Promotion of Renewable Energy Globally

Based on Johannesburg Follow-up

Youn Chen, Stockholm Enivornment Institute (SEI)

TemaNord 2004:531

Promotion of Renewable Energy Globally
Based on Johannesburg Follow-up

TemaNord 2004:531

ISBN 92-893-1019-7
ISSN 0908-6692
Print: Ekspressen Tryk & Kopicenter
Copies: 150

Printed on paper approved by the Nordic Environmental Labelling.
This publication may be purchased from any of the sales agents listed on the last page.

Nordic Council of Ministers
Store Strandstræde 18
DK-1255 Copenhagen K
Phone (+45) 3396 0200
Fax (+45) 3396 0202

Nordic Council
Store Strandstræde 18
DK-1255 Copenhagen K
Phone (+45) 3396 0400
Fax (+45) 3311 1870

www.norden.org

The Nordic Council of Ministers
was established in 1971. It submits proposals on co-operation between the governments of the five Nordic countries to the Nordic Council, implements the Council's recommendations and reports on results, while directing the work carried out in the targeted areas. The Prime Ministers of the five Nordic countries assume overall responsibility for the co-operation measures, which are co-ordinated by the ministers for co-operation and the Nordic Co-operation committee. The composition of the Council of Ministers varies, depending on the nature of the issue to be treated.

The Nordic Council
was formed in 1952 to promote co-operation between the parliaments and governments of Denmark, Iceland, Norway and Sweden. Finland joined in 1955. At the sessions held by the Council, representatives from the Faroe Islands and Greenland form part of the Danish delegation, while Åland is represented on the Finnish delegation. The Council consists of 87 elected members - all of whom are members of parliament. The Nordic Council takes initiatives, acts in a consultative capacity and monitors co-operation measures. The Council operates via its institutions: the Plenary Assembly, the Presidium and standing committees.

Table of Contents

Foreword

Co-operation between energy and environmental division under the Nordic Council of Ministers was established in 1996. The most important task of the Nordic group for Climate Change Issues is to look into international climate change policy issues linked to the UN Framework Convention on Climate Change and the potential for co-operation between the Nordic countries in this field.

The Swedish institute – Stockholm Environment Institute – has prepared this report "*Promotion of Renewable Energy Globally - Based on Johannesburg Follow-up"*. The report presents and compares the definition of renewable energy sources and highlights the complexity of the debate on renewable energy. It focuses on what Nordic experiences can contribute to removing existing barriers and promoting the use of modern renewable energy sources in developing countries. The Nordic group for Climate Change does not necessarily share the views and conclusions of the report, but look at is as a contribution to our knowledge about promotion of renewable energy globally.

Stockholm, May 2004

Olle Björk
Chairman

Summary

Renewable energy sources made their first real entry onto the international energy scene in the 1970s when the two worldwide oil crises occurred. Contribution by renewable energy sources to the world energy supply has since progressively increased. The importance of renewable energy was discussed in for example the 1981's Nairobi UN Conference, as a means of achieving a sustainable future for our planet. Particularly in recent years, with the pursuit of a sustainable global pattern of energy supply and use, it has been widely acknowledged that renewable energy sources must play a key role.

Beyond the acknowledgement of the significance of using renewable energy sources, there is also a need for nations to reach an international consensus on achievable targets for renewable energy. Extensive international discussions in this regard were made during the World Summit on Sustainable Development (WSSD), held in Johannesburg in 2002. At this Summit, all the Nordic Countries and Switzerland together attempted to get the gathering to adopt the goal of increasing the share of renewable energy sources in the world's total primary energy supply (TPES) to 15% by the year 2010. Neither this attempt nor another initiative that aimed at the goal of 10% share of TPES for the new renewable energy sources succeeded. Notwithstanding this setback, the coalition for renewable energy sources that was formed during the WSSD comprising among others the EU, Iceland, New Zealand, Norway, Switzerland and the Alliance of Small Island States, issued a declaration of their own stating their determination to continue their effort to promote their goals.

EU has after the WSSD reconsidered its original proposal and modified it during the Twenty Second Session of the Governing Council/Global Ministerial Environment Forum in February 2003. Instead of setting a global target, the EU is now encouraging national and regional targets and goals based on economic, social and natural conditions with the common aim of eventually reaching a significant share of renewables in the world's energy mix.

Definitions of renewable energy

In general, the definition of renewable energy varies between countries and organisations. The various definitions for renewable sources are causing intensive disputes as the coverage of eligible renewable energy sources can make great difference in implementation of renewable promotion initiatives. This is mainly due to that the definition of renewable energy is used in different connections. In a broad sense, renewable energy refers to sources that can be used as energy resources without their eventual depletion. In a broad sense, renewable energy refers to sources that can be used as energy resources without their eventual depletion. For instance, the Renewable Energy Working Party (REWP) of the International Energy Agency has set down the following definition: "*Renewable Energy is energy that is derived from natural processes that are replenished constantly. In its various forms, it derives directly or indirectly from the sun, or from heat generated deep within the earth. Included in the definition is energy generated from solar, wind, biomass, geothermal, hydropower, and ocean energy and biofuels and hydrogen derived from renewable resources*"

(IEA, 2003a). However, the most notable feature of renewable energy sources is the diversity of sources/resources and technologies, making it difficult to define the coverage of renewable energy sources in a universal format.

The complexity increases when the definition is related to a time-bound target on renewable share on a global scale. The key issues triggering controversies on eligibility of different sources as renewables essentially originate from the understanding of two concepts: renewability and sustainability.

Nordic role

There is a large and growing energy demand in developing countries. There is a large potential for renewable energies to meet this demand, as various technologies are available worldwide. Many modern renewable energy technologies have been developed and applied in Nordic countries, resulting in a fairly large share of renewables. This could be explained not only by abundant natural resource endowments, but also by successful promotion strategies with a sound combination of regulatory measures and financial and economic incentives adopted.

Renewable share in Nordic Countries

	Renewables* (Mtoe)	Renewables/TPES (%)	Major technologies
Demark	1.97	10.1%	Biomass and Wind
Sweden	15.06	31.7%	Hydro and biomass
Norway	13.53	52.8%	Hydro
Finland	7.8	23.5%	Hydro and biomass
Iceland	2.49	72.6%	Hydro and geothermal

* Renewables do not include industrial waste, non-renewable municipal solid waste and pumped storage production

Source: IEA, Renewables Information 2002 (IEA, 2002d).

How to bring together the experience developed in Nordic countries and the potential renewable energy users in developing countries becomes an issue. The key seems to lie in non-technical factors, rather than the technologies themselves.

The most important is to create an enabling environment in developing countries in favor of using renewable energy options. This may stimulate local entrepreneurs to explore the market opportunities. To create such an enabling environment, financial institutions is a crucial component, which must be interested in and willing to provide financial support to the renewable energy development and dissemination.

In addition to advanced technologies of renewable energies, Nordic countries have experiences and expertise in how to develop the renewable energy systems. Through further in-depth study on specific regions or countries and in combination with Nordic technical and non-technical experiences, Nordic countries may be able to provide a strategic development plan of renewable energy sources in targeted countries. This could act as a starting point for further actions.

Chapter 1: Introduction

1.1 Background and Purpose

At the World Summit for Sustainable Development (WSSD) in Johannesburg in September 2002, the European Union (EU), all the Nordic Countries and Switzerland together attempted to get the gathering to adopt the goal of increasing the share of renewable energy sources in the world's total primary energy supply (TPES) to 15% by the year 2010. Neither this attempt nor another initiative that aimed at the goal of 10% share of TPES for the new renewable energy sources succeeded. Notwithstanding this setback, the coalition for renewable energy sources that was formed during the WSSD comprising among others the EU, Iceland, New Zealand, Norway, Switzerland and the Alliance of Small Island States, issued a declaration of their own stating their determination to continue their effort to promote their goals.

In view of the EU Parliament's directive of 2001/77 and the divergences in the assumptions and conclusions of several major global studies on the situation of renewable energy in the world, caused not least by diverging country- and region-specific definitions and understanding of what renewable energy sources actually comprise, it has become necessary to conduct a study that explores in depth the prevailing definitions of renewable energy and their implications and consequences. Further, it is also desirable to explore how the Nordic Countries' efforts can contribute to the promotion of renewable energy utilization and reduction in carbon dioxide emissions within a global perspective.

The present study has been conceived and conducted with the purpose of making a contribution towards the Nordic intention sketched above. The following paragraph provides a brief overview of how this has been undertaken in the succeeding chapters.

1.2 Outline and structure of the study

Renewable energy sources made their first real entry onto the international energy scene in the 1970s when the two worldwide oil crises occurred. Contribution by renewable energy sources to the world energy supply has since progressively increased. The importance of renewable energy[1] was discussed in for example the 1981's Nairobi UN Conference, as a means of achieving a sustainable future for our planet. Particularly in recent years, with the pursuit of a sustainable global pattern of energy supply and use, it has been widely acknowledged that renewable energy sources must play a key role.

Beyond the acknowledgement of the significance of using renewable energy sources, there is also a need for nations to reach an international consensus on achievable targets for renewable energy. Extensive international discussions in this regard were made during the World Summit on Sustainable Development (WSSD), held in Johannesburg in 2002.

[1] Although the new term of "new renewable energy" was not adopted at that time, the renewable energy sources here include those categorised as "new renewable energy sources" afterwards.

