection costs are disproportionately high.

Finance

a) The difficulty in obtaining long-term, low-cost finance packages and support for renewable energy project construction (partly because investors are deterred by the high investment costs per unit of output, see above) is often a significant constraint.

Overall cost-effectiveness

a) Using conventional finance and accountancy methods, all of the above factors contribute to the low cost-effectiveness of renewables, which is perhaps the single most important constraint on their uptake.

Risk and security of supply

a) A high level of both real and perceived risk is associated with the construction and operation of many renewable energy projects, due to lack of experience of these sources, particularly with regard to the reliability of resource assessment, and therefore of the project value.

b) Fluctuating power outputs from renewable electricity generation may reduce the security of electricity supplied through the grid, often resulting in the need for back-up systems which may increase the overall costs of the system.

Social and Environmental Impediments

All forms of energy generation have some degree of environmental impact. Although renewable technologies generally have few of the adverse impacts associated with fossil fuel combustion in terms of greenhouse gas emissions, acid rain and local air pollution, they do have local impacts such as visual impact and noise.[3] A full discussion of the external costs of both conventional and renewable energy can be found in the European Commission’s (EC) ExternE study.[4] Renewable electricity generation is often very location specific (e.g. wind, wave or solar), and in addition, the resource is often located in an area valued for its remoteness or scenic beauty. It is therefore important to take account of local environmental impacts, planning regulations and views of the local residents when designing a renewable energy development in such areas. Lack of experience and awareness on the part of the developer, the planning authorities and the local population can act as a impediment to renewable energy developments. This can be exacerbated by the fact that the environmental benefits of renewable energy do not necessarily benefit the local area directly (e.g., reduction of CO_2 emissions).

The social and environmental impediments to renewables are summarised below:

Environmental costs/benefits

a) Each renewable energy technology has its own set of environmental burdens and benefits which represent added or avoided costs, but these are not always compared with those of conventional generation on a consistent basis. This can put renewable generation at a disadvantage.

Site and planning issues

a) Optimising performance for a renewable energy technology is often highly site dependent.

b) Local objections to some renewable energy technologies, and lack of local planning experience of renewables, may prevent or delay construction.

c) Planning considerations to minimise effects and meet local laws are thus very important.

Political, Legislative and Institutional Impediments

Political and legislative factors can take a variety of forms and may significantly contribute to an unfavourable climate for growth in renewables. The lack of suitable legislation or an inability to enforce the existing rules may account for the poor penetration of renewable energy technologies into the market. At the political level, when there is no clear, long-term, and stable framework for support and development, new technologies are commonly perceived as higher risk choices. Even when objectives have been set, they may not be sufficiently monitored, thus reducing their effectiveness.

Legislation can either help or hinder the take-up of renewable energy sources. For example, tighter legislation on atmospheric emissions may be an impediment to technologies such as waste incineration, whilst favouring other renewables by increasing the costs associated with conventional energy sources such as coal-fired power.

Institutional issues include the lack of common technical standards covering renewable energy technologies, which can be an impediment to trans-national commercialisation. Lack of awareness, education and training amongst many key groups (such as political representatives, the financial community, industry, and the general public) means that renewables are often not even considered as a realistic alternative to conventional methods.

Political, legislative and institutional impediments to renewables are summarised below:

Political impediments

a) Explicit preference may be given to other forms of energy production at the expense of the renewables, and these may be supported financially. This may occur for a variety of reasons, such as security of supply, employment, diversity, cost.

b) Renewables may also have political difficulties with public acceptability, as discussed in the section above.

Legislative impediments

a) Legislation may effectively prevent the use of renewables, for example, if there is no provision to allow electricity to be produced by independent generators, or where grid access is inhibited.

b) Legal requirements such as contracts and operation insurance, environmental compliance, health and safety, may form impediments to the exploitation of a new technology.

c) Rates and differentials in taxation between different energy sources may provide an impediment (or, conversely a boost) to renewable energy sources.

Institutional impediments

a) Typically, the industry base for renewable energy technologies is too small to either bargain effectively or to respond effectively to changes in demand.

b) In many Annex I countries, the demand for electricity is relatively stable (i.e. not growing rapidly) and conventional generation may already have more than enough capacity to serve the demand, so the market for renewables can only grow by displacing conventional generation. This may restrict the market share of renewable energy where modest rises in demand can be met from existing over capacity and/or by demand side management.

c) Lack of innovative financing packages suited to the particular cost structure of renewable electricity generation may hinder the development of renewables projects.

d) In most cases renewable electricity cannot command a premium price to reflect the fact that it has fewer external costs (for example CO_2 emissions) than conventional generation.

e) Lack of information on renewable energy aimed at potential investors, lack of experience with new technologies, and lack of personnel skilled in evaluating and exploiting renewable resources will act as an impediment to take up.

Differences Between Impediments within Economies in Transition and OECD Countries

The process of transition, commencing in 1989/1990, led to a decline in energy-intensive industry, coupled with a fall in economic output. This in turn resulted in a drop in the demand for electricity in most economies in transition and reduced, at least in the short term, the emphasis on the need to exploit indigenous, often renewable, energy resources.

Within economies in transition, energy prices have often been held artificially low by government subsidies for fossil fuel- based energy. In particular, prices paid by domestic consumers have been maintained far below production costs, whereas commercial and industrial users may be paying a higher rate for electricity. The market is therefore distorted, and with prices below costs of production, renewable energy technologies are unable to compete.

Economies in transition have particular problems with financing projects due to the higher risks perceived by outside investors, and the lack of their own capital for investment.[4] These risks stem from the macroeconomic instability of economies in transition, the difficulty in assessing future fuel price and exchange rate fluctuations, and the present weakness of their banking sectors.

Economies in transition countries often face serious environmental problems, such as acid emissions from coal- and lignite- fired power stations. Priority is given to improving energy efficiency, for example encouraging a switch from coal to gas, or to reducing pollution from coal-fired power stations and from industry using abatement technologies. Renewable energy is viewed as a longer-term option, whereas the environmental problems that current policies target are immediate.

EXISTING MEASURES TO SUPPORT RENEWABLE ENERGY IN ANNEX I COUNTRIES

Examples of the measures employed in each country, compiled from IEA publications[6-10], other open literature,[11,12] and direct communication with contacts in Central and East European countries, are listed in Appendix 1. A summary table is presented at the end of this section (Table 1). This section summarises types of measures and then describes the pattern of use of these measures in different Annex I countries.

Types of Measures

In this study measures are classified according to whether they tend to improve the technical potential, economic potential and market potential of the renewable technologies. Measures which address technical impediments (principally research and development) tend to improve the technical potential of renewables; measures which address market impediments tend to improve the economic (i.e. cost effectiveness) potential; and measures which address other impediments, or more general market stimulation measures which are not aimed at particular impediments, tend to improve the market potential (i.e. the final uptake of renewables by the market).

Measures to address technical impediments and maximise technical potential

The main tool for addressing technical impediments is through technical research and development, typically aimed at improving conversion efficiency and reliability and reducing costs and environmental impacts. The typical pattern of research and development support for a new renewable technology is that government programmes provide the initial focus, with increasing contributions from industry as the technologies approach commercial viability. In some countries, industry now leads research and development for the more competitive renewable technologies. However, the majority of research and development on renewable energy technologies is still driven by government programmes, usually with part funding from industry.

Measures to address market impediments and maximise economic potential

Market potential can be maximised both through technical development to improve performance and reduce costs (see above) and through measures which address the price available for renewable electricity and its competing sources. Measures addressing pricing range from the abolition of subsidies on competing conventional fuels to the full internalisation of external costs for all energy sources.

a) **Subsidy reform.**[5] Many Annex I member countries have subsidised energy prices in the past, for various political reasons, such as support for national industries. These subsidies on competing conventional forms of energy are now being phased out as most countries move towards a free market economy. Phasing out of subsidies is almost complete in most OECD Member countries, but in economies in transition which have only recently abandoned their centrally planned economies, the subsidies must be phased out gradually, in order to minimise economic and social hardship.

5 The impact of subsidy reforms on greenhouse gases are described in another working paper in this series: Michaelis; Reforming Coal and Electricity Subsidies. Working Paper No. 2.

b) **Internalisation of external costs.**[6] A full internalisation of external costs is generally held to be not feasible at present, due to the great uncertainty in assigning monetary values to environmental and social impacts. Although there is a consensus among most economists regarding the methodology for estimating monetary values to electricity-related environmental externalities, there is great uncertainty with the estimation of climate change values. In many countries, additional significant barriers to internalisation of external costs exists because many stakeholder groups within the industry oppose externality "adders" regardless of how well they are estimated. However, many countries have considered the adoption of carbon or energy taxes as a partial measure. Six West European countries have implemented carbon or energy taxes (Norway, Sweden, Finland, Denmark, the Netherlands and Austria). Exemption or refund of the carbon or energy tax for renewable energy schemes can make a very significant difference to their financial viability (e.g. Denmark, the Netherlands). However, there is political opposition to carbon taxes in many countries and it is unlikely that a consensus on an EU-level tax will be achieved in the short term. Most countries therefore also apply environmental regulations such as emission limits or quotas and planning guidelines. The formation of a single European market for electricity may either promote or inhibit the application of carbon taxes.

Measures to address other impediments and maximise market potential

A variety of measures have been aimed at addressing other impediments (political, legislative, institutional, social and environmental) or simply at general stimulation of the market, in order to maximise the market penetration of those technologies which are already cost-effective or near to being cost effective. These measures encourage investment in renewable energy, allow realisation of economies of scale, and help to build up a track record for successful commercial operation.

a) **Guaranteed purchase / Price support for renewable energy**. This is the main support mechanism in many West European countries, and it can be highly effective at attracting investors to support renewable energy. It can be implemented either with or without a competitive element as part of the process of allocating funds. It can be funded by all taxpayers via a general tax, by all electricity consumers via a levy on electricity (e.g. UK, Non Fossil-Fuel Obligation (NFFO), by utilities via all their customers (Germany, Electricity Feed Law), or by individual customers (green pricing, being pioneered in the USA, the Netherlands, Sweden, Australia and the UK)).

Competitive price support has mainly been pioneered through the NFFO model, where a levy on all electricity consumption is distributed to renewable energy projects through a competitive bidding process. NFFO has proved very successful at promoting price convergence, for those technologies which are already close to commercial competitiveness. Payment under the scheme depends on the amount of electricity produced, providing a strong incentive to maintain production levels. The need to issue calls for tenders at given intervals has led to some problems: the scheme is expensive to administer; the long gaps between bids lead to problems for developers and suppliers, and the scheme discriminates against smaller

6 The impact of full cost pricing for pollution from particulates, SO_2 and NO_x on CO_2 emissions is analysed in another working paper in this series: Keppler and Kram; Energy Market Reform: Full Cost Pricing. Working Paper No. 3.

developers due to the cost of preparing bids. It is too early to say whether these technologies will remain competitive should NFFO support be withdrawn.

Uncompetitive price support tends to encourage applications from smaller developers, and does not restrict support to technologies which are close to commercialisation. It has been very successful in some cases (e.g. wind energy in Denmark and Germany), although in some countries there have been administrative problems or resistance from utility companies. Guaranteed purchase schemes without price support have been less successful.

b) **Investment support**: grants or subsidies, low interest loans, tax breaks. The earliest support measures implemented in Western Europe often focused on investment grants, and these were very successful in stimulating deployment of renewable energy in some cases (Denmark, Austria), although there were some problems in cases where the responsibility for administering the scheme was left to unwilling or under-resourced utility companies (Greece, the Netherlands). Several West European governments are now moving away from direct investment grants towards tax breaks (Denmark, Sweden, the Netherlands).

c) **Promotional measures**, e.g. information and education campaigns; network of energy centres providing advice to developers (Austria, Denmark); demonstration schemes. These measures are fairly widespread and are valuable for increasing confidence amongst industry, developers and financiers, but they are generally less important than direct financial support.

d) **Large scale demonstration /market stimulation measures** (these may also be combined with direct investment support through grants or subsidies) - e.g. 1000 Solar Rooftop PV Demonstration (Germany) to demonstrate solar panels on a large scale. These measures can be important to raise awareness and build confidence in new technologies. However, it is sometimes found that when the measure finishes, the market for the technology disappears.

e) **Objectives**. Government targets for increased deployment of renewable energy technologies exist in many Annex I countries, although in other countries (particularly EITs) there is sometimes only an unquantified aim to "increase deployment of renewable energy". Objectives are generally insufficient on their own, as they need to be backed by specific measures, but they can give guidance to governmental priorities, and imply government commitment, thus raising the profile of renewable energy with the public, industry, planners and developers. They are also essential for monitoring progress towards an objective.

f) **Legislation or restructuring** to improve the opportunities for small-scale renewable energy schemes to be connected to the grid and to sell their output in the energy markets. In several countries, particularly EITs, there are still no legal channels through which independent producers can sell their output to the utilities. In some cases (e.g. Belarus) all day-to-day operation of electricity generation is still centrally run by the government, with no opportunity for other producers to sell their electricity.

The impact of electricity restructuring on renewable energy investment remains uncertain. On the one hand, restructuring of energy markets towards increased competition may create new opportunities for renewable energy, particularly where conventionally produced electricity benefits from hidden subsidies through, for example, subsidies or non-market pricing of primary fossil fuels. On the other hand, it can also have a negative impact on previously protected markets, exposing fledgling renewable energy technologies to markets in which they are not ready to compete. Technical developments may be required in order to maximise the opportunities for renewable energy in competitive electricity markets (e.g. smart metering schemes for decentralised systems, storage devices, and grid connection technologies).

g) **Voluntary agreements**[7] between governments and industry/ utilities. These are more common in the energy efficiency sector, but there are a few examples of voluntary agreements by utilities to promote renewable energy (e.g. in the Netherlands and the USA). These agreements are attractive to governments and industry alike as they are cheap to set up, and they offer flexibility in the choice of measures to employ. However, they are dependent on the degree of commitment by the industry or utility involved, and may require careful monitoring by government to ensure their effectiveness (difficulties were encountered in the Netherlands, see Appendix 1).

7 Voluntary agreements with industry are assessed in another working paper in this series: Storey; Demand Side Efficiency: Voluntary Agreements with Industry. (Working paper No. 8)

Table 1: Policy Measures for Renewable Energy Promotion in Annex I Countries: by Measure

	Electricity Supply Industry		Green pricing	Economic or fiscal	Regulatory Measures/	Information and	Other targets or	Voluntary Actions
	Objectives or quotas for delivery or capacity	Favourable/ Guaranteed markets	(not nationwide in any country)	incentives	Standards	Education	quotas	
Australia		✓ (voluntary)	✓	✓ 2, 3	✓ 4 (not nationwide)	✓ 1,2,4		
Austria		✓		✓ 1, 3	✓ 4	✓ 3rd party		✓
Belarus								
Belgium				✓ 1, 2, 3, 4	✓ 4	✓ 1 (region)		
Bulgaria						✓ 6 (research institutes)		
Canada	✓	✓		✓ 1, 3	✓ 2	✓		
Czech Republic		(guaranteed sales but low prices)		✓ 2, 3				
Denmark	✓	✓		✓ 1, 3	✓ 2	✓	✓ 1, 2	✓
Estonia								
Finland	✓bioenergy			✓ 1, 3		✓ utility R&D strategy	✓ 3	
France		✓		✓ 2 (overseas territories),	✓ waste regulations		✓ 3	✓
Germany		✓		✓ 1	✓ 4	✓ 4		
Greece		✓bi-lateral				✓ 4	✓ 6	
Hungary	✓delivery			✓ 2,3	✓ 3	✓ 1		
Ireland	✓capacity	✓		✓				
Italy	✓	✓		✓ 1 (new plant)	✓			
Japan	✓	✓purchasing menu		✓ 1, 2	✓ 1, 3	✓	✓ 1	✓
Luxembourg		✓		✓ 1				
Netherlands	✓	✓	✓	✓ 1, 3		✓	✓ 1, 4, 6	✓
New Zealand				3		✓ advice to planners		✓
Norway				✓ 1		✓		✓
Poland								
Portugal		✓		✓ 1 and study/ assessment grants		✓ (biomass centre)		
Romania								
Slovak Republic	✓ output			✓ 1, 3			✓ 3, 6	

	Electricity Supply Industry		Green pricing	Economic or fiscal	Regulatory Measures/	Information and	Other targets or	Voluntary Actions
	Objectives or quotas for delivery or capacity	Favourable/ Guaranteed markets	(not nationwide in any country)	incentives	Standards	Education	quotas	
Spain	✓	✓		✓ 4 (3rd party)				
Sweden		✓		✓ 1, 3	✓	✓		
Switzerland	✓	✓	✓	✓ 1		✓ marketing	✓ 4, 5	✓
Turkey	✓			✓ 2	✓	✓	✓ (regional)	
United Kingdom	✓ capacity	✓	✓	✓ 1	✓ waste disposal sites	✓	✓ 2	
United States	✓	✓	✓	✓ 3 (biofuels)	✓	✓		✓
EU						✓	✓ 3	

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1 IEA, "World Energy Outlook", 1996 Edition, ISBN 92-64-14816-7.
2 IEA, "Policies and Measures for Possible Common Action", Progress report to the fourth session of the Ad Hoc Group on the Berlin Mandate from the Annex I Expert Group on the FCCC, 1996.
3 ETSU, "Environmental implications of renewables", draft report for IEA, 1997.
4 European Commission, "ExternE - Externalities of Energy", EUR 16533 EN, 1995.

Notes:

Economic or Fiscal Incentives, e.g.:
1.Grants and subsidies involving direct transfers.
2.Credit instruments (interest rate loans, soft loans, loan guarantees).
3.Tax exemptions (tax reliefs, credits, deferrals).
4.Others

Regulatory Measures and Standards, e.g.:
1.Planning/ siting legislation.
2.Survey requirements or mapping.
3.Compulsory legislation for utility compliance.
4.Building codes.
5.Others (generally waste-related).

Information and Education

1. Publications, advertising campaigns.
2. Courses for industry.
3. Education programmes in schools and workplaces.
4. Renewable energy advice centres.
5. Others

Other targets

1. Solar heat.
2. Passive solar.
3. Biofuels.
4. Heat pumps.
5. Heat production.
6. Other

POSSIBLE POLICIES AND MEASURES FOR COMMON ACTION TO SUPPORT RENEWABLE ENERGY

The previous sections have shown that electricity generating renewable technologies face numerous artificial and natural impediments to large scale market penetration. For the purposes of identifying groups of possible common actions these impediments have been grouped under the following headings drawn from Figure 1:

- **Technical Impediments -** the need for further improvement in technical performance in such areas as conversion efficiency, reliability, integration to the grid.
- **Market Impediments -** the factors affecting the prices obtainable for renewable energy, and for competing sources of energy, including the treatment of external costs and the allocation of subsidies.
- **Institutional, Political and Legislative Impediments -** these are factors which hinder the market penetration of technologies which are economically competitive (e.g. lack of information or awareness, legislative obstacles, high transaction costs).
- **Social/Environmental Impediments** - lack of experience in complying with planning regulations and gaining public acceptance strongly influences market penetration.

As described in section 3, these sets of impediments impede the maximisation of technical potential, economic potential and market potential for renewables. There are overlaps and linkages between these groups of impediments, and some of the measures discussed below address more than one category. However, the classification is important in showing that no one common action will be effective in enhancing renewables penetration. A linked package of measures is more likely to be successful, by providing a "chain of support" which enables technologies to progress to the marketplace by maximising their technical, economic and market potentials. Such a chain is illustrated in Figure 2.

This chain does not represent a strict chronological succession, but provides a useful framework for discussing actions. For example, measures to stimulate a market for renewables will also benefit technical and economic impediments by fostering a competitive industrial base which will seek economies of scale and further technical improvement. At each stage in the chain, different support measures are applicable, which can be implemented either separately by individual countries or through co-ordinated action by a group of countries. These are described in more detail below.

Figure 2: The Chain of Support for Renewable Energy Technologies

Technical Impediments	**Support technical development** (R&D to reduce costs and improve efficiently)
Market Impediments	Full cost pricing of competing technologies (remove subsidies, incorporate external costs)
	Ensure a full value price for renewable energy (valuing renewables - socio-economic factors)
Institutional, political and legislative impediments	**Market stimulation** (guaranteed purchase, premium prices, investment support, tax breaks, low interest loans)
	Awareness of opportunity (awareness for industry, utilities, developers, via dissemination, methodologies for assessment of markets and resources)
	Harnessing commercial finance (assurance of technical performance via standards and certification, establishing long-term confidence, joint implementation)
	Reduce transaction costs (grid connection, regional energy centres, standardised assessment techniques)
	Ensure availability of skilled personnel (training, awareness, dissemination, demonstrations, qualifications)
	Overcome planning impediments (minimise environmental impact, raise awareness of benefits and opportunities by planners)

Actions Directed At Technical Impediments

Support technical development

Research, development and demonstration plays an essential role in developing renewable energy technologies, from the initial long-term research which identifies new technologies and processes, to the subsequent applied research, development and demonstration, which brings down operating and capital costs and improves efficiency and reliability, either by improving the design of the technology itself, or by improving the manufacturing methods. Demonstration schemes are necessary in order to identify areas for improvement before the product can perform in a commercial environment, and are also very important to increase investor confidence.

Recently, there have been concerns over declining government and industry research and development budgets for renewable energy, and calls for increased international commitment[2]. Whilst it would be politically difficult to agree on a possible common action to increase research budgets, there is scope for increasing the effectiveness of the money spent via possible common actions.

The advantages of performing research, development and demonstration as a common action include elimination of duplicated effort, exchange of ideas, pooling of resources and facilities, and greater opportunities for transfer of research results to the user community. These benefits have already motivated extensive co-ordination of research, development and demonstration programmes on renewable energy by both the IEA (e.g. Implementing Agreements) and the European Commission (e.g. JOULE, THERMIE, TACIS and PHARE, SYNERGY, MEDA, ALTENER). However, there may be opportunities to strengthen and extend these existing programmes, particularly with respect to technology diffusion to EITs and developing countries, and co-operative agreements with industry.

International collaboration on research, development and demonstration tends to reduce as industrial involvement builds up and the technologies reach the fully competitive market stage. Inevitably this leads to fragmentation and duplication of research effort in different countries, and actions to address this issue would be helpful to the industry.

The main disadvantages to co-ordinating and collaborating on research and development are the intellectual property rights conflicts and loss of commercial confidentiality.

Actions Directed At Market Impediments

In order for renewable energy technologies to be able to compete on equal terms in a free market without extra support measures, it would be necessary to remove the distortions and imperfections identified in Section 3, to obtain a “level playing field”.

Full cost pricing of competing energy technologies

Often renewable energy technologies cannot begin to compete with conventional energy technologies due to distortions in the market. These distortions range from direct subsidies for conventional energy (particularly for household electricity in EITs) through to a more general failure to reflect the full social and environmental costs of energy in its market price. Measures to tackle these distortions range from simple removal of subsidies, to various attempts to incorporate external costs into energy prices, either by "proxy" measures such as environmental regulation, emissions quotas or tradeable permits, or by partial incorporation of external costs via application of a carbon or energy tax. However, full internalisation of external costs is hindered by the huge uncertainty over the economic valuation of environmental and social impacts. (Subsidy reform, carbon/energy taxes and full cost pricing are all the subjects of more detailed IEA/OECD studies.) Potential common actions include:

a) **Removal of subsidies** on competing energy sources. Many of the OECD Member countries have already ceased to subsidise, or are taking steps to cease subsidies to conventional energy, but support for nuclear, either direct or indirect, is often maintained. In the EITs of Central and Eastern Europe subsidised primary fossil energy prices are a major impediment to the penetration of renewable energy. Most EITs aim to remove these subsidies eventually in order to move towards a free market economy, although such steps are extremely difficult due to the fragile economic situation in many of these countries. In principle, a common agreement to remove subsidies could facilitate the process in cases where the countries involved compete with each other in global markets. In order to assess whether this is the case in the EITs listed in Annex I, it would be necessary to carry out a detailed economic analysis of the trade systems of the countries involved. With respect to greenhouse gas emissions, such a possible common action would be logical if extra capacity is being installed where a cost-effective case could be made for renewables versus new capacity.

   Some advantage might also be gained from dissemination of the experience of subsidy reform measures in other Annex I countries, thus enabling sharing of information on the best methods of mitigating negative social and economic impacts (e.g. via income support or energy efficiency grants for low-income households to compensate for removal of domestic electricity subsidies, or stimulation of alternative employment opportunities in a coal mining area to compensate for removal of coal subsidies).

b) Financial measures to **incorporate external costs** into energy prices would clearly favour renewables. Much work has been directed at the social and economic impacts of local and regional pollutants such as SO_2, NO_x, particulates, etc. It is not clear whether incorporation of these costs would give a major boost to renewables. Thus it is possible that the main result would be fuel switching (e.g. coal to gas) and the adoption of cleaner conventional fuel technologies (e.g. flue gas desulphurisation (FGD)).

   A greater impact on the market would be achieved by introducing the potential external costs of global warming, although there remains much uncertainty over the magnitude of these costs. Mechanisms for including the cost could involve, for example, a carbon tax on fuel or a system of tradable permits. To date a carbon tax has not proved to be generally politically acceptable, although six European countries have unilaterally adopted carbon taxes. The main concern is that the adoption of a carbon tax would reduce national competitiveness through increasing the costs to industry. However, it has been suggested that revenue-neutral taxes which recycle the tax revenue by reducing the costs of labour can have a "double dividend" effect - both reducing environmental damage and boosting employment.

   Particular problems pertain to the adoption of such measures by EITs, which argue that their stage of economic development should permit them a "catching up" period. Any such measures would probably have to be implemented via a staged transition, starting with OECD countries and spreading to other countries as their economic positions converge. There could be advantages in implementing full cost pricing measures as possible common actions, in order to allay fears about reduced competitiveness, the migration of industry or the import of electricity from adjacent countries, but a level of participation sufficient to avoid free riders is essential. The main problem in applying a universal tax in Annex I countries is the threat of decreased international competitiveness relative to non-Annex I countries. However, there are also problems related to the existence of fossil fuel subsidies and uneven tax baselines, which would make it difficult to apply a universal externality adder such as a carbon tax.

If the political and technical problems associated with the universal adoption of full cost pricing or similar measures prove to be insurmountable in the short term, some benefit might still be gained from the wider dissemination of studies which assess the success of existing measures in individual countries, particularly the carbon and energy taxes adopted in Europe and the sulphur trading system in the United States. This might further the more widespread adoption of successful measures by other countries, and facilitate the design of such measures and ultimately move toward harmonised approaches.

Ensure a full value price for renewable electricity

Renewable electricity generating technologies often offer benefits which are not recognised in conventional pricing structures. These benefits include social and environmental effects, for example, the provision of energy services in remote rural areas, or increased employment in economically depressed areas. Many renewable energy technologies are more labour-intensive in both the construction and operation stages than conventional energy sources - some studies have estimated that renewables create five times as many jobs as fossil fuel technologies, and these jobs are often in rural areas where unemployment is highest. They also potentially offer economic gains arising from their modularity, flexibility, and reduction in transmission and distribution costs and system losses. The development of new methods of valuation of renewable electricity would permit its full worth to be ascertained. For example, the purchase price offered by utilities for sales of surplus renewable electricity generated at the point of use often does not take full account of the avoidance of costs for transmission and distribution. Some countries have recognised this argument, and this has led to the pioneering of “net metering” (i.e. balance of electricity flow) schemes. Some potential actions to promote full valuation of renewable electricity are listed below. Since this is an issue relevant to most Annex I countries a joint involvement in these through a possible common action approach merits consideration.

a) Co-ordinated research on full valuation of renewable electricity, including development of methodologies (e.g. market structure) for placing a value on attributes such as modularity, flexibility and embedded generation. Some isolated research is already underway, but a co-ordinated approach perhaps via an IEA Implementing Agreement would offer benefits and stimulate further work.

b) Pioneering approaches such as net metering schemes could be disseminated to a wider audience, particularly utilities, in order to highlight their successes (e.g. savings in distribution system investment) and build on lessons learnt.

c) Exploration of voluntary agreements between those responsible for regulation of electricity markets and the supply utilities for full value pricing of renewable electricity supplies. This might take the form of agreements on the part of the utilities to offer an increased price to generators of renewable electricity, in order to reflect more fairly its value to the utility.

Actions Directed At Institutional, Political And Legislative Impediments

Due to the political problems inherent in "full cost pricing" as described above, it is unlikely that renewable energy will be able to attain significant market penetration under existing market conditions in the short to medium term. Therefore, many countries are taking measures to stimulate the market for renewable energy by other means.

Even when renewable energy technologies are competitive with other energy sources, their market deployment can often still be hindered by a number of impediments related to obtaining planning permission, negotiating access to the grid, and attracting developers and financial backing. Measures to overcome these obstacles are described below.

Market stimulation

One approach undertaken by several governments to tackle market impediments has been to introduce measures to facilitate or "kick-start" the market for renewables. Such measures include investment subsidies, guaranteed purchase schemes such as government procurement, premium prices, tax breaks, low- interest loans, or large scale demonstration schemes. Such schemes have a range of potential benefits:

- increased involvement of industry leading to reduced equipment costs through economies of scale, increased experience and innovation in production and operation;
- build up of a supporting infrastructure and pool of skilled personnel;
- provision of a guaranteed market giving confidence to both manufacturers and users of the technologies;
- facilitating broader experience with the operation of the technologies and their integration within the supply system.