Chapter 2 of this report highlights the complexity of the debate on renewable energy, followed by a summary of the post-WSSD follow-up on the target setting within the European Union. The core controversial issue related to the renewable targets in the WSSD was the definition of renewable energy sources. Chapter 3 therefore presents and compares the definitions of renewable energy sources that are used as a general definition or as a scope for a given promotional scheme, as well as discusses the key controversies, with particular attention given to European countries. Chapter 4 depicts the current global adoption of renewable energy sources. What Nordic experiences can contribute to removing existing barriers and promoting the use of modern renewable energy sources in developing countries is discussed in Chapter 5.

Chapter 2: Prospects of Renewable Energy

2.1 Renewables - from Rio to Johannesburg

Seeking a roadmap to ensure a healthy planet for future generations, broad issues regarding environment and development were discussed by leaders of nations from around the globe at the UN Conference on Environment and Development in Rio de Janeiro in 1992.

Energy issues were neither on the main agenda, nor among the focus areas of Agenda 21, one of the most significant outcomes from Rio. Increased attention to the role of energy in sustainable development was not given until the 19th Special Session of the UN General Assembly in New York, five years after Rio. Due mainly to continuous environmental degradation and the worsening global poverty situation, the need to construct a sustainable path of energy supply and use was formally recognised in this Session. A mandate to focus on sustainable energy was given to the Ninth Session of the Commission of Sustainable Development (CSD-9).

Approximately one year before the WSSD at Johannesburg, CSD-9 was held in New York. Energy for sustainable development as one of the major themes[2] was discussed for the first time at an intergovernmental level. Renewable energy, on primary account of its unique climate neutral nature and an improving technological maturity, became a key focus of the discussion. In order to tackle the most crucial energy-related issues, such as climate change and poverty alleviation, all participants agreed that the global share of renewable energy must substantially increase. Furthermore, specific options and recommendations on promotion of renewable energy were put forward in the Decision 9/1 of the session.

Achieving sustainable energy was an important theme in the WSSD, giving the question of how to promote renewable energy unprecedented attention. The debate on this issue was intense and complex, particularly concerning setting global targets on renewable energy share in the energy mix.

2.2 Discussion on renewable energy targets at Johannesburg

During the WSSD, two separate proposals on global target setting for increased use of renewable energy resources were presented by Brazil and the EU. The discussions and debates focused on two crucial issues: What targets should be set and what renewable sources should be included in the definitions, as these two issues strongly determine whether the target could be achieved in any specific country.

[2] Major themes were energy, transport and atmosphere.

The Brazilian Energy Initiative for the 2002 Summit

In May 2002, the Brazilian Government proposed to increase by 2010 the use of renewable energy to 10% of the Total Primary Energy Supply (TPES) in the Latin America and the Caribbean region. This so-called Brazilian Energy Initiative received strong support at the 7th Meeting of Environment Ministers of Latin America and the target was adopted by the twenty-one states of the region. Based on the Brazilian Initiative, it was proposed to the WSSD that this target should be adopted in all countries. The proposal also included potential trade of renewable energy certificates among countries to achieve the goal jointly (The Brazilian Energy Initiative, 2002).

In the Brazilian Energy Initiative, new renewable energy sources are defined as:

- modern biomass[3] (excludes traditional uses of biomass as fuelwood and includes electricity generation and heat production from agricultural and forest residues and solid waste);
- small hydropower;
- geothermal energy;
- wind energy;
- solar energy(including photovoltaic);
- marine energy;

According to this definition, renewable energies account for 20.6% of the TPES in 2000 in the six big countries of the region (Argentina, Chile, Venezuela, Colombia, Mexico and Brazil) (UNDP, 2000a). Thus, these countries would be large world renewables exporters if a 10% target would be set globally and a trading mechanism would be adopted. In particular, Brazil has advanced modern biomass technologies enabling the modern biomass use to account for 11.3% of the Brazilian TPES in 2000 (Brazilian Energy Balance, 2002).

The European Union's proposal for the 2002 Summit

The EU is facing the task to fulfil its Kyoto commitment of 8% greenhouse gases (GHGs) emission reduction by 2008-2012 from the 1990 baseline, while the current trend is a 5% increase. The EU is at the same time striving to reduce dependency on fossil fuel, given the fact that EU is the biggest world importer of oil and of natural gas (EU Energy, 2002). Although EU plays a leading role in developing renewable energy technologies in the world, the renewable energy share accounts for only 6% of the TPES in 1998 (Commission of the

[3] Modern biomass refers to more efficient and cleaner ways of using biomass for electricity generation, heat production and production of transportation fuels by adopting advanced technology such as gasification/pyrolysis, high efficient direct combustion, fermentation/hydrolysis and anaerobic digestion, rather than using biomass as fuelwood in a traditional way characterised by lower energy efficiency and indoor pollution. By traditional biomass we mean less efficient and more polluting combustion and other techniques (e.g. traditional stoves).

European Communities, 2001). Therefore, the European Parliament clearly stated in the Directive 2001/77/EC that promotion of use of renewable energy resources is of strategic importance to both security and diversification of energy supply, as well as the mitigation of climate change. This Directive also set a target that 12% of total energy use and 22% of the total electricity in the EU should come from renewables by 2010 (EU Directive, 2001). This target is disaggregated on a country level depending on specific characteristics of different countries.

Drawing upon the experiences in target setting, the EU at the WSSD proposed a global target of 15% renewable energies to be reached by 2010. The renewable energy sources in this proposal include large scale hydropower and traditional biomass.

Debate about the target proposals

The proposals led to a lively debate, where countries opposed to target setting vividly underlined the drawbacks of a global target.

One of the strongest opponents to the EU proposal was the United States. Even though it expressed its support to increased use of renewable energies, US argued that each country should make their own energy plan and set targets based on accessible natural, economic and social resources instead of on a global binding target. The promotion of renewable energies, the US argued, should be propelled by a country's policy and regulatory regime, rather than an international target. The key American argument was that since the cost of renewable energies is still much higher than conventional energy sources, the adoption is not always appropriate (US, 2002). As local conditions to a large extent determine the potential to exploit renewable energy, a global target could create a situation of wealth transfer from countries' that do not have renewable energy resources to countries that have. The other opponents also included OPEC countries, Australia, Canada and Japan. The G77 countries negotiated under one umbrella and many developing countries opposed the proposal on the ground that their development options in terms of energy use would be constrained by this global target, especially with the definition of renewable energy sources not being clear and agreed.

From the perspective of the World Energy Council (WEC), the independent global energy organisation, any form of compulsory targets for any energy sources would inevitably lead to market distortions. Indicative targets may be cost-effective depending on the level on which the targets are applied. A global structure would be inflexible, while national or regional targets may play a strategic role. WEC raised the question, whether or not there is a clear vision that the target is intended to achieve: Is it emissions reduction, energy security or energy source diversification? If it is greenhouse gas emissions reduction that is intended, other ways of achieving the same goal e.g. energy efficiency in buildings, industry and transport, should be considered and compared technically and economically. If the main objective is to solve the problem of energy security and access, especially in developing countries, it is important to assess renewables on a case-by case basis since local conditions affect costs and feasibility. A large variety of issues have to be taken into consideration when specific targets are set. Also, shielding renewables from competition may have the opposite effect from what is intended, impeding the development of renewable technologies in a competitive environment (WEC, 2003).

The EU also came under criticism for not being sufficiently ambitious and for supporting environmentally harmful sources. The proposed target includes all renewables, so only a small increase in the global renewable share is needed to achieve the 2010 target given that the current level is 13.8% of the world TPES, and that both large hydro and traditional biomass are included. However, for the EU member states, the target is fairly challenging since the current share of renewables is only 6% of the total TPES (European Commission, 1997). Moreover, a number of other targets were informally discussed, for example, the Swiss delegation proposed 5% on renewables excluding large-scale hydropower.

At the same time the EU proposal received positive responses from many countries, such as all the Nordic Countries, Switzerland, Bulgaria, Czech Republic, Estonia, etc.. EU and Brazil held talks at WSSD to try to find an agreeable compromise between the two proposals, possibly extending the 2010 deadline and possibly including large hydro on the condition that environmental and social impact assessment would be applied.

For a variety of reasons, such as above-mentioned political divergences and academic discussions on definitions of renewable energy resources, targets and timetables proposed were not adopted. Nevertheless, WSSD in its Plan of Implementation has set the tone for future renewables prospect with the statement: *"With a sense of urgency, substantially increase the global share of renewable energy sources in order to increase its contribution to the total energy supply*" (UNDESA, 2002). The strongest words in support of renewables from the UN ever, sent a clear message that the debate is just taking off. Moreover, WSSD has reached the decision to "*regularly evaluate available data to review progress on these goals"*, giving room for future target setting.

In response to the failure to agree on a renewable energy target and action plan, EU put forward a "coalition of the willing" approach at the final plenary session. This eventually led to the forming of a Coalition of like-minded countries supporting EU's proposal on a renewable energy target. As a result, a Joint Declaration known as "The Way forward on Renewable Energy" was signed and delivered by the allied countries (See Annex I), demanding that time-bound targets on renewable share in the global energy mix should be set to assist countries across the world in making and implementing national policies directing technological development and market penetration of renewable energies with the ultimate goal to substantially increase the global share of renewable energy sources.

2.3 Follow-up initiatives after WSSD

One of the most outstanding outcomes following EU's initiative is the continuously growing number of Coalition members, reflecting that more and more countries are willing to translate the Summit's commitments into firm and tangible targets. The Coalition is growing fast and as of February 2003 the membership states totalled 78. The Members are committed to close co-operation in implementing and setting ambitious and time-bound targets. Furthermore, there are more than 20 countries such as Colombia, Malaysia, South Africa and even Canada that have stated their positive attitudes towards the Coalition and its advocacy (Europa, 2003).

After the WSSD, the Brazilian proposal has been revised. Environmental Minster José Goldemburg emphasised the Brazilian perspective on the Energy Initiatives in the Third Meeting of the Global Forum on Sustainable Development (GFSE-3), held in November 2002, Graz, Austria (Goldemburg, 2002) In his perspective paper, he appealed to take a bottom-up target-oriented approach.

More importantly, EU has reconsidered its original proposal presented in the WSSD and modified it during the Twenty Second Session of the Governing Council/Global Ministerial Environment Forum in February 2003. Instead of setting a global target, the EU is now encouraging national and regional targets and goals based on economic, social and natural conditions with the common aim of eventually reaching a significant share of renewables in the world's energy mix. The shift from top-down to bottom-up target-oriented approach has minimised divergences between the two original proposals. Minor differences of renewable definitions among countries or regions are understandable and become a minor issue, which should not hold back the process from moving forward, considering the like-minded Coalition is only a voluntary agreement.

Coordination among the EU members also took place after the WSSD. The EU energy ministers have recently expressed their willingness to follow-up the issue on Council level. At present the European Commission (DG TREN) is working on a communication on the follow up of the proposal on renewable energy target, which hopefully will bring out clear plans and strategies in this regard.

Moreover, as decided in the WSSD, the International Conference on Renewable Energies will be held in Bonn 1-4 June 2004. Special attention will be given to renewable energy, especially further development of national and regional renewable targets. Another ambition of the Bonn Conference is to further develop the like-minded Coalition, in parallel to taking in all the countries which are willing to contribute to the increase of using renewable energy sources in the global context.

Few concrete initiatives and announcement from the Johannesburg Summit were explicitly related to renewable energy, but rather to energy in general. The German Government announced a 500 million euro contribution over the next five years to promote cooperation on renewable energy. Shell presented a proposal for setting up a "one million solar homes" fund. The UK Government launched a "Renewable and Energy Efficiency Partnership" (UNDESA, 2002).

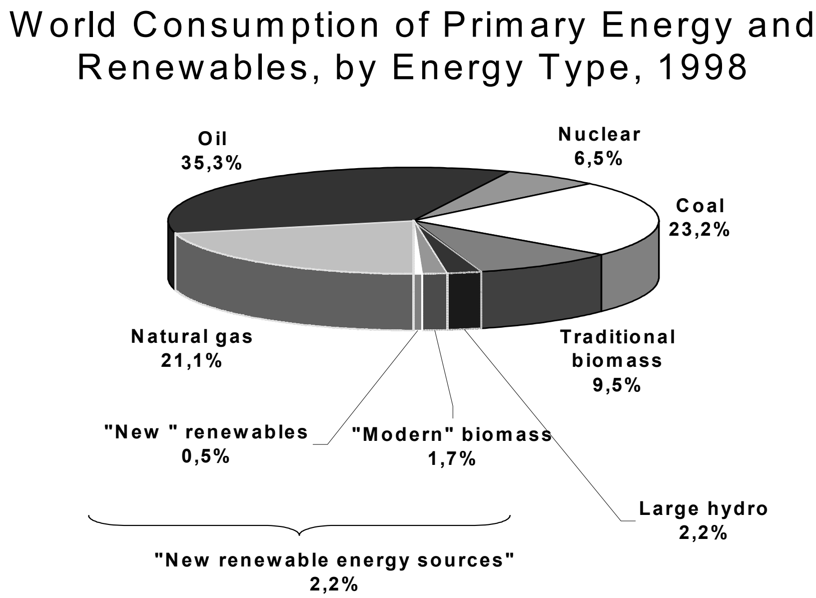
Chapter 3: Definitions of Renewable Energy

In general, the definition of renewable energy varies between countries and organisations. The various definitions for renewable sources are causing intensive disputes as the coverage of eligible renewable energy sources can make great difference in implementation of renewable promotion initiatives. This is mainly due to that the definition of renewable energy is used in different connections.

In a broad sense, renewable energy refers to sources that can be used as energy resources without their eventual depletion. For instance, the Renewable Energy Working Party (REWP) of the International Energy Agency has set down the following definition: "*Renewable Energy is energy that is derived from natural processes that are replenished constantly. In its various forms, it derives directly or indirectly from the sun, or from heat generated deep within the earth. Included in the definition is energy generated from solar, wind, biomass, geothermal, hydropower, and ocean energy and biofuels and hydrogen derived from renewable resources*" (IEA, 2003a). However, the most notable feature of renewable energy sources is the diversity of sources/resources and technologies, making it difficult to define the coverage of renewable energy sources in a universal format. Other agencies suggest different definitions based on particular purposes or situations, including or excluding specific resources or technologies.

The complexity increases when the definition is related to a time-bound target on renewable share on a global scale. This issue is very crucial to subsequent realization if a target would be set, as shown in the following Figure 1, new renewables that cover modern biomass, tide, wind, solar and geothermal account for only 2.2%, which is a fairly small portion as compared with the traditional renewable energy sources (traditional biomass and large hydro power) of 11.7% of the world TPES in 1998.

Figure 1.



Source: World Energy Assessment 2000, UNDP.

In this context, having an unambiguous and widely acknowledged definition is a prerequisite to reach global or regional targets on renewables. Below the definitions of renewable energy used in different European countries and by international organisations will be introduced. The major points of difference will be identified and discussed.

3.1 Definitions in European Countries and by International Organisations

Table 1 presents which energy sources are included in the definition of renewable energy in different countries. To facilitate comparison, major sources have been listed and for each country the applicable boxes ticked. Not all countries investigated have defined officially "renewable energy sources". For these countries, the definition[4] of renewables used in national promotional schemes, if any, is used. Otherwise, the national statistical scope of renewable energy is presented as an alternative.

As shown in Table 1, despite that all definitions fall into the overall category of renewable energy sources, a wide range of variations exist. Some differences are distinct, and some are merely slight. This paper gives an overview of differences in different definitions, rather than a comparison in terms of advantages and disadvantages, as it is believed that each definition has its grounds and comparative advantages in the specific context of each country. Considerations when establishing definitions may focus on infrastructure invest-

[4] Note that the concept of definition here shall be understood in a broader sense, which covers general/official definition, the scope used for a given promotional scheme or even for statistics.

ments made, local or indigenous natural resources, available technology for applying the resources, future energy trends, as well as implication and commitments to the local and global environment protection. This can be particularly reflected by slight difference in the inclusion of each country's definition, for example, pumping stations being included in the hydropower category in France, or ceiling for small-scale hydropower as renewable being set at 20 MW in UK.

A brief comparison of different methods to develop definitions is made below.

National definitions

When an official definition is made, a variety of elements must be taken into consideration. Among them, the national strategy for energy security is probably the most important determinant in defining the coverage of renewable energy sources. The emerging concern of energy dependency and long-term strategic security has brought renewables onto the agenda of many countries. This concern is coupled with another concern of compliance with international agreements with the aim to tackle the global warming issue. National endowments of renewable energy sources and existing infrastructure also clearly influence the definition of what is renewable or not, as for example the discussion regarding the inclusion of peat in the Finnish renewable energy definition, as well as different national definitions on biomass.

Promotional schemes

The definition used by a renewable energy promotional scheme is not necessarily different from the national definition. Slight differences in the two definitions exist in some cases since the promotional scheme is an approach to convert the long-term strategy for renewables into feasible schemes setting targets and providing economic or other incentives. What type of renewables included in the schemes and targets may not follow the same categories as that of existing energy mix. Considerations regarding creating competitive market conditions could also influence the coverage of promotional schemes.

Remarks

It is noteworthy that the definitions for promotional schemes, statistical use, or even for official purposes in any given country are likely to have a different range in terms of what to be included and excluded, compared to the scope defined by the international organisations such as IEA whose concerns and focuses are much based on a global context. However, it by no mean implies that the countries as such do not recognize the other forms of renewable energy sources, such as tidal energy if not included in its definition scope, as renewable energy.

Table 1: Comparison of definitions of renewable energy sources (* : *Source is specified in the following texts*.)

Countries/ Intl. Org	Solar (PV & Thermal)	Wind power	Large-scale Hydropower	Small-scale Hydropower	Geothermal	Biofuels	Biomass	Waste-to-energy	Landfill gas	Biogas	Peat	Heat Pump[a]	Ocean Energy	Comments
Austria[1]	X[2]	X		X[3]	X		X		X[4]	X				1) Renewables for electricity generation only (Article 40, Federal Electricity Act (Elektrizitätswirtschaftsorganisationsgesetz or ElWOG) 1998/2000, 2) Solar thermal energy is excluded. 3) Size of small-scale hydro is defined by provincial law. 4) Including gas from sewage treatment plants.
Belgium[1]	X	X	X		X		X[2]			X				1) At the federal level, the definition of renewable energy in recent electricity policies refers to “all energy sources except fossil fuels and nuclear fission”. The coverage of renewables in the Table is from RES Policy Report for Belgium. [On-line] http://www.agores.org/Publications/EnR/BelgiumRE2000.pdf 2) Including wood and biodegradable fraction of the wastes for incineration.
BP statistics[1]			X	X										1) Only one renewable, hydro power, is included in the statistical data, see further the following text.
Denmark*	X	X		X[1]	X		X[2]						X	1) Hydropower < 10 MW; 2) Biomass (biodegradable vegetal and animal waste);
EU*	X	X	X		X		X[1]	X[2]	X[3]	X			X	1) Biomass refers to the biodegradable fraction of products, waste and residues from agriculture (including vegetal and animal substances), forestry and related industries. 2) The biodegradable fraction of industrial and municipal waste. 3) Including gas from sewage treatment plants.
Finland*	X[1]	X	X	X			X[2]	X[3]		X	X[4]	X		1) The use of solar energy is a very small portion in the Finnish energy mix. 2) Wood-based fuels, such as firewood and wood industry residues for district heating, the CHP (Combined Heat and Power) use and direct use by domestic households; 3) Referring to industrial wastes, including black liquor from wood industry. 4) Peat is often considered as “slowly renewable”.