It should be noted that it is important to establish long-term confidence in the market, and thus the market stimulation measures should be designed to ensure a secure market for at least ten to fifteen years. Although these stimulation initiatives are necessarily nationally based, and tailored to different electricity market structures and operations, there are some areas which could be pursued more effectively through possible common actions:

a) Wide **dissemination** of the results of market support measures or policies to all Annex I countries, with the aim of encouraging the replication of successful measures and avoiding the pitfalls of less successful schemes. The brief review in this paper has demonstrated that the most successful approach is generally to employ a comprehensive range of measures which support technologies in all stages of the path to commercial competitiveness, and thus the most successful countries have backed market stimulation and promotion measures with strong support for technical research and development. Dissemination of measures could build on the Climate Technology Initiative (an IEA Member country programme), but focus specifically on renewable energy, and extend its geographic coverage to include EITs. The criteria for assessing the effectiveness of measures can be based on the increase in installed capacity, and also on the price convergence with other sources, to ensure that the technologies survive in the market when the measure is phased out. Each country may adopt the measures which are most suitable to their own situation, and learn from the experience elsewhere in order to adopt “best practices”.

b) Financing assistance, e.g. **common investment funds** to support investment in renewables through investment or operating subsidies or low interest loans, perhaps targeted specifically at EITs. Funds are already available from development banks such as the World Bank or the European Bank for Reconstruction and Development (EBRD), but these funds are often directed more to large-scale centralised energy supply projects. The creation of a special fund dedicated to renewable energy, perhaps utilising the existing support mechanisms of the World Bank and EBRD, could therefore be advantageous. Even when renewables achieve commercial competitiveness, assistance with investment costs will still be beneficial because of the “up front” nature of the investment profile, and the lack of readily available investment capital in some EITs.

c) The agreement of **common objectives** can be a useful tool for demonstrating political commitment. Although often common objectives are not legally binding, internationally agreed and publicised objectives are still useful in focusing the attention of governments and industry on suitable actions, and in raising the public profile of the issues concerning renewable energy deployment and its benefits. Common objectives could be agreed by Annex I countries, either for achieving a given share of electricity as renewables, for increasing deployment of renewables by a certain percentage, or setting country-specific objectives as for CO_2 reduction. The means of achieving the objectives could then be left to each country to determine. One possibility proposed in the Declaration of Madrid[5] is to require energy utilities to purchase a set proportion of their electricity from renewable sources. However, voluntary agreements and other market stimulation measures could also be explored.

Many countries already have individual objectives, and so does the EC (the ALTENER target aims to increase the contribution of renewable energy to 8 per cent of primary energy by 2005, and the recent green paper proposes a 12 per cent contribution by 2010). The willingness of countries to enter into such an agreement could be connected to their obligations under international environmental agreements, such as the UNECE Sulphur protocol, as countries which have already signed up to these agreements will benefit from increasing deployment of renewables.

Awareness of Opportunities

Commercial opportunities for renewable electricity generation may stem from market stimulation measures of the type discussed above. In addition, there are niche opportunities, often associated with remote communities separated from the transmission grid, in which certain renewable energy technologies are already commercially competitive. These latter opportunities occur in Annex I countries and to a greater extent in developing countries. They are important because they offer additional demand for renewables, which would increase the volume of production and hence the potential for economies of manufacture.

The problem is raising awareness of the opportunities, particularly those linked to niche markets, amongst the manufacturers, developers and utilities which need to exploit them. Much of the renewables industry is composed of small to medium sized enterprises (SMEs) which do not have the resources to prospect for such opportunities. SMEs will also be concerned by the risks associated with such developments, particularly because they do not have the size to acquire and retain a “corporate knowledge” of the problems involved and approaches for their solution. These issues can potentially be tackled through various dissemination, promotion and marketing activities. Potential common actions include:

a) Aggregation and publication of information on niche markets world-wide to enhance awareness of them and their attractiveness to investors.

b) Dissemination of case histories of successful deployment of renewable electricity technologies in both Annex I countries and other markets. This is already done to some extent through the IEA CADDET-Renewables Implementing Agreement, but there may be scope to target the Implementing Agreement on utilities and developers.

c) Development and dissemination of standard certified methodologies for assessment of renewable resources to assist with project planning and project financing plans.

Harnessing commercial finance

Measures for stimulating the market, as described above, can include the provision of finance by governments in the form of low-interest loans or investment grants. However, in the long term it is desirable to ensure that commercial finance can be harnessed for investment in renewable energy schemes. In order to do this, it is necessary to improve the confidence of investors in new renewable energy technologies which are not yet established in the market. Measures to achieve this include the assurance of technical performance, and development of standard, certified techniques for assessing resources and for evaluating the robustness of project financing plans (see section on *Awareness of Opportunities* above). Potential measures include:

a) Development of technical standards. The development of standards is thought to be important in order to increase the confidence of investors and developers in renewable energy technologies. There are also other advantages - standards may help to reduce installation and maintenance costs, and achieve economies of scale in production. However, there are also potential problems - standards can force smaller companies out of the market and centralise production in a few large companies. They can also stifle innovation, and freeze development of technologies at the wrong point in time, effectively reducing standards to the lowest common denominator. Finally they can remove the flexibility necessary to adapt technologies to local conditions. Care is thus necessary in the design of standards. European standards for some technologies (solar thermal, photovoltaics, wind and biodiesel) are currently being developed under the ALTENER programme, through organisations such as CEN and CENELEC[6], and this work could be extended to other technologies and other Annex I countries if appropriate.

b) Standard certified methodologies for assessing resources, as described in Section *Awareness of Opportunities*, would not only reduce the project planning costs of developers but would also improve the confidence of financiers backing a project.

c) There could be scope for providing a “brokerage service” (which the Solar Century Project is attempting to do) which brings the renewables industry together with the financial community to develop suitable finance packages. Such packages could be based on a life-cycle analysis of the project costs, in order to avoid rejection of cost-effective projects because of their high initial investment costs.

d) An important source of finance in the future could be "green consumerism", whereby customers voluntarily pay extra for their electricity, with the assurance that the money will be spent on renewable sources. Trial schemes have been implemented in several OECD Member countries, notably the United States and the Netherlands, and utilities in several other countries are showing an interest. The advantage from the utilities' point of view is that this is a cheap way of responding to governmental and consumer pressure to support renewable energy. However, it is important to design the schemes carefully in order to overcome consumer scepticism, by demonstrating a real commitment to renewable energy by the utility and ensuring a transparent and verifiable operation of the scheme.[7] Possible common actions could include dissemination of the results from the current pilot schemes, with the eventual aim of replication in other countries and by other utilities. Other assistance which could be carried out at the international level might include the development of guidelines on marketing and "branding" green power; the provision of public education materials to explain the benefits of renewable energy; provision of better information on how to price green electricity (including technology costs), and development of a certification scheme to build credibility in the market for green power.

In the future, it might be possible to implement a more ambitious green electricity scheme in a single European market for electricity. This might help to even out supply/demand imbalances and transmission loss problems (although the actual electron received by a "green" consumer might not be "green", appropriate transfers of funds are made). It is questionable whether "green consumerism" should be supported as a permanent solution, that is, whether "green" consumers should be asked to subsidise others when there are common benefits from reduced pollution, etc. However, in the short term, green consumerism could be a valuable tool for developing the market for renewable energy.

Minimise transaction costs

The implementation of renewable energy schemes often requires a disproportionate effort to overcome administrative and institutional impediments, involving high "transaction costs". Such impediments include assessing the renewable resources (Section *Awareness of Opportunities*), obtaining planning permission, negotiating access to the grid if necessary, and persuading investors to supply financial backing. As the greatest opportunities for deployment of renewable energy often lie in small, decentralised applications, the most appropriate developers will usually be SMEs or individuals, who cannot afford the high transaction costs involved. Any measure which can reduce these costs will therefore have a great effect on the market penetration of renewables. Possible measures which could be undertaken as common action include:

a) Encouraging the establishment of regional energy centres which can provide assistance for developers. This was carried out to great effect in Denmark. Energy centres have already been established by the EC in various European countries, but there may be scope to extend their geographic coverage or strengthen their use to promote renewable energy deployment. This is in line with an EU proposal in the Declaration of Madrid[14] to establish European Renewable Energy Sources Information Centres.

b) International consensus on the desirability of removing impediments to new entrants to the energy market could lead to acceleration in the implementation of regulations or voluntary agreements, for example to simplify the procedures and reduce the costs of connection to grids for new small producers. This could lead to the development of guidelines for utilities and regulators, concerning issues such as suitable charging structures for new grid connections. However, such guidelines should take account of the significant differences in modes of grid operation between countries.

Ensure availability of skilled personnel

Most of the measures described above require the availability of personnel with the appropriate skills and qualifications for design, installation and maintenance of technologies, and development and assessment of renewable energy schemes. Some experienced personnel are produced through involvement in research, development and demonstration projects. However, there are currently few educational or vocational courses specifically targeted at renewable energy technologies and developments, and those which do exist tend to be heavily oversubscribed. Also, there is generally low coverage of renewable energy technologies in more broadly based courses on engineering, architecture, geography or planning. As a result, not only are suitably qualified personnel for implementing new schemes lacking in many countries (particularly EITs and developing countries), but awareness of the potential for renewable energy technologies is low amongst the engineering and planning community at large. Such problems could be addressed by the following measures:

a) creation of internationally recognised academic and vocational qualifications in renewable energy technology design, installation and maintenance;

b) provision of specialised courses on renewable energy technologies design, installation, planning, maintenance at international centres;

c) consensus with academic organisations to include a stronger coverage of renewable energy technologies in traditional academic courses such as architecture, civil engineering, mechanical engineering, electrical engineering, agriculture, geography, land-use and planning.

Actions Directed at Social and Environmental Impediments

Renewable electricity technologies often face problems with social and environmental acceptability. These problems arise from factors such as their low energy density which often entails use of large areas of land; location of the best renewable resources in areas of scenic beauty; and lack of awareness of the benefits of renewable energy by planners and the public. These impediments could be tackled by the following possible common actions:

Minimise environmental impacts

There could be value in carrying out co-ordinated research and development on methods of minimising the environmental impact and increasing the social acceptability of renewable energy schemes, e.g. methods to reduce noise and visual impact of windfarms; technologies to reduce emissions from waste-to-energy plants; research on the environmental impacts of energy crop cultivation; socio-economic impacts of co-operative ownership of renewable energy schemes. The results of this research and development should be disseminated widely to manufacturers and developers in Annex I countries so that they can improve the design of their schemes and technologies.

Improve awareness of planners and end-use consumers

There is a need to improve the awareness by planners of the benefits which renewables offer, in order to reduce problems associated with obtaining planning permission. For example, global environmental benefits might not be taken into account if planners concentrate only on local impacts. Improved awareness might be achieved in several ways:

a) development and publication of planning guidelines which outline a framework for taking into account the benefits as well as the possible adverse impacts of renewable energy schemes. This should be widely disseminated to planning authorities in Annex I countries. This would allow developers, manufacturers and planners to minimise the environmental impacts of renewable energy developments, and could reassure the public that the development could conform to internationally recognised planning standards.

b) wide dissemination of profiles of successful renewable energy developments and their benefits, particularly where novel solutions to minimising environmental impact have been employed.

c) A solution proposed by the EC[14] is to organise training courses for representatives from local authorities which would enable them to identify opportunities for renewable energy.

d) Awareness could be raised via the establishment of advisory centres, perhaps building on the concept of the UK's Energy Design Advisory Service (EDAS) which aims to maximise the potential for passive solar and energy efficient building design in the United Kingdom by offering a technical advisory service to architects, planners and developers.

e) Public relation campaigns could raise the awareness of the end-use consumers.

Maximise planning opportunities

Opportunities for renewables could be enhanced by consideration of the potential for utilising renewable energy technologies at an earlier stage in the planning process. Such technologies are often more cost-effective when incorporated into the original design of a development, such as in the use of photovoltaic panels to replace conventional building cladding materials. It would therefore be very useful to implement measures which encourage automatic consideration of the possibilities for deploying renewable energy schemes when new developments are planned. For example, there could be a common voluntary adoption of planning guidelines which recommend including an assessment of the potential for utilisation of renewable energy technologies for every new development. This could ensure that cost-effective and appropriate opportunities for deployment are not missed through lack of awareness.

Enhanced opportunities for renewable electricity generation could also arise through greater use of Strategic Environmental Assessment (SEA) by governments, funding agencies and planners. SEA is an extension of project-level environmental impact assessment which is being promoted by the European Commission[8] and by organisations such as the World Bank.[9] It encourages consideration of all the alternative strategies for meeting an objective (say, the provision of increased electric power to a community), and comparison of their environmental impacts.[10] It could thus be a valuable tool both for highlighting the environmental benefits of renewables compared to conventional power options, and for minimising the local environmental impacts of new renewable schemes. A common agreement amongst

Annex I countries to disseminate the methodology and the benefits of SEA and promote its use in the power sector could be very beneficial.

Single Market For Electricity - The EU Experience

Some potential common actions do not fit into the simplified "support chain" discussed above. These are the more complex measures arising from the potential for increased trade between countries. Different electricity markets and market conditions exist in different countries or regions. There are ongoing efforts to develop a single market across the different economies in Europe.

It is difficult to predict the impact of the developing international markets for electricity on the market status of renewable energy. On the one hand, trading of electricity across borders will increase the size of the market for renewable energy and thus lower the resource-cost curve by ensuring that more of the cheapest, most efficient options are taken up. (It might also help to even out problems associated with over- dependence on intermittent sources, although transmission losses would negate this effect for trade over long distances). This could help to stimulate the industry. On the other hand, if there is completely free trade in electricity, then renewable electricity which is currently supported in protected markets by national governments could be squeezed out of the market by cheaper conventional technologies such as combined cycle gas turbine, unless there are accompanying safeguards for renewables.

Various methods of attempting to ensure that renewable energy continues to play a part in liberalised international electricity markets have been proposed:

a) **Placing an environmental responsibility on regulators**. Recent proposals in Germany have attempted to incorporate environmental considerations into their plans for market liberalisation by placing a responsibility on regulators to maintain an environmentally sustainable energy supply, and relaxing the licensing procedures for renewables and combined heat and power[11] (CHP). Similar provisions are included in the forthcoming EC directive on the internal electricity market.

b) **Integrated Resource Planning**. The proposed EC directive on integrated resource planning (IRP) could also play a crucial role in safeguarding renewables in a single electricity market, and also in ensuring the active involvement of electricity utilities, which have a vital role to play in promoting the uptake of renewables.[15]

c) **Renewable energy credits**. The EC has suggested consideration of a system comprising an obligation on member states to meet a certain percentage of electricity supply from renewable sources (which could be considered as common objectives, see section on *Market stimulation* (c)), enforced on each retail electricity supplier, coupled with issue of tradeable renewable energy credits to allow trading of these obligations between suppliers[15]. If appropriate, such a system could be coupled with a surcharge mechanism. The advantages of such a scheme would include its equal impact on all utilities, and the motivation for utilities to work on reducing the costs of the renewables which they adopt. A major issue to be addressed would be the method of enforcing compliance with such a scheme.

The development of a single market might also have implications for the application of carbon or energy taxes to internalise external costs. On the one hand, a single market may encourage the harmonisation of taxes, which could represent an opportunity to implement a carbon tax. On the other hand, there are indications that the opening Nordic electricity market may result in a shift of taxes from production to consumption of final energy, because it is argued that the different production mixes coupled with different taxation rates would impede competition. In effect, this would entail the replacement of existing carbon taxes with a flat-rate electricity tax which would not favour renewable energy [12].