Countries/ Intl. Org	Solar (PV & Thermal)	Wind power	Large-scale Hydropower	Small-scale Hydropower	Geothermal	Biofuels	Biomass	Waste-to-energy	Landfill gas	Biogas	Peat	Heat Pump[a]	Ocean Energy	Comments
France* [General definition]	X	X	X[1]	X	X	X[2]	X[3]	X[4]		X[5]				1) Including pumping stations. 2) Referring to methyl esters and ethanol. 3) Including: 1) wood and wood wastes from forestry and wood processing industry; 2) residues from paper industry; 3) Agricultural residues, such as straw, residues from coffee processing, and from sugar cane processing in the overseas departments. 4) Including municipal and industrial wastes for incineration. 5) Gas from sewage treatment plants.
Germany* [General definition]	X	X	X	X	X	X	X		X	X		X[1]		1) Heat pumps are regarded as a technology in between renewable energy utilization and energy efficient applications. (Reiche, 2002)
Greece[1]	X	X		X[2]	X		X			X[3]			X	1) Renewables for electricity generation only, (defined in Article 2 of the Greek Law 2773, 1999); 2) No more than 10 MW; 3) Excluding the gas from industrial and municipal wastes.
Iceland*			X		X									

Countries/ Intl. Org	Solar (PV & Thermal)	Wind power	Large-scale Hydropower	Small-scale Hydropower	Geothermal	Biofuels	Biomass	Waste-to-energy	Landfill gas	Biogas	Peat	Heat Pump[a]	Ocean Energy	Remarks
IEA*[, 1]	X	X	X		X		X[2]	X[3]		X[4]			X	1) Derived from the IEA's "Renewables in Global Energy Supply-An IEA Fact Sheet", on-line available: http://library.iea.org/dbtw-wpd/Textbase/nppdf/free/2003/renew2003.pdf 2) Biomass is defined as any plant matter used directly as fuel or converted into other forms before combustion. Included as wood, vegetal waste (including wood waste and crops used for energy production), animal materials/wastes, sulphite liquor, also known as "black liquor", and other solid biomass. It also includes charcoal produced from solid biomass. 3) Municipal waste consists of products that are combusted directly to produce heat and/or power and comprises wastes produced by the residential, commercial and public services sectors that are collected by local authorities for disposal in a central location. Hospital waste is included in this category. Some of the waste (the non-biodegradable part of the waste) is not considered renewables as such. However, proper breakdown between renewables and non-renewables is often not available. Industrial waste consists of solid and liquid products (e.g. tyres) combusted directly, usually in specialised plants, to produce heat and/or power and that are not reported in the category solid biomass.

Countries/ Intl. Org	**Solar (PV & Thermal)**	**Wind power**	**Large-scale Hydropower**	**Small-scale Hydropower**	**Geothermal**	**Biofuels**	**Biomass**	**Waste-to-energy**	**Landfill gas**	**Biogas**	**Peat**	**Heat Pump[a]**	**Ocean Energy**	**Remarks**
Italy[1]	X	X	X		X		X	X[2]					X	1) Renewables for electricity generation only (Legislative Decree No 79, 1999). 2) Organic and inorganic wastes.
Luxembourg[1]	X	X	X		X		X	X[2]						1) Energy Law: Law of August 3, 1993. 2) Non-recycled dumped wastes.
Netherlands*	X	X			X		X	X[1]				X[2]		1) Wastes that do not containing synthetic fraction 2) Industrial heat pump is not included
Norway [General definition]	X	X	X[1]	X	X		X	X	X	X			X	1) Norway does not include large hydro as a new renewable energy source but large hydro is included within the definition of renewable energy sources.
OECD statistics[1]	X	X	X			X	X	X	X					1). The Statistics Norway Report, On-line available: http://www.ssb.no/english/subjects/10/08/10/nos_energy/nos_c703_en/tab/t-101.html
Portugal[1]	X	X	X	X	X		X	X[1]		X			X	1) As defined in the governmental programme (E4) by the Ministry of Economy, 2000 and ERSE: Caracterisacão do Sector Eléctrico-Portugal Continental 2000. 2) Debating.
Spain*	X	X	X[1]	X[2]	X	X	X[3]	X[4]		X			X	The Royal Decree 2818/1998 1) Between 10-50 MW 2) Less than 10 MW.Primary biomass: natural biomass or energy crops (growing period less than 1 year before being used). 3) Secondary biomass: including residues from primary use of biomass, manure, sludge from sewage treatment plants, forest and agriculture residues.
Sweden* [General definition]	X	X	X		X		X						X	

Countries/ Intl. Org	Solar (PV & Thermal)	Wind power	Large-scale Hydropower	Small-scale Hydropower	Geothermal	Biofuels	Biomass	Waste-to-energy	Landfill gas	Biogas	Peat	Heat Pump[a]	Ocean Energy	Remarks
U.K[1]	X[2]	X	X[3]	X[4]	X		X[5]	X[6]	X	X[7]			X	1) Definition from Renewable Obligation Act. b All plant using renewable sources built before 1990 (unless re-furnished). 2) Only solar PV. 3) Only the new large hydro (more than 20 MW) built after the enforcement of the Renewable Obligation in April 2002. 4) Small hydro is defined as a capacity with less than 20 MW. 5) Referring to energy crops (wood). 6) Only the biodegradable fraction of wastes is eligible. As well as energy extracted from mixed wastes by using advanced conversion technology. 7) Gas from sewage treatment plants.
UN[1]	X	X	X		X		X						X	1). Source: (UNDP, 2000). Chapter 7. Renewable Energy Technologies. World Energy Assessment, UNDP, 2000. p. 221.

Secondary source: Reiche, Danyel, 2002. Handbook of Renewable Energies in the European Union

a: Heat pumps used are the types with and without input electricity energy; note that heat pump is a type of technology possibly using renewable energy sources as energy input, rather than a renewable energy source.

** means more detailed description in the following paragraphs.*

The Definitions in the EU

In the EU regime, different descriptions or defined scopes for renewable energy sources can be found in for example the White Paper for a Community Strategy and Action Plan and EUROSTAT. Although the definition of renewable energy sources in the EU Directive 2001/77/EC is only for the purpose of this Directive, it has often been seen as the most authoritative one in the EU context. In this Directive, Article 2 states that renewable energy sources shall mean non-fossil energy sources (solar, wind, geothermal, wave, tidal, hydropower, biomass, land fill gas, sewage treatment plant gas and biogas).

In order to keep consistency with EU's policies on waste management, non-biodegradable wastes are not included as a renewable energy source. However, in the Directive's definition no distinction between traditional biomass and modern biomass is made, and none between small and large hydro power. In EU's Proposal on a global renewable target at the WSSD in 2002, this same definition of renewable energy was used.

The definition in the Directive includes nearly all the renewable energy sources covered in the different EU member states' definitions. The differences in definition among member states are significant, due to inherent variations among countries in distribution of energy resources, existing infrastructure and market conditions. Included in all definitions are onshore wind power, solar energy (solar thermal and Photovoltaics) and biomass.

It is worth noting that biomass in most countries is used as a general term containing biofuels, biogas and even landfill gas and the like. Some countries, however, intend to promote specific forms of bioenergy, such as biofuels in the case of Germany and France, who are taking the lead in this area, and thus include biofuels as a separate category.

Definitions in the Selected European Countries

NORDIC COUNTRIES

The **Swedish** National Energy Authority (STEM) as the main governmental agency responsible for promotion of renewable energies in Sweden defines solar, wind, hydro, geothermal, biomass and ocean energy as renewable energy sources. However, various definitions of renewable energy are used in different contexts and no official general definition exists. An example is that, for the Swedish green certificates scheme launched on May 1, 2003, only those hydropower with less than 1.5 MW and all newly built hydropower are included, and whether or not landfill gas and biogas will be included is still pending. However, the Swedish Parliament has decided to include peat in this promotional system, even though peat is defined also by the Parliament as a non-renewable energy source due to its slow regeneration rate. In this case, the green certificate system in Sweden is a tool for promoting specific sources and cannot be used as a background for a general definition of renewable energy sources.

Denmark in its official energy policy and statistics defines renewable energy as energy from sources that can be regenerated. Energy generated from waste is treated differently depending on the context and is sometimes included.

In 2001, Green Electricity Certification as a promotional scheme for renewables was introduced in the new energy act. The definition in this scheme is based on the EU definition of green electricity from 2000. In the draft EU directive, hydropower was included up to 10 MW. Although in the final EU directive no size limitation for hydropower was included, Denmark has limited the eligibility to plants below 10 MW for hydropower.

Electricity produced at municipal waste incineration plants is not accepted as green electricity, since those plants shall be non-profitable and are thus unsuitable to act on an electricity market with free price setting. However, electricity generated from other bio-waste sources, for example, biogas from slaughter house wastes or solid residues from wood industry can be accounted for as green electricity. Therefore, the sources as such are defined as renewable energy sources (Danish Energy Authority, 2002).

Norway has almost the same definition for renewable energy as IEA. The only difference between the two definitions lies in the scope of municipal waste for energy purposes. In the Norwegian definition all municipal wastes are included while only the biodegradable part in the IEA's.

Norway now has a total installed hydropower capacity of 27 596 MW at 740 hydropower plants larger than 1 MW. Production in a normal year is calculated to be about 119 TWh. Norway is the sixth largest hydropower producer in the world and the largest in Europe and produces more than 99% of its electricity this way.

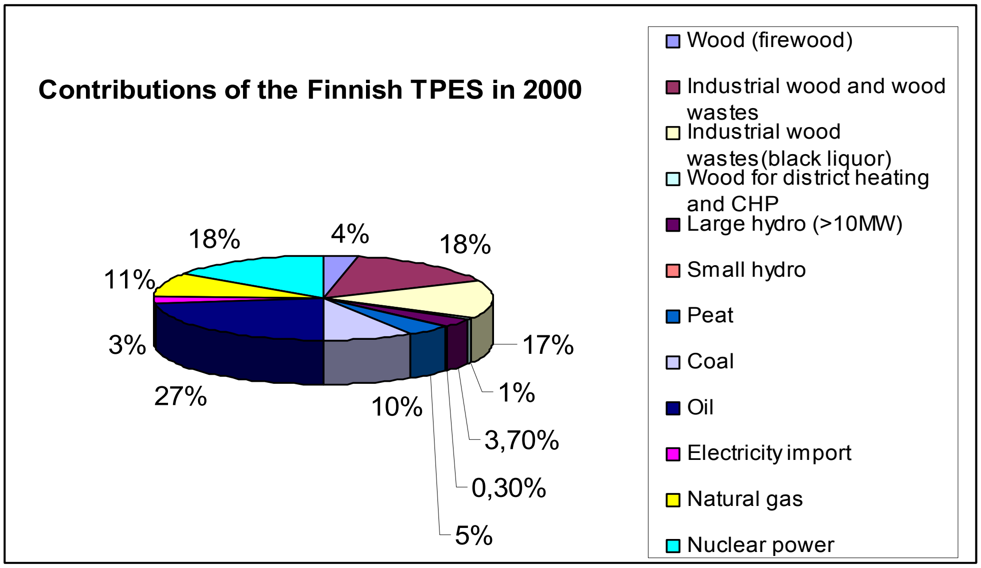
On 1 January 2002, there were 28 wind turbines in Norway, with an installed capacity of about 17 MW. In 2002 wind power production was about 30 GWh (0.03 TWh).

Biomass in Norway includes firewood, black liquor, bark and other forms of wood waste, and municipal waste from households and industry used in the production of district heating. Fuel such as gas, oil, pellets and briquettes can be produced from biomass. In 2002, the recorded use of bioenergy totalled approximately 57 PJ, corresponding to 15.8 TWh. The pulp and paper industry used approximately half of this, of which two-thirds was black liquor and one-third bark. In recent years, there has been an increase in processing of biofuel. Large amounts of processed biofuel are exported to Sweden.

Finland has no official definition of renewables. Table 1, includes the renewable sources that are usually included in statistical data. Whether to include peat and waste-to-energy as renewables is still under discussion. As shown in Figure 2, peat supplied around 5% of the Finnish TPES in 2000. Although peat takes several thousand years to regenerate, some argue that it should be classified as a "slowly –renewable" energy source, given its contribution to CO2 binding, as for instance in the case of Finland whose undisturbed peat lands are so large that they may compensate for the emissions from use of peat in energy production

(Crill et al. 2000). Waste-to-energy fuels in Finland contribute a very small portion of energy supply, accounting for less than 0.6% of the TPES.

Figure 2: Finnish Energy Supply in 2000

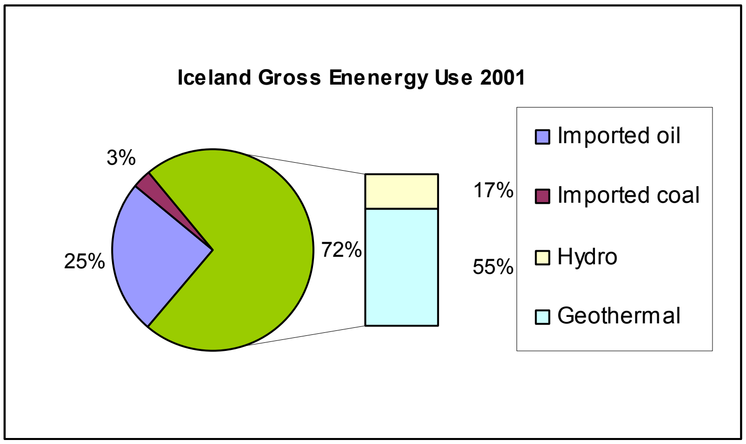


Source: Statistics Finland 2001

Iceland has a large indigenous renewable energy potential. This potential is however derived only from two sources, namely, hydropower and geothermal energy. As shown in the Figure 3 from energy statistical data in 2001, renewables accounted for over 72% of the total energy consumption in Iceland. Although only hydropower and geothermal energy are defined as renewables, in international dialogues Iceland often refers to the definition of renewable energy used by the International Energy Agency (IEA).

Although hydrogen is an energy carrier rather than an energy source, the development of hydrogen technology catches the world's attention as the hydrogen in Iceland is derived from domestic renewable energy sources by electrolysis process. In contrast, most of the hydrogen used in Europe is from natural gas, which is a typical fossil fuel.

Figure 3: Icelandic Energy Consumption in 2001



Source: Statistics Iceland, 2001

In **Germany**, the general definition illustrated in Table 1 originates from BMU (*Bundesministerium für Umwelt, 1999*). However, different definitions for eligible renewables are applied by various promotional schemes in Germany. For example, the new Act on Granting Priority to Renewable Energy Sources (EEG)[5] uses the following definition of green electricity for promotion of renewables[6] (Meyer, 2003).

- Small hydro with a capacity of no more than 5 MW;
- Wind power (onshore and offshore);
- Solar PV;
- Biomass, vegetal and animal waste in facilities less than 20 MW under the condition that waste must be non-harmful to environment and health;
- Gas from landfills, sewage treatment and mining plants[7] with a capacity of no more than 5 MW.
- Geothermal.

In order to provide financial assistance to potential investors, a number of soft loan schemes are offered by *Kreditanstalt für Wiederaufbau* (KfW) and *Deutsche Ausgleichsbank* in Germany. Specific definitions are applied for such programmes. For example, for the Market Incentive Programme for an increased use of renewable energy, only large biomass plants, biomass plants using CHP technology, biogas plants, hydropower stations (up to 5 MW), geothermal energy utilization are eligible for use of soft loans (Reiche, 2002).

[5] EEG was operational in April 1, 2000. It aims to support sustainable energy supply in Germany with a concrete target of 12% of German electricity from renewable sources by 2010 from the current level of 6%.
[6] A feed-in model is a policy scheme by which electricity obtained from renewable sources can be purchased at a long-term minimum guaranteed price.
[7] Although the methane from coal mining plants is supported in the scheme, it is not considered as a renewable energy source.

Netherlands' definition in Table 1 is restricted to the electricity generating renewables. This original definition was generated from the 3rd White Paper on Energy Policy in 1996, revised in the 1997 report "Renewable Energy-Advancing Power: Action Programme for 1997-2000". In this definition, small scale hydro power was included.

Since July 2001, the Green Certificates System has been introduced on the Dutch electricity market, requiring a redefinition of eligible categories of renewable energy sources from which green electricity can be generated. In 1998, small hydro with a production capacity with less than 15 MW was defined as renewable for electricity generation. However, after January 2002, any size of hydro power was excluded from the coverage of the renewables scheme, only retaining solar PV, wind power and biomass without synthetic components as renewables eligible to receive green electricity certificates (Ministry of Economic Affairs 1999: 11 pp., Groencertificatenbeheer 2001).

United Kingdom definitions are subject to different promotional schemes adopted. The above listed definition is applicable for a newly issued promotional scheme, namely Renewable Obligation (RO) that came into effect in April 2002, in replacement of the previous Non-Fossil Fuel Obligation (NFFO) (Reiche, 2003: p.241) (UK Government, 2002). RO is a quota scheme to ensure a specific portion of supplied electricity from renewable energy sources (Meyer, 2003). The UK government has set a target for green electricity of 5% of UK's total licensed electricity by 2003 and 10% by 2010 (UK Government, 2002) (Meyer, 2003).

France has a general definition made by Ministere de l'Economie, (des Finances et de l'Industrie, 2001a.) However, the French renewable promotion system of feed-in tariffs scheme[8] is applicable to the following renewable energy sources.

- Wind energy;
- Small hydro power;
- Biomass electricity generation (the eligibility is under the discussion);
- Biogas and PV (the eligibility is under the discussion).