Benefits of the Penetration of Renewables

Sections 3 and 4 examined the impediments to the commercial penetration of electricity generating renewables and the actions currently being undertaken to tackle these impediments. This has indicated that the main short-to medium-term (i.e. to year 2010) drivers for these technologies are the market stimulation measures being implemented by several OECD Member countries combined with niche market opportunities. With regard to the latter, development banks such as the World Bank, EBRD, etc, have a key role in supporting the exploitation of these opportunities. The potential common actions identified in Section 5 may be roughly divided into two groups:

- additional or alternative measures to stimulate the market for renewables (i.e. removal of subsidies to other generation sources, incorporation of external costs, full value pricing, renewables investment fund, agreed deployment targets);

- measures to capture the full benefit of existing market stimulation activities (e.g. awareness of opportunities, overcoming planning impediments, research, development and demonstration collaboration, availability of personnel, etc.).

The first group of possible common actions is probably the most difficult to implement because it requires high level political decision-making. However, in qualitative terms, these actions do offer the benefit of extending market stimulation to a broader range of Annex I countries, and therefore increasing the potential for increased deployment of renewable electricity generation in the short- to medium-term.

The second group of possible common actions is more concerned with deriving maximum benefit from the existing market opportunities. These may require a lower level of decision-making, and therefore may be more easily implemented. In qualitative terms, the benefits will be threefold. First, the actions could assist renewable energy technologies to exploit their near-term market opportunities to the maximum. Second, by facilitating the development of both the manufacturing and utilisation industries, establishment of a pool of skilled personnel, developing technology and assessment standards and establishing a planning culture an overall infrastructure could be established, which will be in a stronger position to pursue longer term commercialisation opportunities. Finally, the accelerated market penetration of renewable technologies could lead to further cost reductions and performance improvements by a "learning by doing" process.[13] There is great scope for further cost reductions for renewable energy technologies. For example, photovoltaic systems have decreased in cost by 40 per cent over the last decade, and are predicted to decrease by another 40-50 per cent over the next decade.[2]

Rationales for possible policies and measures for common action include:

- sharing the costs and benefits, and hence the risks, of various programmes;
- allowing cross-fertilisation of ideas and approaches to occur among countries, improving the chances of finding successful and cost-effective solutions;
- enlarging the potential market for new renewable energy technologies, allowing economies of scale to be achieved more easily;

- giving clearer market signals to manufacturers and suppliers operating in an international market; and
- enabling countries to implement measures that could not be implemented on an individual basis.

Overall, the potential common actions could have the effect of facilitating enhanced deployment of electricity generating renewables in both the short to medium term (to year 2010) and the longer term (2010- 2030). There are economic, social and environmental benefits to be derived from this:

- contribute to diverse, secure and sustainable energy supplies;
- reduce emissions of CO2 and hence reduce economic, social and environmental impacts of climate change;
- reduce other local and regional environmental impacts, (e.g. SO2 emissions) yielding social and economic benefits;
- generate increased employment in manufacturing, installation and maintenance, particularly in rural areas, and stimulate the growth of SMEs;
- enhance social and economic cohesion particularly for isolated rural communities through the provision of improved energy services, and by maximising use of indigenous resources in countries which are dependent on imported fuel; and
- increase international co-operation and understanding (more favourable terms of trade, opening up of export markets for equipment suppliers and investors).

So far this discussion has concentrated on a qualitative assessment of the potential common actions in terms of their contribution to the market penetration of renewable electricity technologies, and the associated social, economic and environmental benefits. From the perspective of the Annex I Expert Group, the key question should be “how much more renewables will be deployed and over what time frame if the possible common actions are implemented?” A quantitative answer to this question is beyond the scope of this study, and indeed may not be amenable to analysis, since it involves assumptions on the scope of implementation and effectiveness of the possible common actions, as well other factors affecting the electricity market (e.g. fossil fuel prices, demand growth).

A crude scoping can be made based on internationally acknowledged scenarios for energy supply and demand. The approach used is to compare the “Current Policies” and “Ecologically Driven” scenarios of the World Energy Council[14] (WEC), in order to obtain a very rough estimate of the extra deployment of renewables which could be obtained through additional support measures. The “Current Policies” scenario assumes the continuation of current trends, which depend in some part on existing market support measures, leading to a modest growth in renewables. The “Ecologically Driven” scenario assumes a shift towards accelerated development of renewable energy resources propelled by government support, as part of a global ecological initiative which includes energy efficiency measures, and thus leads to an overall reduction in energy use, compared to the Current Policies scenario. This scenario is intended to represent the upper limit achievable for renewable energy, and requires a sustained international effort. Thus, it would be compatible with a full implementation of the entire range of possible common actions described in Section 5, including those which are acknowledged to be difficult to implement, such as reaching an international consensus on adoption of carbon taxes, and common agreement to increase funding for renewable energy research and development.

Table 2 presents the WEC predictions for energy use from renewable energy under the two scenarios. For comparison, total renewable energy production in 1990 was 1559 Mtoe, of which only 164 Mtoe was from "new" renewables (the rest was from traditional biomass and large-scale hydro). The WEC study suggests that traditional renewable energy would decline slightly in the ecologically driven scenario, due to concerns over the lack of sustainability of traditional biomass use, and the environmental impacts of large-scale hydro.

In order to translate these figures into an estimate of the benefits which might accrue from the adoption of possible common actions by Annex I countries, it is necessary to first scale the WEC figures so that they apply only to Annex I countries, and to then estimate the proportion of the benefits which would be derived from possible common actions, as opposed to unilateral national actions. It is also necessary to translate the estimates of total energy use into figures for electricity generated, and then convert this to CO_2 avoided.

The figures were converted to the increase in deployment in Annex I countries by summing the contributions of Western Europe, CIS and Eastern Europe, and North America. An allowance must also be made for Japan, Australia and New Zealand, which are part of the Pacific/China category. The WEC[15] provides a breakdown of this category into "Centrally Planned Asia" (mostly China) and others (mostly Japan, Australia and New Zealand, but also Indonesia and Malaysia), of which the "others" account for approximately 42 per cent of renewable energy production. It is therefore assumed that Annex I countries account for 40 per cent of the China/Pacific category.

It should also be noted that the application of possible common actions in Annex I countries could increase the deployment in other countries, by leading to cost reductions and performance improvements as part of the "learning by doing" process, and by strengthening the renewable energy industries and thus increasing the export of technologies to other countries. This effect is not quantified in this analysis.

The above analysis suggests that at least 229 Mtoe of additional deployment could be achieved in Annex I countries. It remains to estimate what proportion of this increase could be achieved via application of the Possible common actions described above. There is no basis for quantification of this ratio, but as a rough illustration, a figure of 50 per cent will be used (i.e. it will be assumed that an additional 115 Mtoe could be deployed by vigorous application of the full range of possible common actions, including action to internalise external costs, increased government support for research and development, and accompanying market support measures).

This approximate figure can be translated into an estimate of reduced CO_2 emissions by making an appropriate assumption about the power plant which is displaced by the renewable sources. This analysis is based on the approach of a recent IEA study on the environmental impacts of renewable energy[4]. The study calculated avoided CO_2 emissions based on the WEC study for three different cases: displacement of emissions from CCGT plant (to give a lower bound), from modern coal-fired plant with NO_x reduction and FGD (to give an upper bound) and from the current generating mix (to give an average figure). Using a similar approach, it can be estimated that around 330 Mt of CO_2 could be saved annually by 2020, assuming displacement of the current generating mix, and 508 Mt CO_2 assuming displacement of modern coal capacity. However, it must be stressed that this is a very crude analysis. First, the approach of equating the potential increased deployment to the difference between the two scenarios is open to question. Second, the WEC study should not be regarded as conclusive, and thus the initial estimate of potential savings is also uncertain. Also, the estimate is highly dependent on the assumption that around

50 per cent of potential savings could be achieved through implementation of possible common actions. The actual figure will depend on the scope and effectiveness of the actions implemented.

The study did not address the costs of possible common action to enhance the penetration of renewables in general, or the implementation aspects of any specific measure. Given different national circumstances, possible common actions might be based on geographic regions, trading ties, common interests, industrial structures or policies already in place.

Table 2: WEC projections for renewable energy use in 2020

Region	**CurrentPolicies**		**Ecologically Driven**		**Difference**
	Mtoe	*percentof Global*	*Mtoe*	*percentof Global*	*Mtoe*
NorthAmerica	358	2.7	487	4.4	129
LatinAmerica	565	4.2	661	6.0	96
WesternEurope	242	1.8	269	2.4	27
CIS&Eastern Europe	146	1.1	189	1.7	43
Mid.East/N.Africa	66	0.5	80	0.7	14
Sub-SaharanAfrica	349	2.6	350	3.2	1
Pacific/China	718	5.4	792	7.1	74
Central/SouthAsia	401	3.0	452	4.1	51
Total	2844	21.3%	3279	29.6%	435
Newrenewables	540	4.0%	1344	12.1%	804
Traditionalbiomass andlarge-scale hydro	2304	17.3%	1935	17.5%	-369
Approx.AnnexI total	1033		1262		**229**
Newrenewables	312		657		**345**
Traditionalbiomass andlarge-scale hydro	721		605		**-116**

CONCLUSIONS

The review of obstacles to the wider deployment of renewable energy technologies and the review of the scope of existing measures in Annex I countries has led to the identification of a list of possible policies and measures for common action. By supporting renewable energy technologies at all stages of their progression into the marketplace, these actions are capable of reducing the costs of such technologies and enhancing their deployment. This will in turn stimulate further cost and performance improvements. The increased deployment of renewables could lead to significant environmental, social and economic benefits, including significant reduction of CO_2 emissions by Annex I countries.

The possible common actions identified and discussed in Section 5 are summarised in Table 3 below. These have been grouped roughly according to which type of impediments they address, although, as discussed previously, some of the market stimulation measures address several groups of impediments simultaneously. Table 3 also gives a view of the likely political sensitivity to be encountered in implementing these measures. In this context, sensitivity aims to take account of the complexity of decision-making required on the action, the time frame likely needed and the complexity of implementation.

The aim of this study has been to identify as many options as possible for further consideration by the Annex I experts. Many of the options identified require further work to assess their viability and draw up more detailed designs. It is recommended that all measures merit further consideration at this stage. However, it may be prudent to focus first on the low to medium sensitivity measures which offer the opportunity for earlier progress. Thus, it is worth noting that, in theory, the most effective and efficient way of stimulating the uptake of renewable electricity technologies would be to achieve consensus on the full removal of subsidies and complete internalisation of external costs for non-renewable energy technologies. However, in practice, experience has shown that this is unlikely to be feasible in the short term. Furthermore, because of the uncertainty of the effect of restructuring on the increased penetration of renewable energy technologies, the most feasible common actions to consider in the short term are those measures to capture the full benefit of existing market stimulation activities, such as awareness of opportunities, overcoming planning impediments, research, development and demonstration collaboration, and training of skilled personnel. Specific initiatives are addressed below.

Initiatives for possible policies and measures for common action

As discussed previously, the most effective possible common actions identified here would also be the most difficult to implement in political terms: common agreement to act on internalisation of external costs; and common agreement to provide extra funding for renewable energy research and development, and investment support. Although it is recommended that further opportunities to pursue these measures are taken wherever possible, the discussion below focuses on the low to medium-sensitivity options, which could be achieved within a shorter time scale.

Table 3: Summary of Potential Common Actions to Support Electricity Generating Renewables

Impediment Type	Possible common action	Political Sensitivity*
Technical	Collaboration on RD&D	Low
Market	Removal of subsidies to other supply options	High
	Incorporation of external costs	High
	Research into the full value of renewables electricity	Low
	Dissemination of net metering approaches	Low
	Exploration of voluntary approaches for full value pricing	Medium
Institutional, political and legislative	Dissemination of experience of market support measures	Low
	Establish a common investment fund support renewables	High
	Agree a common target for renewables deployment	High
	Disseminated information on niche markets world wide	Low
	Dissemination of deployment case histories	Medium
	Develop and disseminate standard certification methodologies for resource assessment	Medium
	Develop technical standards for technologies	Medium
	Establish a brokerage service between the renewables industry and financial services	Medium
	Encourage Green consumerism	Medium
	Establishment of regional energy centres to assist renewables developers	Medium?
	International consensus on the removal of rules for grid access to new entrants to the power generation market	High
	Create internationally recognised qualifications in renewable energy	Medium
	Provision of specialised personnel training centres	Medium
	Promotion of stronger coverage of renewables in traditional academic courses	Medium
Social/Environmental and planning	RD&D to reduce environmental impacts	Low
	Development of planning guidance	Medium
	Consideration of potential for RE at the planning stage of new developments	Medium

* The Political Sensitivity rating is purely subjective. It is meant to indicate the complexity of decision making required on the action, the time frame likely needed and the complexity of implementation.

Many of the possible common actions can be grouped into specific initiatives which involve particular groups of participants and similar types of measure (e.g. dissemination, discussions, study groups etc). These initiatives sometimes span more than one of the five groups of possible common actions discussed in Section 5. They are listed below.

A. Dissemination of experience with measures to promote renewable energy

Several of the possible common actions identified include the wider dissemination of experience gained with the deployment of various measures. There is an opportunity to integrate these actions into a unified dissemination initiative, perhaps using the vehicle of the Climate Technology Initiative. The topics for dissemination would include:

a) Experience with removal of subsidies, including the effects on trade, and methods of minimising social and economic hardship;

b) Experience with incorporation of external costs via carbon and energy taxes, including the possibility of the "double dividend" effect of revenue-neutral taxes, and the effect of such taxes in a single electricity market (experience from the Nordic countries);

c) Experience with market support and stimulation measures, such as guaranteed pricing schemes and government procurement programmes, investment subsidies, and green pricing initiatives. Should include the advantages and disadvantages of different types of support measure (e.g. competitive vs. non-competitive tendering for guaranteed purchase schemes), and optimum design of such schemes (e.g. development of guidelines on pricing and marketing green power);

d) Experience with measures to increase the involvement of energy utilities, for example: IRP, regulation, pollution permits, renewable energy credits, voluntary agreements, and measures to improve the access of independent renewable energy generators to the grid;

e) Experience with the use of Strategic Environmental Assessment (SEA) in planning for power sector needs by national governments, funding agencies and utilities.

The dissemination initiative could be structured around a series of workshops, with associated high-quality publications targeted at policy makers. The aim would be to share the experiences of different countries, in order to encourage replication of successful measures and promote "best practice" in design and application of each of the measures listed above. It would be important to ensure a good attendance of national policy-makers at the workshops.

B. Co-ordinated research on integration of renewable electricity into energy systems

Much of the international research on renewables has focused on technical aspects of development. As technologies begin to move towards the marketplace and encounter non-technical impediments, there is scope to extend this research to cover other aspects of the integration of renewable energy into national energy systems. This could be done via an IEA Implementing Agreement. The subjects for research could include:

a) Valuation of renewable electricity, to include development of methods of assessing the market benefits arising from modularity, flexibility, and embedded generation, social benefits such as increased employment and energy independence in remote rural areas, and environmental benefits;

b) Reduction of environmental impacts - methods of reducing impacts through, for example, careful siting of wind turbines.

The results of such research should be disseminated widely to the renewable energy industry and to utilities and developers.