A clear **Spanish** definition was not established until the issuance of the Royal Decree 2818/1998, specifying the coverage as shown in Table 1. Besides the renewable energy sources in this definition, cogeneration plants are eligible for support under the 1998 specified terms, as are urban wastes and energy plants which produce biogas from various sorts of organic wastes.

Italy, in two decrees launched in March and November of 1999 respectively, has classified as renewable energy sources for electricity generation solar energy, wind power, hydropower, geothermal, biomass, waste-to-energy and ocean energy. This definition is basically in accordance with the aforementioned EU definition except for inclusion of inorganic

[8] Feed-in tariff scheme is designed to offer a guaranteed fix tariff to electricity generators under the purchase obligation principle defined by law ("Obligation D´achat) for renewable energy sources.

wastes. According to statistical data from Enea (Ente per le Nuove Tecnologies, l'energia e l'ambiente), a national agency that performs research as well as operational tasks, biofuels and biogas are separated from biomass energy. Biogas is referred as gas from landfills and sewage treatment plants. Promotional policies also include biofuels.

Definitions used by International Organisations

International Energy Agency (IEA)

In statistical information of renewables, different definitions on renewable energy sources are used for different purposes. In the IEA fact sheet regarding Renewables in Global Energy Supply, the definition includes:

- Combustible renewables and waste;
- Solid biomass and animal products – wood, vegetal waste, animal materials/wastes, sulphite liquor, and other solid biomass. It also includes charcoal produced from solid biomass;
- Gas/Liquids from biomass;
- Biodegradable Municipal Waste ;
- Biodegradable Industrial Waste;
- Hydro Power;
- Geothermal Energy;
- Solar Energy;
- Wind Energy;
- Tide/Wave/Ocean Energy.

The non-biodegradable part of the waste is not included as renewable energy, but is often in practice as national statistical often do not contain a proper breakdown is according to IEA.

In IEA Renewables Information 2002, renewable sources exclude industrial waste, non-renewable municipal solid waste and pumped storage production[9].

British Petroleum Statistical Review

The BP review of world energy of 2001 focused on fossil fuels, such as coal, oil, natural gas, rather than the entire range of energy sources. Out of non-fossil fuels, only nuclear and hydroelectricity are included in the review. The reason that BP presents for not including renewable energy sources in the main BP Statistical Review of World Energy is difficulty with completeness, timeliness and data quality.

[9] Pumped storage production is electricity generated by falling water that is pumped up from the lower hydropower reservoir to replenish the upper reservoir, meaning no overall gain in electricity. In fact the electricity used for pumping exceeds the amount generated, because of inevitable energy losses.

NGOs

Most NGOs are supporting new renewables, such as solar, wind, tidal, geothermal but not large hydro and traditional biomass considering these energy sources considerable negative environmental effects.

Renewable Energy Certificate System

The most encompassing definition of green electricity can be found with the Renewable Energy Certificate System (RECS) established primarily by European Power Companies and Certification bodies with the objective to develop standards for a European Green Certificate market. In the Basic Commitments for participants in RECS, the definition of Renewable Energy is all energy excluded that generated from fossil or nuclear fuels.

3.2 Controversial Issues in Definitions

The key issues triggering controversies on eligibility of different sources as renewables essentially originate from the understanding of two concepts: renewability and sustainability.

Hydroelectric sources

From a pure technical perspective, in accordance with the basic criterion of non- depletion of energy generation, any size of hydropower falls into the family of renewable energy sources, if silting and drought are neglectable. Therefore many countries, as well as regional and global organisations, e.g. US, Canada, EU and most EU member states as well as the UN, have identified hydropower including large hydro as a renewable energy source (Frey et al, 2002).

However, considering the problems associated with the past development of hydropower, in particular negative environmental impacts, the scale of hydropower becomes a concern.

Large-scale hydro

There is no specific general definition of large scale hydropower that is accepted worldwide. The definition is mostly made in contrast to the more commonly accepted upper limit of 10 MW for small-scale hydropower. Exceptions can be found for instance in China with 25 MW, Japan with 50 MW for small hydro (Majot, 1997).

The development of large hydro is associated with the building of large dams to construct reservoirs. Such developments can reduce the aesthetic value of the landscape and come into conflict with the protection of the cultural heritage and have various impacts on the flora and fauna in and around river systems. Rapid changes in production and therefore in discharge volume is characteristic of hydropower. Changes in discharge volume may have an impact on fish stocks and other freshwater organisms. Other negative effects that sometimes occur include e.g. loss of sources of livelihood and even displacement of population. Due account should of course be taken of such effects to make hydropower compatible with sustainable development. To what extent such disturbances would occur is largely dependent on the scale of the dam and technologies applied, as well as managerial capacity and environmental awareness. The anticipated environmental impacts are the main reason why many rivers in Nordic countries are protected against hydropower development. Applications for licences for hydropower developments in river systems in Nordic countries go through extensive procedures, including a thorough review of the environmental impact. An application may be refused on environmental ground.

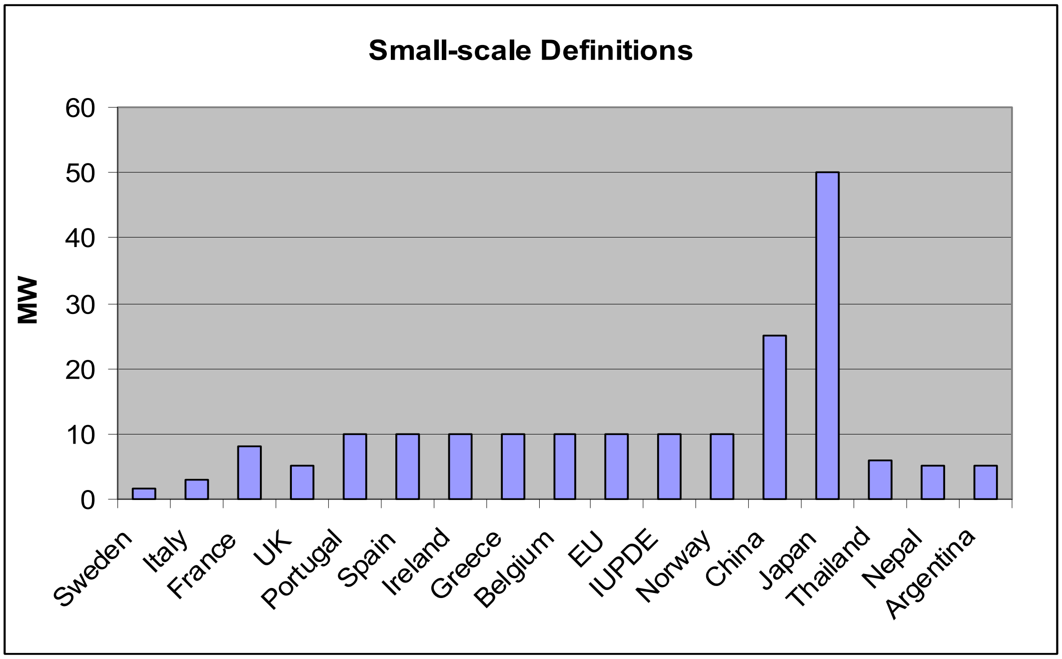
Another issue surrounding hydropower is whether a large hydro reservoir is able to generate electric power without depletion and whether the electricity generated from a large hydro can be characterised as carbon zero emission. Silting up of the dam can in some cases reduce the productivity and lifetime of a large hydro power system. Therefore, some find it difficult to claim it to be a non-depletable energy resource, since once a reservoir loses its storage capacity, the associated energy resource is depleted. Others argue that this can be predicted and avoided in the technical design of such hydropower plants.

With respect to climatic friendliness, not all large scale hydro plants with dams can produce climate neutral electricity. The so-called reservoir emission gases from vegetal decay and anaerobic bacteria might produce a significant amount of methane, one kind of greenhouse gases, if the flooded area of the reservoir used to be rich in vegetation and little cleaning-up is made before filling with water. However, the emission in question will gradually be reduced, and may thus not pose a significant problem to the climate in the long term. Moreover, for hydro power plants with a small ratio of flooded area compared to electricity generation capacity, the methane emissions tend to be extremely low.

Small-scale hydro

In the EU and around the world, there is no consensus on the definition of small hydropower. As illustrated in Figure 4, however, a limit of 10 MW currently seems to be the most widely accepted (Paish, 2002).

Figure 4: Defined scale for small hydro power[10]



Sources: Majot, 1997. Beyond Big Dams; Paish, 2002)

Within the category of small-scale hydro, based on the scales a further division can be made, as shown in Table 2.

Table 2: Classification of small-scale hydropower

Most widely used definition		*Alternative definitions*
Small	<10 MW	Japan: < 50 MW; China: < 25 MW; Thailand: < 6 MW; Nepal, Nigeria, Argentina: < 5 MW.
Mini	<1 MW	Indonesia, Spain: < 5 MW; Turkey: < 3 MW; France, Italy, Luxemburg: < 2 MW; Tunisia, Argentina: < 500 kW.
Micro	<100 kW	China, France, Italy, Luxemburg: < 500 kW; Thailand, Indonesia: < 200 kW; Tunisia: < 10 kW
Pico	<20 kW	

Source: World Atlas of Hydropower & Dams, International Journal on Hydropower and Dams, January 1995.

[10] The background for the Swedish definition of hydro less than 1,5 MW is that subsidies are needed for those plants and does not reflect that only hydro of this size is renewable.

Mini-scale hydro, in most cases referring to run-of-river[11] with no dam or storage, is often considered as one of the environmentally benign energy technologies available. However, in some countries such as Sweden, the negative impacts from small or mini hydro are as severe as the large hydro. From a cost-effectiveness perspective, the small or mini types of hydropower are less competitive compared to the big ones given the low capacity factors and a need for back-up systems (The World Bank, 2002a).

Summary remarks

All in all, it is impossible to draw a general conclusion about the eligibility of hydropower as a new renewable energy source, as each hydro power plant is site specific. Regardless of the size, some hydro power plants are environmentally highly advantageous, others less so. Large hydropower plants containing a large amount of water and with sizable drop height are able to generate much more power than small creeks, thus the associated specific environmental and social externalities do not always compare negatively for the large and positive for the small, if measured by "implication intensity", *viz* externalities per kilowatt electricity generated. In addition, such externalities should be assessed from various perspectives using integrated approaches, such as water comprehensive management and sustainable irrigation.

In order for policies to be generally applicable and operational, trade-offs must be made. An expedient way to solve this controversy is to make a clear division, which simply excludes large hydropower out of the coverage of new renewables. Another way to deal with the issue is, as seen in the discussions during the Johannesburg summit, to include only dams that are environmentally and socially acceptable, as certified by an independent authority.

Biomass use

The discussion on biomass centres on whether resources are used following a sustainable pattern and whether the use carries negative impacts on for example human health or ecological destruction. This indicates that how the biomass is produced, collected and used is the key. Based on efficiency of energy conversion, biomass use can roughly be divided into two categories, i.e. traditional use and modernised use of biomass (*See more in the footnote* 3, *on page 8*). The following paragraphs present controversial issues surrounding sustainability of biomass resource generation and discussions on traditional use versus modern use of biomass energy resources.

Sustainability of biomass resources

With regard to sustainability of biomass use, it varies from region to region depending on local conditions. Some sorts of biomass such as animal wastes or agricultural or forestry residues can be regarded as sustainable. If biomass resources are collected for example from forest or bush wood areas as "free goods", known as "non-commercial", there is often

[11] Run-of-river is a type of small-scale hydro power with no associated reservoir.

little contribution to the de-vegetation from biomass use. The case of India, shows that forest cover has increased despite the expanding firewood consumption for cooking in rural areas (Kishore et al., 2004; UNFAO, 1997). Of course, the result still depends on local conditions for example in some African countries, collection of biomass resources can cause serious local ecological damage in open-access regions.

If a large amount of biomass is used for commercial trade either at the international level among countries or at the local level from rural areas to peri-urban or urban areas for various purposes, for example industrial use of charcoals in Brazil for iron-making, the renewability of the resources may be challenged, unless the tree felled do not originate from sustainable dedicated plantations. The unsustainable use of biomass resources as such would thus lead to forest degradation or even deforestation and biodiversity loss.

With respect to dedicated energy plantations, some argue that the expansion of biomass for energy purposes would negatively affect other land uses such as food production, biodiversity, soil conservation, particularly in developing countries. Others, however, argue that energy plantations as such would produce multi-benefits beyond energy supply for local or regional residents, potentially improving living standards and well-being.

It is therefore impossible to provide a general conclusion on the sustainability of traditional use, without doing a more specific analysis of a particular biomass system.

Traditional biomass

The traditional biomass, mostly referring to energy extracted by direct combustion in conventional devices such as mud stoves, is usually characterised by low energy efficiency and is associated with air pollution especially indoor pollution which causes human health damage, such as various respiratory diseases, particularly to women, small children and elderly. Globally, as shown in Figure 1, approximately 85% of biomass energy resources are used in a traditional way, mostly in developing countries for domestic energy needs such as heating and cooking (Goldemburg, 2003). It is also important to be aware that statistics on traditional use of biomass is very limited and often inaccurate especially within developing countries, partially because no official transaction records are kept, even when the biomass is traded in a commercial manner.

Assuming there would be adequate feedstocks available for inefficient use of biomass for energy purposes in the future disregarding the fact that energy demand has been increasing along with growing world population and improved living quality, issues pertaining to global warming may be noteworthy to consider. There is evidence to show that flue gases produced by incomplete combustion of biomass, mainly a mixture of carbon monoxide, methane, total non-methane organic compounds and N_2O, have high global warming potentials (GWPs) and would contribute equivalently nearly as much as actual CO_2 emitted (Hayes and Smith, 1994). Indeed it does not give a "net" carbon emission to the atmosphere, unlike fossil fuels, due to the nature of climate neutrality of biomass. As a matter of fact, the traditional use of biomass to some extent weakens the inherent carbon "sink" effect of biomass, because it releases carbon deposited in the biomass and soil at a faster speed than it would otherwise do. This becomes particularly true when it comes to the countries or regions where forest covers are less than desirable.

Traditionally, biomass is typically used in the form of firewood, charcoal and crop residues. Animal waste is also especially important in developing countries, for example cattle dung in India, crop stalks in China and charcoal in Africa. Burning them indoors is likely to cause serious indoor pollution and consequently undermining human health. There is substantial evidence of health impacts of traditional household energy use. World Health Organisation (WHO) estimates that approximately 2.7–3.0 million premature deaths a year, accounting for 5-6% of global mortality, were caused by indoor air pollution (The World Bank, 2002b; UNDP, 2000b). In addition to the high toll on human health, traditional use of biomass has damaging social effects on for example poverty alleviation, gender equity and education.

Modern use

Modern biomass, in general terms, refers to utilisation of biomass as an energy resource in an efficient and sustainable way to generate heat and/or to produce modern energy carriers such as electricity or a variety of liquid and gaseous fuels (Gross et al., 2003).

Using biomass in a modern way has a number of significant advantages over traditional use such as improved indoor air quality, increased productivity, enlarged application ranges for example bio-liquid transport fuels, sustainable use of the resources for example by dedicated plantation of biomass. Hence, modernising utilisation of biomass provides all countries, but developing ones in particular, with significant opportunities to meet the increasing energy demand together with additional social benefits, whilst contributing to GHGs emission reduction in a global context.

Furthermore, modern biomass covers a larger range of feedstock compared to traditional biomass, including not only agricultural and forests residues, but also solid waste and energy crops---mainly referring to fast-growing species for example salix, poplar, sycamore, and silver maple, but also food crops (Cassedy, 2000). Although bioenergy generation from dedicated energy plantations is still within a small scale and experiences are limited in comparison with residue/waste-based modern biomass applications, it will have to play an important role in the scale-up of energy production from biomass.

Concern of efficient land use may arise, subject to the fertility, climate, water resource, and management skills of the plantation of energy crops in different places. More importantly, the effectiveness of such plantations should be assessed against the net production of dry biomass substance that may substitute fossil fuels at reasonable costs. Therefore such plantations are often associated with modern biomass technologies such as combined heat and power (CHP) generation, efficient heating appliances using pellets or briquettes or powder to gain higher energy efficiency. This pattern may lead to a benign circle toward sustainable energy.

From a health perspective, it is obvious that indoor air pollution caused by incomplete combustion of biomass can be substantially reduced using cleaner energy carriers such as biomass-derived producer gas, biogas, electricity and pipelined heat distributed from energy generation plants.

In addition, there is a growing potential to replace at least partially fossil transport fuels with bio-liquids extracted from biomass by a number of thermo-chemical and biological conversion technologies. Bio-ethanol seems to be one of the most promising alternatives in view of the fact that it has been produced from fermentable sugar-based crops with commercialised conversion technology and used as bio-fuel in Brazil and US (UNDP, 2000b).

Summary remarks

It is undeniable that both traditional biomass and modern biomass are renewable energy resources based on the inherent nature of renewability. The dividing line between renewable and new renewable in this regard can be drawn upon the assessment on sustainability of the accessible natural resources, utilisation and associated environmental and social issues.

Chapter 4: Possible implication on greenhouse gas emissions

Most scientists have reached consensus on the fact that there exists a correlation between the observed emission of GHGs and global warming and that excessive consumption of fossil fuels has made significant contribution to the increased concentration of GHGs in the atmosphere. As projected by IEA in the World Energy Outlook 2002, the world emission of CO_2, one of the key GHGs, will by 2030 increase by 70% above current levels, with an estimate of two-thirds of such increase coming from developing countries. The large potential of renewable energy in mitigating the trend of global warming has been widely recognised, albeit the share in the current world energy mix is still small.

4.1 Global renewable energy adoption

Using the broader definition of renewable energy sources, which includes large hydro and traditional biomass, renewable energy accounts for 13.8% of the world TPES in 2000. Out of this 73% comes from developing countries, where traditional use of biomass is one of the major energy sources. In developed countries, by contrast, new renewable energy sources and large hydropower play a dominant role. 50% of the global total electricity generated from hydro power and 70% from new renewables come from OECD countries. (IEA, 2002a)

Although the penetration of some new renewables into the global energy mix has accelerated, for example, an annual growth rate for wind power of 30% and for PVs of 20-31% (IEA, 2003b), the share of new renewables such as solar, modern biomass, geothermal and wind power contributes only a small proportion of energy needs at present, accounting for around 2.2% of the world TPES as illustrated in Figure 1.

Selected Renewable Energy Sources

<u>BIOMASS</u>

Biomass is considered a renewable energy source due to its attributes of self-regeneration, provided that exploitation of biomass resources is carefully managed, and as a sustainable energy source due to its climate-neutral nature if the "leakage"[12] issue can be neglectable (IEA, 1998a; IEA, 1998b).