C. Exploration of possibilities for financing assistance for renewable energy

As discussed in Section 5, renewable energy could benefit from the existence of an international fund to provide investment capital. This has been recognised by the World Bank, which set up the Solar Initiative in 1994, with the aim of increasing financing for renewable energy projects, gearing support towards the special requirements of renewable energy investments (small project size, capital-intensive investment profile, etc.) and raising awareness of opportunities within the Bank and within developing countries. The number of renewable energy projects supported by the Solar Initiative had risen to around ten per year by 1996. A scoping study performed by the IEA could establish whether there is scope for similar schemes focused on Annex I countries, perhaps utilising the existing support mechanisms of the EBRD. This initiative could be extended to a general “brokerage” service to put renewable energy companies in touch with financiers who have experience of dealing with RE investments.

D. Study of niche markets world-wide

Awareness of opportunities for investment in renewable energy could be enhanced by a study to assess the scope for deployment of renewable energy technologies in niche markets world-wide. Such a study could be carried out by consultants in collaboration with national energy agencies, renewable energy trade associations and business organisations.

E. Dissemination of case histories of successful renewable energy deployment

As mentioned in Section 5, awareness of opportunities for deployment of renewable energy technologies could be enhanced by wider dissemination of case histories of successful deployment world-wide. One approach would be to modify and extend current mechanisms, such as the IEA's CADDET Renewable Energy Implementing Agreement. In so doing, it could be necessary to target some material to planners, by demonstrating the local social and environmental benefits of renewable energy developments, and disseminating information on methods of reducing the local environmental impacts of renewable energy technologies.

F. Development of technical standards and standard methodologies for assessing renewable resources

As discussed in Section 5, the confidence of investors could be increased by the development of technical standards for certain technologies, although care must be taken to avoid stifling innovation. A contribution to the development of technical standards could be made via the existing initiatives being undertaken by CENELEC, the European Committee for Electrotechnical Standardisation, and in co-operation with renewable energy trade associations.

In addition, the development of standard methodologies for assessing renewable resources could reduce transaction costs for renewable energy developers, and increase the confidence of investors.

This could be initiated via a consultancy study, and the results disseminated to potential developers and investors.

G. Establishment of regional renewable energy centres

Several of the potential common actions could be implemented via regional renewable energy centres - either by extension of the function of existing centres such as those set up by the European Commission throughout Europe (not exclusively for renewable energy), or by initiation of new centres devoted to renewable energy. The functions performed by such centres might include:

a) provision of advice to potential developers, to minimise transaction costs. Such advice could include professional technical advice and general advice on relevant legislation and planning procedures;

b) provision of specialised courses on the design, installation and maintenance of renewable energy technologies;

c) a centre for training courses for representatives from local authorities, to assist them in identifying opportunities for renewable energy in their region, and in assessing the benefits and mitigating any adverse impacts of such schemes.

It is suggested that a scoping study be conducted to assess the need for such services in Annex I countries, and the extent to which they are already provided by existing energy centres, in order to ascertain whether the establishment of further centres would be useful.

H. Integration of renewable energy into academic courses

As discussed in Section 5, possible common action could be to:

a) establish recognised academic and vocational qualifications for renewable energy technology design, installation, operation and maintenance;

b) integrate discussion of renewable energy technologies into conventional academic courses in engineering, architecture, agriculture etc.

Both of these actions would require extensive liaison with academic organisations throughout Annex I countries. It is suggested that an IEA study group is set up to investigate the potential for such action, and to establish a dialogue with key academic organisations. The discussion could begin with the main universities who currently provide renewable energy training, and expand through suitable academic fora to include other education establishments.

J. Possible common action to raise awareness of planners

As discussed in Section 5, there could be a significant benefit from raising the awareness of renewable energy by local planners. Suitable actions could include:

a) Development of planning guidelines for assessment of the benefits of renewable energy technologies and mitigation of any adverse local environmental impacts (could be integrated with training courses, see G.c above).

b) Negotiation of a consensus between local planning authorities to incorporate consideration of the potential for renewable energy into all new developments, perhaps via the use of Strategic Environmental Assessment.

These actions could be implemented via the Local Agenda 21 initiative, by local government associations working in partnership with consultancy organisations with experience of assessing renewable energy schemes.

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APPENDIX I: EXAMPLES OF MEASURES TO SUPPORT RENEWABLE ENERGY IN ANNEX I COUNTRIES

Australia

The main channel of government support is through research and development. In recent years this has been supplemented by measures to boost market deployment.

- The Renewable Energy Promotion Programme ran from 1992-95, to promote stand-alone power in rural areas. Installation incentives were offered in some states.
- A$4M over 4 years was allocated to support the RET industry in March 1995.
- A program to provide low-interest credit for purchasers of solar water heaters and energy efficient products.
- There are initiatives in most states to encourage the use of renewable energy equipment.
- RE equipment is exempt from sales tax.
- A$13.5 million over 7 years has been allocated to a new co-operative research centre for RE. A$3.9 million has been allocated to a three-year ethanol research and development programme.
- Green pricing initiatives are being considered by the six state-owned power corporations, and a market trial is being introduced by EnergyAustralia, whereby customers can purchase 25 per cent, 50 per cent or 100 per cent of their electricity from green sources (landfill gas, wind, small hydro, PV) at a 25 per cent premium.

Sources: 4, 5, 6, 34

Austria

The government is committed to increasing the share of renewable energy. Renewables make up 24 per cent of Austria's total energy supply, with hydropower providing 69 per cent of all electricity. The focus for future development is on biomass and solar, with a long term target to double the share of bioenergy to 300 PJ/y (about 25 per cent of primary energy). A package of measures is used, with a total government subsidy of Sch 400 million in 1994, of which Sch 250 million (19 M ECU) was for biomass (Ref 6 states 51.3 million for biomass, 82 million for non-hydro RE). By the end of 1994, 16 300 heating systems based on wood chips, 1 037 000m2 of solar collectors and 1MW of photovoltaic systems were in operation.

- Energy taxes. In June 1996 an energy tax on electricity and gas consumption was introduced, with renewables and coal excluded from the tax. Refunds are payable to energy-intensive industries, although there have been criticisms from industry over delays in paying the refunds. Early plans for the tax to be recycled into CO2-saving measures were also shelved in the face of a government budget deficit. (21)

- There are premium payments for renewable electricity based on avoided cost, e.g. wind generated power receives twice the payment given to gas based power.

- Financial subsidies. Federal Government and Länder subsidise investment costs in biomass heating systems, small district heating systems, biogas facilities and solar heating systems. The Solar Energy Programme provides Federal government support for grid-connected pv. The Länder supports thermal solar and heat pump installation. Further public money has also been spent to support annuities of commercial credits for bioenergy projects. Subsidies can be between 20-50 per cent of the total investment costs of district heating installations based on biomass.

- There is a good infrastructure of regional energy agencies offering support for RE development projects.

- Research projects. Austria spends 28 per cent of its energy research and development budget of Sch 270 million on renewables, of which about Sch 20 million (1.5 M ECU) is spent on biomass projects such as cultivation of energy plants and further improvements in combustion technologies.

Sources: 4, 5, 6, 9, 10, 11, 21

Belarus

Almost all electricity is produced centrally from imported gas and oil, or imported. There is a small contribution from renewable energy, mostly wood and wood waste, with a little hydropower. Potential for hydro, solar and wind energy is quite low, but the TERES II study suggests a significant further biomass (wood and wood waste) resource.

There are no state or public organisations with specific responsibility for renewables, little state financing of research and development, and no legislation to permit private generation, grid access, or to ensure a fair price is received for renewable electricity. However, a new energy policy document states the intention to promote energy from wood and hydro resources, and to increase use of wind power and biogas in rural areas, backed with funding of 60 billion Roubles (6 million ECUs) in 1996. The Minister of Energy has also stated that if a wind farm is built it will be given access to the grid, and the electricity produced will be purchased at a rate twice that of other electricity. This would apply only to the first wind farm, and as described above there is no supporting legislation. Prospects for deployment of renewable energy may improve in the future due to the increase in prices of fuels imported from Russia and elsewhere since the collapse of the Soviet Bloc.

Sources: 12, 13, 14

Belgium

The current contribution of renewable energy is negligible - less than 2 per cent of electricity production, mostly from wood, forestry waste and municipal waste. This is due mainly to the low prices of conventional energy coupled with (until 1994) an unfavourable pricing structure set by a committee consisting of distributors and large producers. For the last two years the government has been trying to promote increased use, to help meet CO_2 reduction commitments. “Autoproducers” using renewable energy sources, cogeneration or waste energy are now granted favourable tariffs, and can sell as much electricity as they like off-peak. Surplus electricity based on hydro, wind, biogas and biomass receives an extra bonus of 1BF/kWh. However, some commentators believe that this is still inadequate.

Source: 9

Bulgaria

Bulgaria relies heavily on imports of fossil fuels. The only renewable technology contributing to electricity supply is hydropower, which supplies 11 per cent of electricity. There is a good potential for small scale hydro, biomass and solar power, but exploitation is restricted by the low price of conventional energy, by the lack of a legal framework for sales to the grid by IPPs, and by economic instability.

Bulgaria has a target to reduce CO_2 emissions to their 1988 level by 2000, but feels that EITs should receive assistance from developed countries to achieve such aims. Bulgaria is in favour of joint implementation measures. A climate change action plan was drawn up as a result of a study funded by the USA. As a result of this, several projects to promote RE have been carried out by research institutes.

Source: 2, 3, 15

Canada

Hydropower supplies 12 per cent of primary energy, other RE (mostly biomass and waste, particularly wood and paper industry waste) 4 per cent. For the last twenty years, the main channel for government support has been research and development. Many provinces and utilities support information programmes and research and development activities. A new strategy for renewable energy is being drawn up, which will focus more on market deployment.

- Ethanol from biomass is supported through a federal C$ 0.10 per litre tax exemption, supplemented by some provinces. The National Biomass Ethanol Program is a $70 million credit fund for eligible production schemes.

- The Green Power Procurement Initiative promotes the testing and deployment of renewable energy (wind, solar, small hydro, biomass) in Canadian government buildings.

Sources: 4, 6, 8

Czech Republic

Installed generating capacity is 30MW, and renewables (small hydro and wind) provide around 0.2 per cent of power production. The Czech government has agreed to stabilise aggregate greenhouse gas emissions at the 1990 level by 2000. In general, the priorities are for switching from solid fuels to gas, improving energy efficiency, and installing environmental controls on coal fired plant, rather than in investing in renewable energy. However, verbal support is given to renewables in the Czech Energy Policy document, and several measures are aimed at promotion of RETs. The Czech Energy Agency, EVA, proposes a target to increase the share of RE to 6 per cent by 2010 through subsidised loans, favourable rates for grid-connected renewables, promotion, information and training.

Grid access and energy prices

The Energy Act 222, in force since 1995, places a duty on power utilities to buy electricity generated by renewable energy under condition that it is technically feasible, although the producer must pay the costs for grid connection. The electricity price set by the state is standard for all producers, and is very low (Kc1.032/kWh, which is around 2.3 pence). This low price, in combination with the costs of grid connection and the "technically feasible" requirement, form major barriers for independent producers. Price reform is underway, and industrial energy prices are now comparable with Western countries, but energy to households is still subsidised in order to minimise social impacts.

Loans, tax breaks and other measures

Over the last five years the Czech Republic has channelled Kc 100 million (£2.3 million) into interest-free 3-year loans for up to 40 per cent of the cost of renewables projects. There is a reduced VAT rate for biogas and solar devices. Operators of small hydro, wind, solar, geothermal and biogas plants are exempt from income tax for 5 years. Other measures include the "Oleoprogram" to support bio-fuel oil production, and a programme of information and demonstration of RE use in rural areas.

In common with other Central and East European countries, there are problems in raising finance for investments in renewable energy infrastructure. Third party financing has been considered as an option to overcome this problem, and the government is also in favour of hosting activities implemented jointly.

Source: 2, 3, 16, 17

Denmark

Denmark was the first country to set up a specific support programme for renewable energy, via its funding of capital grants for wind energy following the 1973 oil price shock. The Energy 2000 Plan, a package of measures launched in 1990 and updated in 1993 and 1995, set a target to double renewable supply between 1988 and 2005, mainly through increasing biomass and wind capacity to 1500 MW. Government, utilities and other parties are negotiating on measures needed to ensure this target is met. A more ambitious plan, Energy 21, was unveiled in 1996, with targets to increase the contribution of wind, solar and biomass energy from 8 per cent to 13 per cent of primary energy by 2005, and to 35 per cent by 2030.

- Guaranteed capital grants of 30 per cent for wind energy in 1978 were gradually reduced until their removal in 1989, but RE may still receive a subsidy of up to 30 per cent of installation costs. Much of the investment in wind energy is by private households forming local co-operatives. 75 per cent of wind turbines are owned by private bodies. This has been important in reducing local opposition to wind energy.

- A ten year agreement between utilities and the government required utilities to pay 85 per cent of the consumer rate for RE from 1985 to 1995. Refunds of carbon and energy taxes (see below) almost doubled this rate. Wind energy is now supported by the 1992 Wind Turbine Law requiring utilities to buy all wind energy at a guaranteed price, and pay for any grid modifications necessary.

- A recent review has removed the rules limiting private investment in wind turbines to the investors own parish and restricting the amount invested to the equivalent of their annual electricity bill.

- The 1991 State Subsidies for Electricity Production Act and the 1992 Act of State Subsidies for Promotion of CHP plants and Exploitation of Biomass Fuels allow non-utility producers a subsidy of DKr 0.27 / kWh sold to the grid from biogas, wind or hydropower (or straw, waste and wood under certain conditions), and 0.1 DKr/kWh for small-scale biomass (or natural gas) CHP.

- 1990 Heat Supply Act - mandatory conversion of all district heating plants to gas or biomass CHP. There are Government grants for conversion of district heating plants to biomass or biogas CHP.

- June 93 - utilities instructed to increase use of biomass in power generation to 1.2 MT straw and 200 000 t wood per year by 2000, so long as technical problems are resolved.

- There is a good infrastructure of regional energy agencies offering support for RE development projects.

- Recent problems with finding suitable sites for wind turbines are being addressed through a package of measures including local authority plans, upgrading of existing sites, and study of offshore wind potential.

- A carbon tax was introduced in 1992 - 100 DKr/ tonne for commerce and households, and 50 for industry (with refunds for energy intensive industry). Revenue is recycled as investment grants of social security reductions. A phased increase to 200 DKr / tonne for industry is planned, and a new SO2 tax of 10 DKr / tonne S is being phased in from 1996 to 2000. There are also environmental taxes on coal and electricity (0.1 DKr / kWh). RE is exempt from most energy taxes.

- There is significant government supported research and development in biomass (1.5 billion DKr to 1997) and wind. Although the total budget for energy research and development has been falling since 1992, the proportion for renewables has increased to 44 per cent in 1994.

- There are voluntary targets negotiated between the government and the other political parties for increasing wind and biomass capacity.

The measures appear to have been successful, with RE accounting for 6.9 per cent of TPES in 1993.

Sources: 4, 5, 6, 18, 35

Estonia

Estonia has very little indigenous coal, gas or oil but substantial reserves of oil shale, peat and wood. Energy supply is almost entirely from fossil fuels, dominated by indigenous oil shale, and there is a very high carbon intensity. Electricity supply is almost all from two large oil shale plants, which are seen as vital for the Estonian economy and employment, although they produce serious air pollution and groundwater pollution from ash disposal. There is a very small contribution from hydroelectricity, wood and peat. Estonia has not developed explicit greenhouse gas reduction strategies or measures. Future plans aim at installing pollution controls on the oil shale plants and improving their efficiency, or investing in new nuclear power plants, rather than investing in renewable energy. There is a large wind resource, but Estonia does not have the technical or financial means to exploit this. There is potential for increasing the use of wood, energy crops and forestry waste, but this is hindered by lack of investment capital.

Sources: 2, 3, 19, 20

Finland

Large hydropower supplies 3 per cent of TPES and other RE (mostly wood and wood waste) about 15 per cent. RE given significant support due to its importance in reducing dependence on imported energy and boosting rural employment. Peat is considered semi-renewable and receives subsidies. As a result of this support, Finland is now a world leader in forestry biomass technologies.

- An environment tax on fuels with a CO2 component (38.3 Mk per tonne of CO2) and an energy component (3.5 Mk per MWh) was introduced in 1990. Renewable energy is exempt from the environment tax, and peat (considered semi-renewable) is taxed at a lower rate. Natural gas, peat and biomass are also exempt from excise taxes. There is pressure to reduce these taxes in the face of deregulation and competition from Sweden, and the tax may be replaced by a uniform energy tax per kWh in 1997, due to the opening of the Nordic electricity market.

- A Bioenergy programme was launched in 1994 with a target of raising the use of bioenergy by 30 per cent (1.5 MToe) by 2005. It has a budget of Mk 500 million per year (initially split into 210M for preferential taxes, 150M for investment grants, 50M for small wood production operations and 80M for research and development) and focuses on the use of wood as a source of energy. Tax relief for biomass had to be reduced when Finland joined the EU in 1995, so the programme emphasis has recently changed towards information, promotion of new technology in industry and exports, and away from subsidies and tax breaks.

- A Wind Energy programme was launched in 1992 to increase wind capacity from 10MW to 100MW by 2005. Annual funding (mainly for demonstration and investment grants) will increase from 13 Mk in 1992 to 20 Mk in 1999, then decline to 7 Mk after 2000 by which time wind energy should be competitive due to environmental taxes.

- 25 per cent of the energy research and development budget (136 M Mk in 1994) is devoted to RE.

Sources: 4, 5, 6, 21

France

Hydropower provided 2.8 per cent of TPES and other RE (mostly biomass) 5.2 per cent in 1994. RE is important to maintain diversity of supply in view of France's reliance on nuclear power and imports, and traditionally support has been strongest for liquid biofuels and wood energy, making use of set-aside land. A new support programme was announced at the end of 1995, which will be based on competitive tendering as for NFFO, and will favour wind energy, although biomass, hydro and solar will also be eligible. The target is for 250-500 MW to be commissioned by 2005.

- 13 wood-based energy projects will receive state funding of 74 M FF over 1995-98.
- There was government funding of 40 M FF (66 per cent) for joint state-industry bio-energy projects in 1993.
- Biofuels are exempt from petroleum excise taxes.
- EdF is required to purchase renewable energy, including hydropower produced by private companies, at EdF's marginal avoided cost.
- research and development is supported on wood energy, pv, solar thermal, waste and biofuels.
- There are taxes on SO2, NOx and particulates for large combustion plants.

Sources: 4, 5, 6

Germany

Germany is the largest consumer of energy in Europe. Hydropower is 0.5 per cent of TPES, and other RE is expanding quickly, having increased from 0.1 per cent in of TPES in 1990 to 0.8 per cent in 1994. Germany is now the world's second largest producer of electricity from wind.

The strong government support is carried out by policies and measures by both the Federal Stated (Lander) and the municipalities. The Lander and the municipalities give financial incentives for the installation and use of renewable energy. At the Federal level, some regulations are privileging renewables in the area of housing and are stimulation the production and use of renewables (biomass, biofuels, bioproducts) in agriculture.

Some examples of government programs include:

- The Electricity Feed Law (Stromeinspeisungsgesetz), introduced in 1991, allows independent power producers to sell electricity generated from renewable sources to the German utilities for a fixed premium price. A different fixed price is paid for each technology, irrespective of daily or seasonal demand fluctuations. This is not popular with the German utilities because the prices are funded by the final customers, and customers of a utility purchasing a higher proportion of renewable energy pay more than a customer of a utility relying on conventional means of generation. The law is currently being contested in the German courts, with the utilities proposing that the cost of funding RE should be borne by all electricity consumers, irrespective of utility, or by the German people as a whole. Utilities are also fighting their responsibility for payment of grid connection costs. Wind technology has been most affected by the introduction of the feed law, increasing from 61 MW installed capacity in 1990 to 1122 MW in 1995.
- The Federal programme for renewables, with DM 100 million funding for 1995 to 1998, provides direct investment grants for the installation of solar collectors, heat pumps, hydroelectric plants, wind power plants, photovoltaic plants, biomass and biogas facilities.

Extra subsidies may be provided by the Länder authorities. The south German utility, Bayernwerk, has recently announced a substantial four- year programme of support for renewables and energy saving as part of a voluntary agreement with the Bavarian government, which will include investments in solar and biomass plants.

- The ERP Funding Programme by the Deutsche Ausgleichsbank (DtA). The DtA is an official body of the German Government whose funds originate from the European Recovery Programme (the Marshall Plan). The DtA has supported renewable energy within its environmental programme since 1990, by giving long term low-interest fixed-rate loans (up to 20 years). This transfers the risk of changing interest rates to the DtA, because the loan contracts can be cancelled by the debtor at any time. The impact of the ERP Programme has been great. Funding for environmental projects in 1994 was 3 200 M ECU, and it is estimated that around 80 per cent of wind power installations have received funding and loans from the DtA.

- A carbon / energy tax is being discussed.

- The 250 MW Wind Programme. The 250 MW Wind Programme ran from 1990 to 1995, and successfully achieved its aim of installing an additional 250 MW of wind energy capacity. Wind developers received output or investment subsidies.

- The 1000 Solar PV Rooftop Programme. This was launched in 1990 to demonstrate the use of PV rooftops for decentralised power generation. The Programme also aimed to increase knowledge of the installation of such systems and optimisation of the technology. The Programme was extended in 1991 to aim towards the installation of 2250 PV Rooftops.

- Research and development on RE was 32 per cent of the total energy research and development budget in 1993. Solar energy research and development was DM113 million in 1995 (about 15 per cent of the total energy research and development), and a demonstration programme “Solar Thermie 2000” was launched in 1993. Most research and development is carried out by the private sector.

Sources: 4, 5, 6, 9, 22

Greece

- Greece has few energy resources so RE is important to reduce dependence on imports. Large hydro supplied 0.9 per cent of TPES in 1993 and other renewables (mostly wood in the residential sector) around 2.5 per cent. However, there is considerable technical potential for solar, wind, geothermal and small hydro. Approximately 27.6 MW of renewable energy electrical capacity has been installed since measures to support RE were introduced in 1990, the majority being wind.

- The 1990 Economic Development Law 1892/90 allows subsidies of 45-55 per cent of the capital cost for RE schemes which satisfy certain conditions. Tax credits, cheap loans and favourable depreciation rates are also provided. However, the Public Power Corporation (PPC) was responsible for awarding licenses, but was not required to pay a set rate for renewable energy, and very few licenses were issued until the law was revised (see below).

- The legal framework was revised in 1995 (Law 2244/94) to permit the production of electricity generated by Renewable Energy schemes of less than 50 MW capacity by independent or auto-producers. Licences are issued by the Ministry of Development, and the PPC must then sign a guaranteed 10 year purchase contract with prices set between 70-90 per cent of existing consumer tariffs, depending on the technology. This resulted in an increase in applications from independent power producers to build plants, but out of 400MW of applications, only three small wind farm licenses totalling 25 MW have been granted.

- A major source of funding is the EU Support Framework which will provide 75 MECU from EC structural funds, matched by 25 MECU from Greece, for promoting RE via demonstration and information projects and other measures.

- Favourable prices of about 7 cECU/kWh are paid for autonomous systems (e.g. islands) rather than the lower prices (3.1-5.8 cECU/kWh) paid for interconnected schemes.

- Wind, passive solar, pv, geothermal, small hydro and biomass research and development is supported by the government.

Sources: 4, 5, 6, 9

Hungary

Renewable energy supplies 2-3 per cent of TPES, mostly from domestic wood combustion and geothermal energy. There is little potential for hydro and wind power, but substantial potential for further development of biomass (forestry and waste) energy and solar power.

In 1995 Hungary approved a CO_2 reduction target to return emissions to the average 1985-87 level by 2000, and a Greenhouse Gas Action Programme will be launched in a few years. A target has been set to increase RE to 5 per cent of primary energy by 2000. The main emphasis of energy policy is on improving energy efficiency and installing end-of-pipe treatments for coal fired stations and factories. The large reduction in energy demand due to economic restructuring and fuel price rises has hindered deployment of RETs, and lack of investment capital is a major barrier. However, several measures have recently been introduced to support RE:

- The Law on Electricity approved in 1994 sets an obligation to buy electricity from renewable sources. A decree from the Minister of Industry and Trade regulates the prices. There is a draft plan to set favourable rates for purchase of renewable electricity by the grid. However, legislative problems still obstruct progress in some areas, e.g. the Land and Agriculture acts hinder biomass exploitation.

- There is a duty and VAT reduction on renewable energy equipment.

- Grants and soft loans for renewable energy projects are provided by the Central Environmental Fund. Some soft loans for RE projects are also provided from other sources, e.g. the PHARE Revolving Fund and the Energy Efficiency Preferential Loan System (formerly German Coal Aid).

- Some research and development and feasibility studies (mainly solar and bio-energy) are supported by the Ministry of Industry and Trade and the Ministry for Environment and Regional Policy.

- A Biomass Programme is supported by the World Bank, and a feasibility study on the national biomass potential has recently been completed. Two projects to convert district heating systems from fuel oil to wood chips are being implemented with a WB loan.

- Four PHARE demonstration projects are underway.

Sources: 1, 2, 3, 15

Iceland

Iceland has very large geothermal, hydro and wind power resources. Electricity is almost entirely supplied from hydro-power, and heating from geothermal energy. The market for renewable energy is largely saturated, and there is little prospect of further development (for example, of wind or solar power) unless future political and economic developments permit export of electricity to Europe.

Source: 2

Ireland

Ireland has limited indigenous resources and RE is important for maintaining security of supply and providing rural employment. In the past, the main avenue of support was via EU-funded demonstration projects. However, a NFFO-type price support scheme, the Alternative Energy Requirement, was recently initiated (see below). As a result of the high level of interest generated, a new strategic initiative has recently been established, comprising a package of measures to support RE.

- The Alternative Energy Requirement (AER-1) - In 1995 the government carried out a competitive bid for renewable energy generating capacity, supported by Ir £70 million for purchase at a price above current avoided costs. This will result in 85 MW of RE capacity (mostly wind, with some waste) over the next few years.

- Several demonstration projects, particularly for wind, have been supported by the EU.

The new strategic initiative on renewable energy includes the following complementary measures:

- Further competitions, funded by the Operational Programme for Economic Infrastructure, aimed at securing an additional 100MW of installed capacity by 1999. This includes Ir £7.5 million for a competition for a biomass-fuelled electricity generating plant, with a price cap on the electricity produced of 4p/kWh.

- The completion of a study to assess the total renewable resource in Ireland.

- The establishment of a working group on grid connection issues

- The establishment of a Renewable Energy Information Office;

- The drawing up, in consultation with the Power Procurer and the ESB, of a scheme to cater for the development of small scale renewable energy based electricity generating projects;

- The provision (with EU support) of up to £1M for the building, by the end of 1999, of a pilot wave energy electricity generating plant;

- Allowing third party access to the electricity network for Renewable generators who wish to sell green electricity directly to electricity consumers;

- Guaranteeing electricity market access for EU Thermie funded renewable energy projects;

- Setting targets for the future generation of electricity from renewable energy for the 2000-2010 period; and

- The pursuit of further fiscal measures to support renewable energy development in the context of the greening of the 1997 budget.

Sources: 4, 5, 6, 37

Italy

Italy is highly dependent on imported fuels. Renewable energy contributed significantly to TPES in 1993, accounting for 5 per cent (mostly hydro and geothermal, followed by wood and waste, with some wind and solar). RE is supported through several measures, including investment grants (Law 10), preferential pricing (Law 9), tax exemptions and research and development. These measures are predicted to result in about 110 MW hydro, 435 MW wind and 675 MW biomass capacity by 2000. The government is opposed to an EU carbon tax because energy excise taxes are already very high in Italy.

- Law 9/91 allows independent producers to sell electricity to the grid. ENEL is obliged to buy the electricity at fixed prices, revised annually, set by decree CIP 6/92.

- CIP 6/92 - This allows the purchase of RE electricity at subsidised prices, which vary between technologies and are updated annually, funded by a levy paid by users based on electricity consumption. Levy rates differ, depending on the user's voltage connection to the grid. This arrangement has been in force for 6 years (with an earlier version of the arrangement in 1989) and has been very effective in promoting RE, with 2880 MW accepted in 6 offers. However, the scheme is oversubscribed and the choice of which projects to accept is left to ENEL, with no very clear guidelines on selection criteria. This has caused inconsistencies due to the inclusion of “similar” technologies such as CHP, and plants burning oil residues or the products of minor gas fields, in the decree. Demand for inclusion is intensifying in the run-up to the privatisation of ENEL, and the future of the scheme is uncertain.

- Law 10/91 - allows investment grants up to 50 per cent of the capital costs of RE plant, but actual funding under this measure has been delayed due to budgetary problems.

- Government funded research and development on RE comprised 9 per cent of total energy research and development in 1993. RD&D is also supported by the state-owned electricity company, ENEL. For example, ENEL has recently supported the development of three experimental wind farms designed to test performance under harsh climatic conditions, and supported a large pv demonstration plant at Serre in 1994.

– Certain biofuels are exempt from excise taxes within set quotas, and subsidies are provided for diester production on set-aside land.

Sources: 4, 5, 6

Japan

Japan has the world's fourth largest energy demand after the United States, Russia and China, and is highly dependent on imports. Renewable energy is supported by the government in order to contribute to security of supply and environmental protection. The target is for new renewable energy sources and energy from waste to provide 3 per cent of total primary energy by 2010 (currently hydropower contributes 1.2 per cent of TPES, geothermal 0.5 per cent and other renewables 0.9 per cent). Measures include government support for research and development in the New Sunshine Programme, the setting of a framework for deployment and the provision of a wide range of financial incentives such as subsidies, tax breaks and low-interest loans.

– The New Sunshine Programme supports a variety of renewable energy technologies, particularly PV, but with some support for fuel cells, geothermal, wind and bio-energy.

– 70 000 roof-top PV applications will be supported in order to boost the fledgling solar industry. In addition, the government has positively encouraged the industry to set up manufacturing operations in neighbouring countries (with substantially lower wage costs) as a means of reducing the final costs of PV arrays. These actions have catapulted Japan into the major league of PV manufacturers.

– Standardisation of technologies is encouraged.

– Low interest loans are available from the Japan Development Bank for the construction of hydro plant or geothermal schemes, and there are favourable loans for solar systems from the Solar System Development Association.

– There are tax incentives for investment in RE schemes.

Sources: 4, 5, 6, 23

Latvia

The main renewable resources in Latvia are hydropower, wood and peat. Three large hydroelectric plants supply around 30 per cent of Latvia's electricity and 7 per cent of primary energy. There is limited potential for wind (on the coast), agricultural biomass/biogas, geothermal and solar energy.

The government plans to increase deployment of renewable energy in order to reduce dependence on imported fossil fuels and to contribute to Latvia's informal target to stabilise CO_2 emissions at 1990 levels by 2000 (although more urgent priorities are improved energy efficiency, fuel switching to gas, and price reform). A carbon tax will be introduced as part of a new “Natural resource tax”, which taxes emissions of particulates, CO, NO_x, SO_2 etc. There is a programme to increase construction and renovation of small hydro plants, and there are also assessment and demonstration activities in the field of wind, solar and geothermal power. Electricity from wind and small hydro plants is offered double the average tariff for the first eight years of operation.

Barriers include low energy prices, lack of technical staff skilled in renewable energy technologies, and lack of investment capital. Latvia supports joint implementation measures so long as they are in addition to existing commitments by developed countries.

Sources: 3, 24, 25

Lithuania

Virtually all primary fuels are imported except for some indigenous peat. Electricity generation is mostly from nuclear power with a small contribution from hydropower (2.8 per cent). Some small hydropower plants are currently being refurbished for connection to the grid. There is a large unexploited wood and wood waste resource from the forestry industry. Lithuania has not yet adopted any CO_2 reduction targets and has no financial resources to invest in new energy technologies. It would be willing to act as a host for activities implemented jointly.

Source: 2, 3

Luxembourg

Luxembourg is highly dependent on imports of energy. Hydropower supplies 0.3 per cent of TPES. There is some support for renewable energy in the form of grants for wind, solar or bio-energy installations. There is also price support for surplus electricity from wind or solar sources. There are purchase guarantees for RE generation up to a maximum capacity of 1.5 MW. AEL is promoting the use of thermal solar energy in leisure installations, and evaluating wind energy potential.

Sources: 4, 5, 6

Netherlands

TPES in the Netherlands is dominated by Natural Gas (around 50 per cent), with RE contributing only 1 per cent of TPES in 1990. Waste is currently the major source (85 per cent) with contributions from biomass, small hydro and wind, plus solar water heaters and pv units. The first measures to support RE were introduced in 1990, with a target to increase the renewable share of TPES from 1 per cent in 1990 to 3 per cent by 2000, 5 per cent by 2010 and 10 per cent by 2020. The early measures were limited in their success, and have recently been revised (see below). A number of measures are used, including research and development, investment subsidies and the payment of some fixed premium prices to generators. Although there are numerous autoproducers, there are no genuine IPPs as an installed capacity of 2500MW is needed to obtain a license for public supply.

- As a result of the National Environment Plan in 1990, Dutch electricity companies agreed to voluntarily reduce CO2 emissions and recover their costs via a levy on consumer prices of up to 2 per cent (the MAP payment). About 310 million guilders (M Dfl) are collected annually through the levy. However, the resulting investment in RE was patchy as most utilities focused on CHP. There have also been allegations that not all of the money raised from the levy was spent on the intended purpose.

- Distribution companies are obliged to purchase surplus power from autogenerators. In the past, price support for RE was at the discretion of the utilities. Recently a fixed premium price has been negotiated for wind energy of 16.3 cents/kWh, including 5.4 cents MAP payment and 3 cents ecotax refund. Green electricity also receives a lower rate of VAT (6 per cent instead of 17.5 per cent).

- Subsidies of up to 35 per cent of installation cost were available for investment in wind and solar energy until 1996 (except for solar hot water boilers which will continue until 1997). A simple vetting process was carried out by NOVEM, with no competition and no required rate of return. However, demand exceeded the funds available. The method of calculating subsidies was dependent on the technology. 95 per cent of the wind and PV and 90 per cent of solar capacity was installed as a result of these investment subsidies. This scheme has now been replaced by the “VAMEL” system of tax breaks for the first year of investments in approved green projects.

- There is strong support for research and development, demonstration and promotion of RE. The research, development and demonstration programme covers PV, Waste and Biomass, Solar and Geothermal technologies. The total Government spend on RD&D in 1994 was 22.34 M ECU.

- Environmental levies to capture the externalities of energy use were introduced in 1992. Coal, gas and oil are taxed at different rates based on their carbon and energy contents. District heating is exempt. In addition, there are energy conservation levies, and an energy tax on small consumers was introduced in 1996.

- Green pricing schemes are run by three utilities: NUON, PNEM/Delta and EDON. Customers pay an increased tariff on some or all of their electricity, with the assurance that the utility uses the extra income to purchase renewable electricity.

Sources: 4, 5, 6, 9

New Zealand

Hydro-power currently provides 15 per cent of TPES and geothermal 12 per cent. Promotion of competition in the wholesale electricity market is expected to have a favourable impact on renewable-energy based production. A package of measures to support wind, solar, biomass and wave energy was recently announced, including formation of an research and development strategy for RE, demonstration projects, planning guidelines, and duty-free entry for larger wind turbines. A number of projects have already been announced, including 70MW of geothermal plant and the country's first wind farm, which will operate on a purely commercial basis.

Sources: 4, 5

Norway

Large scale hydropower provides 46 per cent of TPES and almost all of Norway's electricity. Biomass wastes and wood are also widely used for heating, but use of wind and solar energy is very limited.

- CO2 taxes were imposed on fossil fuels in 1991. The tax varies significantly with the product, and is not strictly related to the carbon content. There are also consumption and generation taxes on electricity. VAT on electricity is 23 per cent.

- research and development. A new research and development programme, the "Efficient and RE Technology Programme", was introduced during 1995, merging the previous Bioenergy, Solar, Wind and Wave programmes. The budget for 1995 is 31 million NOK. 70 per cent of the research and development programme funding is spent on product and technology development with Industry contributing an equal amount. The remaining 30 per cent of the funding is allocated to more long term research projects.

- Introduction measures e.g. demonstration projects. The 1994 budget for introduction measures was 20 million NOK. This Programme will be reorganised during 1995.

Sources: 4, 5, 6

Poland

At present 1.5 per cent of Poland's primary energy is supplied by renewables, of which 1 per cent is hydro and 0.5 per cent biomass (mostly wood). A recent study supported by the United States - the Polish Country Study to Address Climate Change - concluded that certain renewable technologies were competitive with other mitigation options in terms of CO_2 reduction. These included wood and straw combustion, solar collectors for agricultural application, geothermal heating plants and further biogas plants, wind generators and CHP. Some measures to overcome the most serious political, institutional and economic barriers were proposed. RETs could help to provide much-needed peaking capacity to the Polish power system, avoiding reliance on insecure gas supplies from the CIS.

The draft energy policy proposes to increase the use of biofuels after 2000, and to invest in new hydro, wind and solar energy plants. However, other issues (energy efficiency, price reform, environmental controls) may receive priority in the short term. Nevertheless, there are some measures to encourage investment in renewable energy schemes, and further measures are being discussed:

- Competition is being introduced into the energy sector, and subsidies are being eliminated causing prices to increase, and making RETs more competitive especially in remote locations. However, against this background of price rises, further environmental taxes (e.g. energy or carbon taxes) are not politically feasible, although small fees have been payable by industry on greenhouse gas emissions since 1993.

- Decision no. 26 of the Ministry of Industry in 1993 allows individuals to sell electricity produced from renewables from installations less than 5MW to the grid, via utilities, and the regional distribution companies are obliged to buy it for at least 85 per cent of the averaged price to final consumers. This is a much higher price than companies have to pay for electricity from the national grid, and this regulation is unpopular with the Polish utilities.

- Under Order 203 (Ministry of Finance, 1990) there is a five year tax holiday for investors in small hydro, wind and biogas schemes.

- Under Order 431 (Ministry of Finance, 1993) farmers who build renewable energy schemes for agricultural production are entitled to a tax exemption of 25 per cent of the investment cost for 15 years.

- A European Commission Baltic Renewable Energy Centre was established in Poland in 1995, supported by the SYNERGY programme, in order to develop appropriate policies to overcome political barriers, and to promote greater utilisation of RE in Poland.

Poland has established an Energy Law providing for, inter alia, introducing market mechanisms in the energy sector. It also includes Integrated Resource Planning (IRP), as recommended by the EU Directive. The Polish Power Grid Company already applies integrated planning of development of the energy sector, including Demand Side Management (DSM) projects. A DSM project implemented at present will result in avoiding 200 000 tonnes of CO_2 emissions. In the energy sector, cogeneration is widely applied. It is envisaged that preferred IRP investments will result in the reduction of greenhouse gases, with the further development of this option, particularly with natural gas.

Poland intends to stabilise CO_2 emissions at 1988 levels by 2000 but this is dependent on access to new technologies. Financial constraints are a major barrier to RETs.

Sources: 1,3, 15

Portugal

Hydropower accounts for 5 per cent of TPES and other RE for 6 per cent. The government supports the increased use of renewable energy, with a target of an extra 170MW of RE capacity before 2000. Financial assistance is provided, partly from the EC.

- Laws permitting small scale private energy production were introduced in 1988, leading to a rush of applications for small scale hydro licences. New construction of mini-hydro almost came to an end in 1993, when funding from the EC's VALOREN programme ceased, mainly due to a 40 per cent drop in industrial electricity prices between 1988 and 1993. The 1994 Energy Programme provides financial support for RE including investment grants of up to 40 per cent of the capital cost. In November 1995, a law was passed offering higher prices to producers from renewable sources. 87MW of small hydro have been commissioned since 1988, although there are now problems with local opposition to new schemes.

- The 1992 Budget law set a reduced VAT rate for renewable end-use technologies such as solar panels.

- Funding for renewable energy research and development is being increased, and now comprises 50 per cent of the energy research and development programme, although the programme is a small fraction of GDP.

- There is a guaranteed purchase scheme for RE subject to a minimum efficiency requirement.

Sources: 4, 5, 6, 26

Romania

Renewables, mainly hydro and geothermal, supplied 8 per cent of TPES in 1990. There is significant potential from wind, solar and biomass (agricultural waste). However, the government has other economic priorities in the short term, and there is a lack of hard currency for investments in RETs. Other barriers are very low energy prices in the short term (this is expected to be resolved by 2005), and the lack of a legal framework for production by IPPs.

Renewable energy could have significant benefits for the economy and employment of rural communities in Romania, helping to ease the transition to a market economy. A report by the Romanian Agency for Energy Conservation suggests several potential measures for promoting solar energy, including tax credits, information campaigns, the adoption of international standards and the obligatory installation of solar systems in new buildings. The report also suggests strategies for promoting wind, small hydro, biomass and geothermal energy. Romania supports joint implementation of climate change measures, but the priority is for energy efficiency measures rather than RE. projects.

Sources: 3, 27

Russian Federation

There is significant unexploited potential in Russia for hydroelectric, wind and biomass energy, and local potential for solar, geothermal and tidal energy. Historically, significant research and development efforts were directed at renewable energy, and many small hydroelectric schemes existed until they were displaced by the spread of the electricity grid in the 1980s. 1500 wind turbines (mostly micro-turbines of less than 1kW), have been constructed, and a few PV panels and solar collectors have been installed, together with small geothermal and tidal power schemes. However, the development of renewable energy ceased due to economic difficulties after the collapse of the Soviet Union. There is a shortage of capital for investment in new projects, and energy efficiency takes priority over renewable energy. However, interest is now reviving and some new activities have recently begun to assess the situation in preparation for the Russian Climate Change Action Plan. The activities focus on implementation of pilot and demonstration projects (especially small hydroelectric and wind stations) plus general support by tax and credit privileges for non-traditional energy. The “Environmentally Sound Energy” plan of the Ministry of Fuel and Energy includes plans to construct solar stations, and two projects are awaiting funds for construction. Proposals for new demonstration /semi-commercial wind farms are being prepared, and it is hoped to obtain funds from the World Bank. A possible CO_2 tax is being investigated although there is opposition from industry. This opposition is similar to the opposition to any new tax, and this, under the current very complicated and cumbersome taxation system.

Sources: 2, 36

Slovak Republic

Renewable energy, mostly hydro-power, currently supplies around 3 per cent of primary energy. There is significant further potential for hydro, solar and biomass energy in the Slovak Republic. There is a program to increase the share of RE to 6 per cent of primary energy by 2010.

Under Act 286/1992, five year tax exemptions are granted to small hydro, wind, thermal pumps, solar, biogas and geothermal schemes. A 1993 decision to prepare a programme of subsidies and taxes to promote RE is being worked on. Fixed purchase rates for renewable electricity are envisaged. Regional energy plans promoting waste and biomass schemes will be drawn up. The Slovak Republic would be willing to act as a host for joint implementation measures.

Source: 1,2, 3, 29

Slovenia

Almost a third of electricity is generated from small and large scale hydro plants, and solar, geothermal and biomass resources are used for heat. The electricity utility has an informal agreement with the government to purchase small hydro power at preferential rates, and many small hydro plants are currently being refurbished. However, the main emphasis of national energy policy is on expanding the supply of gas.

Source: 2

Spain

In 1994 hydropower accounted for 2.5 per cent of TPES and other renewables (mostly wood) for 0.8 per cent. The government announced its first support for RE in 1994, as part of the CO_2 reduction policy. There is a target to increase the use of renewables by 1.1Mtoe between 1991 and 2000, focusing on solar, biomass and small hydro.

Utilities must buy electricity generated by renewable sources of less then 100MW at a premium price, under five year contracts. The mean electricity price for conventionally generated power is determined by the government annually. The RE then receives a premium over the mean price from the government/ agent - in 1995 it was 88 per cent of the small consumer price. As there is no pre-set price for the electricity and actual prices may vary, it is difficult to model the cash flows of a project as is necessary for a bank loan. For example, prices paid to autogenerators have recently been cut to stem the rate of increase of capacity, which was displacing conventional generation, in the face of protests from the utilities.

There is strong involvement from the regional governments in order to try to maximise the benefits to local economies. Applicants for contracts are expected to demonstrate how they would contribute to industrial development in the region.

Investment subsidies of 20-40 per cent are available for wind, solar and biomass projects through the PAEE (Energy Saving and Efficiency Plan) which was introduced in March 1995.

Sources: 4, 5, 6, 9, 28

Sweden

National policy is to base the energy system as far as possible on sustainable sources. Hydro and biomass (including wood, waste and peat) are Sweden's main indigenous resources, each providing around 14 per cent of TPES. The measures listed below, based on taxes and investment grants, have not been successful so far for wind energy, with an installed capacity of only 40 MW.

- The 1997 Energy Policy bill provides investment grants of up to SKr 3000 /kW (up to 25-35 per cent of capital costs) available for biofuel CHP installation, 15 percent of the investment in wind power plants with an electrical effect of at least 200 kW, and 15 percent of the investment in environmentally friendly, small- scale hydroelectric plants. Skr 100 million over a five-year period has also been assigned for the procurement of new technology for electricity production.

- There is no premium purchase scheme. However, a variety of tax breaks are offered to private investors, largely households forming local co-operatives. Taxation and subsidy schemes also support biofuels for district heating and CHP.

- There is an energy tax which does not apply to industry, a CO2 tax (introduced in 1991) which applies only at 25 per cent of the full rate for industry, and an SO2 tax. Fuel for electricity production is exempt, and fuel for CHP plants is taxed at half the rate.

- Energy research and development was SKr 588 million in 1993, of which 10 per cent goes to biomass and 10 per cent to other renewables. The biofuel programme stresses demonstration of more efficient generation methods.

- Green pricing schemes for electricity are being developed in response to consumer pressure. The largest utility, Vattenfall, operates the ELVIRA fund: consumers pay into this fund, the amount is matched by Vattensfall, and the sum is spent on renewable energy. Stockholm Energi tried to establish a green pricing scheme but the municipality ruled that customers should be able to choose the source of electricity but should not have to pay extra for the choice. Another green pricing scheme is being investigated by the Gothenburg utility. (9)

Sources: 4, 5, 6, 9

Switzerland

Switzerland imports all of its fossil fuels, but 13.2 per cent of TPES is from hydropower and 5.2 per cent from other renewables. Further development of the hydro resource is limited by environmental considerations, and the government does not support wind energy because of poor wind resources and environmental impact concerns.

Energy policy was formerly promoted by individual cantons, but since 1990 the Swiss Federal Government has had a mandate to carry out a national energy policy in pursuit of specific goals e.g. the rational use of energy and the production of energy from environmentally benign sources. This has resulted in the following programmes:

- The Energy 2000 Action Programme. This was launched in 1990, and is aimed at stabilising emissions of CO_2 at 1990 levels by 2000. Although mainly concerned with energy efficiency measures, it includes the target to increase the contribution of non-hydro renewables to electricity generation by 0.5 per cent and expanding their share of heat production by 3 per cent from 1990 levels by 2000, and to increase hydro generation by 5 per cent. The target for heat is expected to be met partly by use of waste in the cement industry, and partly by a strong promotion of heat pumps. The programme included subsidies, tax breaks and marketing and promotional methods. However funding for the programme, initially set at SF 170 million per year, has fallen, so in 1995 only SF 54.4 million was available and this resulted in the phasing out of a number of incentive schemes. Nevertheless, the programme has been successful so far, with an increase in renewable energy contribution to the heat supply of 1015 GWh (34 per cent of target for 2000), and of renewable energy contribution to power generation of 130 GWhe (44 per cent of target).

- Regional support. Several Cantons also support RE through additional measures e.g. Berne provided SF 5 million subsidies for RE projects and removed institutional barriers to the deployment of solar collectors.

- The Decree on Efficient Energy Use (DEU). This requires the utilities to purchase the output of renewable energy schemes at a guaranteed price based on the production cost of a new indigenous power station. The current average price paid for RE is SF 0.16/kWh. The Government has proposed an Energy Law to permanently replace the DEU which runs out in 1998.

- There were plans for a CO_2 tax is to be phased in from 1996 to 2000, with exemptions for energy- intensive industry. However, this ran into opposition, and has been replaced by a voluntary energy- saving agreement with industry, to be replaced by the tax if unsuccessful.

- RE receives 25 per cent of energy research and development expenditure, which is the second highest proportion of GDP in the IEA. The research and development Programme is mainly concerned with solar, woody biomass and heat pump technologies. Wind power is considered to be inappropriate for Switzerland so it is not included within the research and development programme (although the Government is supporting plans to construct two wind farms in the west). Public funding for research and development on Renewables is expected to decrease to SF 51 million by 1995.

Sources: 4, 5, 6, 38

Ukraine

The main renewable energy resource at present is hydropower, which generated 6 per cent of electricity requirements in 1994, but the potential for further expansion is limited. However, wind energy is considered to have a high potential, and there are ambitious targets for deployment, but these are backed by very limited funds. There is also potential for development of solar, biomass and geothermal energy.

A major problem in the Ukraine is the history of high government subsidies for energy. In 1992, energy subsidies accounted for 5 per cent of total government expenditures. The industrial sector paid between 5 per cent and 45 per cent of world energy prices, and the household sector paid between 0.1 per cent and 32 per cent. Subsidies for industry and agriculture were removed in 1992, and the subsidies to the household sector began to be reduced in 1995. Prices are now close to production costs, but still below world energy prices. Nevertheless, due to falling real incomes, energy prices represent a huge proportion of family incomes - around 50 per cent in a typical case. There have been major problems with non-payment in all sectors, and further price increases in the short term are not feasible.

Low electricity prices still cause problems for renewable energy development. A major wind farm under development by a joint US-Ukrainian venture has run into financing problems because current electricity prices are less than the projected production prices.

Source: 2, 30, 39

United Kingdom

Renewable energy accounts for 0.2 per cent of TPES, mostly as large hydro. The government's target is for 1500 MW of new RE-based generation capacity by 2000, to help meet UNFCCC obligations. Until

1990, government support was limited to research and development. Today, the main measure for support of RE is the Non-Fossil Fuel Obligation (NFFO) scheme - a market-stimulating measure aimed at those RETs which are predicted to become competitive with conventional sources in the short to medium term. The NFFO was set up in 1990, and requires the Regional Electricity Companies (distribution utilities) to buy a certain amount of their requirements from renewable sources. Calls for proposed projects are issued about every two years, and on selection, schemes receive a premium price for their electricity through a levy on final electricity prices paid by the consumer.

The government's approach is to divide renewable energy technologies into categories based on their market prospects. Technologies identified as likely to be contributing by the year 2005 (e.g. wind, waste, biomass) are given market support via NFFO. Appropriate research and development support will also be provided. Technologies at the assessment stage will be investigated to provide sufficient information to form a reliable view of their potential, and those shown to have sufficient prospects (e.g. solar PV) will be supported by research, development and demonstration. Technologies such as wave, geothermal and tidal, which are unlikely to contribute significantly by the year 2025 will be subject to a watching brief.

After four rounds, contracts for over 2000MW of declared net capacity have been let, of which over 400MW is currently operational, and the Government is confident of meeting its 1500MW target. (Typically, around 30 per cent of projects which succeed in obtaining a NFFO contract proceed to completion, the rest being abandoned for reasons such as failure to obtain planning permission or financial backing, and this is allowed for statistically in the NFFO decision-making process). NFFO has been a major success in stimulating the development of the UK renewable energy industry, in increasing capacity and in reducing the costs of renewable electricity generation. The NFFO process allows accurate control of costs because each order is for a specified amount of capacity at known prices. It has been estimated that the scheme will cost about 180 million ECU/y, over the period 1995-97. The scheme has been extended to Northern Ireland and to Scotland. In addition, 15 year contracts are now standard. Because the scheme allocates capacity based on a series of technology bands, it provides a mechanism for support of a wide range of technologies, although technologies which are not sufficiently close to commercialisation, such as solar PV, are excluded. NFFO policy is kept under review in response to market developments, such as the privatisation of the electricity supply industry and liberalisation of electricity markets. Under current Government plans there will be a fifth Order in 1998.

There have been some administrative difficulties with the scheme, e.g. long gaps between calls for proposals causing “boom/bust” cycles; expensive administration especially at the bid stage; confusion over which projects qualified for support leading to wasted effort in preparing bids, and the failure of many projects to be implemented due to problems with obtaining planning permission, financial backing, fuel supply contracts, manufacturing capacity etc. The allocation of support based entirely on the cost of electricity produced has led to the acceptance of several schemes with unfavourable environmental impacts, particularly wind farms in scenic locations, and this has fuelled public opposition. It has also been alleged that the cost of preparing competitive bids deters small private investors from tendering, although many small enterprises have been successful in obtaining contracts. The Government view is that, although there will be both winners and losers, the aim of reducing prices through competitive bidding so that eventually renewables can compete without subsidy is in the best long term interests of the industry. There have been fewer criticisms of the scheme as it has settled down and become more widely understood.

Two “green pricing” schemes are just being introduced: Green Electron and Renewable Energy Company.

Sources: 4, 5, 6, 9, 10, 31

United States

The United States is the largest producer and consumer of energy in the world. Hydropower accounts for 1.1 per cent of TPES, geothermal energy 0.7 per cent. Based on the oil embargoes of the 1970s and declining oil production, the United States developed an 'energy security' policy to promote cleaner, more diverse indigenous sources of energy. Programmes ranged from tax credits to government support to demonstrate new technologies. Key programmes include:

- PURPA (Public Utilities Regulatory Policies Act, 1978). PURPA sought to inject competition into the market, diversify the mix of power generation, and encourage the deployment of small-scale production facilities. Utilities are obliged to purchase electricity from "qualifying facilities", which include CHP and renewable plants, at the avoided cost of generation and distribution. By 1991 32 000 MW had been added under PURPA, 40 per cent of which (12 800 MW) were renewable, compared to an original projection of 12 000 MW of renewables by 1995.

PURPA implementation was left broadly in the hands of the Public Utility Companies (PUCs). The most notable application of PURPA was the California Renewables Programme of the first half of the 1980's, which became the world's largest and most dramatic programme to stimulate the development of RETs. In California, the Energy Commission also adopted a range of supportive measures including resource surveys. Utilities also became involved, for example, Southern California Edison embarked on a major research and development programme and offered relatively attractive tariffs which considered the avoided costs of its operations, as well as assisting some of the independent generators with feasibility studies and interconnection support.

The California Energy Commission also encouraged the development of standardised contracts, including guaranteed prices offered for power purchased by the utility, to give potential independent generators a secure price for planning and raising investment capital. Tax credits for RES investments known as SO-4 were issued. These were based on the assumption of escalating marginal fuel prices for the first 10 years of a 30 year contract. Other support measures to the PURPA included the novel use of tax breaks and credits to encourage investors to fund the development of RET projects in almost risk- free circumstances. Tax credits were reduced to 10 per cent for two years (for solar technologies), with a further one year extension granted in 1988.

The effect of this programme was that installation rates in California rose from 10 MW in 1981 to 60 MW in 1982, and trebled in each of 1983 and 1984 to reach a level of 400 MW/y. The cumulative investment in Californian wind energy by 1986 totalled about $2000 million, with the value of energy generated put at $100 million/y. Other renewables had similar success, but at a much reduced level to wind. For example, Luz International installed two pilot plants in 1984 and 1985 for solar thermal power, and proceeded with a series of five 30 MWe solar plants, steadily reducing cost and improved performance.

However, the programme as a whole has not been without its problems. Poor technical reliability of the early projects (some technologies used were still then at the research and development stage), falling oil and gas prices, and the penetration of foreign technologies (reducing local political support), meant that the programme began to draw to a close in the mid 1980's, a situation which has only now began to be reversed. Despite the difficulties, the programme of economics and financial measures (as well as the use of regulation) certainly stimulated rapid development of RET projects.

- Government research, development and demonstration. Numerous programs exist to improve the energy diversity through basic research, demonstration collaboratives and technology transfer. These programs are established primarily through the US Department of Energy (DOE), which sets the priorities. National Laboratories have the responsibility to carry out the programs. Federal spending on renewable electricity research and development in 1995 was $305 million, focused on solar, wind, biomass and geothermal power. There is substantial collaboration with industry.

- Tax Incentives. There are a number Federal and state tax incentives, e.g. a tax credit of 1.5 cents/kWh for wind and “closed loop” biomass generation, and a 10 per cent investment tax credit for solar and geothermal schemes. Ethanol is subsidised as a transport fuel, with a 54 cent per gallon of ethanol tax exemption, but recent attempts to make the compulsory oxygenate component of gasoline come from renewable sources were overturned. The most common types of incentive are:

    - deductions or accelerated depreciation which reduce the income on which taxes must be paid;

    - tax credits which reduce the income tax liability;

    - tax exemptions where exempted revenue is excluded from calculations of taxable income or projects are exempted from certain taxes (such as VAT, sales tax or local property taxes).

  The precise role that these incentives have played in promoting RE is not easy to quantify, although projects have not proceeded due to the lack of a local property tax concessions. Concessions are still available from numerous states and local authorities.

- Electricity Generation Procurement Processes. Traditionally, United States regulators used competitive bidding to establish appropriate tariffs. However, this did not account for all the non-financial costs and benefits of each technology, including water requirements, power quality, fuel type and diversity, environmental aspects and costs, effects on transmissions and distributions systems and dispatchability, and hence the PURPA system allowed renewables to compete more successfully. Generation procurement regulations are now undergoing rapid change in the US electricity supply industry, replacing competitive bidding with fair treatment of all bidders and a focus on CEE (customer energy efficiency). IRP (integrated resource planing) requires utilities to look at all alternatives for energy supply, including CEE and renewable generation, to find the lowest cost option for meeting supply needs. In the near future however, the continuing drive to de-regulate the power industry will increase competition, probably disadvantaging renewables with their high up-front costs.

- Other Incentives. The United States is trying other incentives to promote RE, such as limits on emissions and pollution credits. Certain limits or credits are set aside only for utilities installing renewables facilities. State and federal programmes exist for the government to purchase renewable energy at internal government sites such as remote communications facilities or military bases. Some technologies have been given government loan guarantees or technical assistance.

– Distributed Utility Concept. Electricity supply in the US was, until the late 1980's, characterised by a set of utilities with an emphasis on generation (especially through large coal and nuclear plant), on high-voltage AC/DC transmission, low-growth or no-growth strategies, etc.

Changes in legislation and other policy measures, such as the PURPA, FERC transmission access programme, tax credits for renewables, US Department of Energy programmes, and demand side management (DSM) and integrated resource planning (IRP), have led to the introduction of the concept of a Distributed Utility (DU). This concept is achieved by restructuring the utility to incorporate distributed generation, storage and feeder-specific demand side management, customer energy efficiency and renewable energy technologies in its operations to augment central station plants. Photovoltaics are the most commonly used renewable energy technologies in DU projects, offering benefits of modularity, fuel risk avoidance and avoidance of distribution costs.

By adopting this approach the utilities are able to realise the benefits of:

– increased transmission and distribution asset utilisation;
– enabling value-added customer energy services;
– technological advances (in production, delivery and control, end-use);
– more economical use of existing resources;
– financial value of deferring/avoiding purchase of new plant;
– hedging against uncertain rules and load growth;
– improved operations, service quality, customer satisfaction, profits.
– Green pricing schemes, whereby the customer pays a premium to receive electricity from a renewable source (usually a grid-connected wind farm), are being developed in response to consumer pressure, and may offer a future for renewable energy in the increasingly competitive electricity markets. Nine utilities are currently planning or operating experimental green pricing schemes, although the schemes do not attract a high level of support at present (typically a few hundred customers per utility have signed up). Similar "Green Power Marketing" schemes ask customers to contribute donations to fund the development of RE projects, e.g. the installation of PV panels on schools in the area, or provide a service for customers to pay for the installation of PV panels on their own homes.

Sources: 4, 5, 6, 32, 33

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APPENDIX 2

List of Acronyms

CHP	Combined heat and power
CIS	Commonwealth of Independent States
EC	European Commission
EITs	Economies in transition
FGD	Flue gas desulphurisation
IEA	International Energy Agency
IRP	Integrated resource planning
NFFO	Non-Fossil Fuel Obligation
OECD	Organisation for Economic Co-operation and Development
SEA	Strategic environmental assessment
SMEs	Small and medium-sized enterprises
UNFCCC	United Nations Framework Convention on Climate Change
WEC	World Energy Council

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