Despite the fact that the global geographical distribution of biomass is relatively even, the use of biomass as energy resource varies significantly from country to country. This is because a wide variety of feedstock and conversion technologies are being used. Also, the urgency of energy needs to be met by biomass varies to a large extent.

---

[12] "Leakage" here refers to the unavoidable use of fossil fuels in the process of utilizing biomass energy (IEA Bioenergy, 1998b).

Current biomass use for energy is estimated to be around 11% of the world TPES. Most of this is covering energy needs in developing countries, where biomass accounts for on average one third of the total energy consumption (IEA, 2000, and UNDP, 2000). It is worth noting that there is great difference in using biomass among developing countries. For example, in China and India, biomass accounts for 19% and 42% of the TPES respectively. This can be compared to the situation in many of the least developed countries where the share can reach up to 90% (UNDP, 2000). However, most of the biomass is used in traditional or non-commercial ways and this use is difficult to account for accurately or goes unreported. For instance, biomass data for China and India are not included in the World Energy Council statistics.

Although traditional use not universally causes serious environmental and health problems, modern biomass used mostly in industrialised countries minimise negative environmental impacts and reduce health risks through modern and efficient technologies such as advanced combustion technologies and gasification[13]. The consumption of modern biomass is however limited, providing only 1.8% of the total energy supply in OECD countries (IEA, 2002a).

From a long-term perspective, biomass resources can be a good alternative to fossil fuels as they are abundant in most parts of the world and various commercially available conversion technologies by which transformation of current traditional use of biomass to modern energy could occur. An increased conversion efficiency could contribute to: 1) mitigate the conflict of land use for food production and for energy crops, and to maintain a sustainable use of natural resources; 2) substantially reduce the negative impacts on environment and human health. To achieve such a transformation, a number of barriers must be removed (further discussed in Section 5.2).

HYDROPOWER

Over nearly the whole past century, especially the first half before oil took over as the dominant force in energy provision, hydropower was developed at a rapid pace in a number of regions such as North America and Europe. The continuous development of hydropower has led to a significant share of the world electricity production from hydropower. In 2000, nearly one fifth of the electricity was generated from various hydro power stations across the world. Hydropower, particularly large hydro (> 10 MW) is thus the largest renewable resource used for electricity generation (IEA, 2002b).

The hydropower production and potential is unevenly distributed as it depends to a great extent on geographic location and climatic conditions particularly net annual rain water

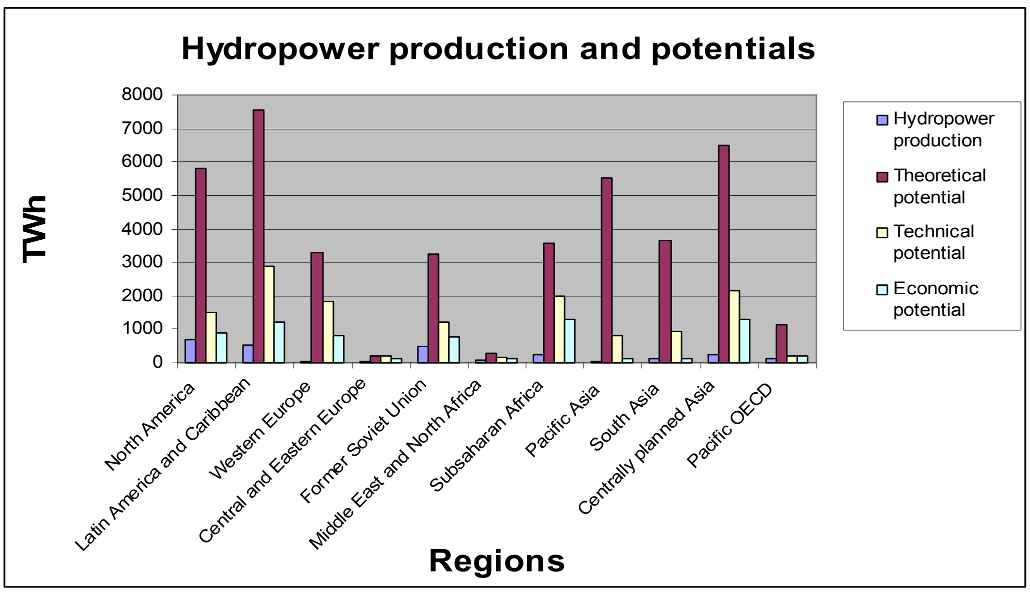
[13] The positive features of gasification (except for pressurised BIGCC) as indicated here apply **only** to woody biomass. The gasification of non-woody biomass such as traditional agricultural residues is beset with the technical problems caused by the resulting tar and ash, which are difficult to deal with satisfactorily and blocking the channel to successful commercialisation of biomass gasification technologies (Aznar et al., 2001; Corella et al, 2001; Simell and Kurkela, 1997)

runoff. In the following Figure 5, the current production, theoretical, technical and economic potentials for future development are presented with different regions.

In addition, according to the world's dam builders estimates, there is about 12,000 TWh/y world hydropower potential that is technically feasible for future development, among which 8,800 TWh/y is economically feasible (i.e. competitive with other power sources) (Pirche, 1993). Asia (including the Russian Federation) and Latin America hold approximately 73% of the potential, Europe only 10% and North America 8% as a large portion of the technical potential in these regions has already been exploited (International Journal on Hydropower and Dams, 1995).

The economic and technical potential of hydropower in the world is enormous. However, environmental concerns may slow down the growth. This could help to explain the considerably slower pace of dam constructions in the past 40 years compared to the previous 40 years during which 85% of the world's dams were built. Even so, the global hydroelectricity increased by more than 20% in the 1980s, with a 50% increase occurring in Asia and more than a doubling in parts of Latin America and China (US Dept. of Energy/IEA, 1992).

Figure 5:



Sources: World Atlas and Industry Guide, 1998, and UNDP, 2000[14]

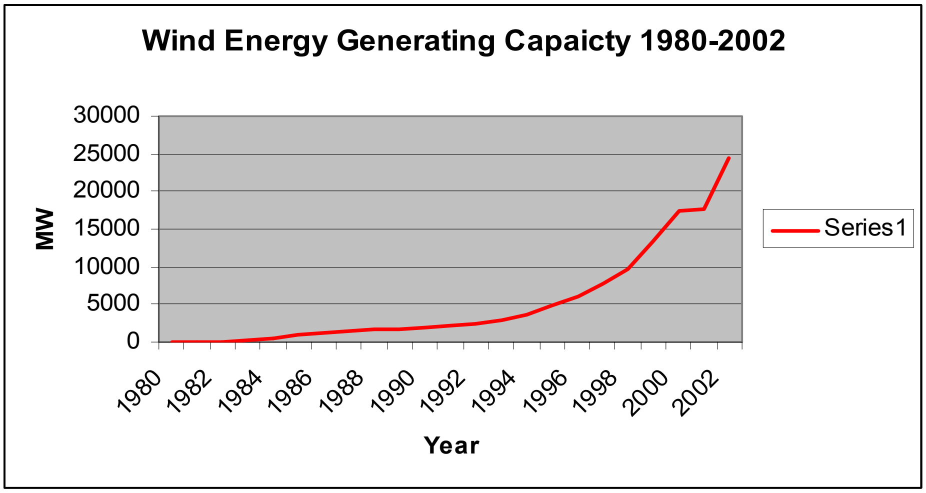
WINDPOWER

In the past decades, especially after operation of the first modern grid-connected wind electricity generator around 1980 and with the increasing governmental incentives provided to

[14] *Several countries in Pacific Asia do not publish their hydro power economic potential. As a result the reported economic potential for the regions are too low-and in South Asia the economic potential is even lower than the electricity generated. (cited from UNDP, 2000: World Energy Assessment, 2000. p. 154.)*

stimulate the development of windpower, tremendous progress has been made worldwide, as shown in Figure 6.

Figure 6:



Sources: World Watch, and UNDP, AWEA

Despite the fact that wind energy is growing at a fast pace, averaging 30% per year since 1990, wind power currently makes little contribution to the primary energy supply, accounting for only 0.026% of the world total (IEA, 2002a) (UNDP, 2000, p230-235).

Similar to hydropower, capacity and potential for wind power to generate electricity vary much between regions and with topographic conditions, as shown in Table 3. Europe is playing a leading role in this sector. The cumulative capacity installed in EU has nearly tripled from 1998 to 2002, representing over 70% of the total world wind power capacity. One third of the world's capacity, equivalent to half of the European capacity is installed in Germany. One-third is installed in the rest of Europe and the remaining is distributed in the rest of the world.

Table 3:

Worldwide Wind Capacity (MW), 1997-2001				
Regions/Countries	Cumulative Capacity 1997	Cumulative Capacity 1998	Cumulative Capacity 2000 data	Cumulative Capacity 2001
Canada	26	83	140	207
US	1,611	2,141	2,555	4,245
South & Central America	44	68	103	125
Total Americas	**1,681**	**2,292**	**2,798**	**4,577**

Denmark	1,116	1,420	2,297	2,417
Finland	12	18	38	39
Sweden	122	176	231	280
Germany	2,081	2,874	6,113	8,753
Spain	512	880	2,402	3,335
Italy	103	197	389	697
UK	328	338	409	485
Netherlands	329	379	448	483
France	13	21	79	85
Greece	29	55	189	272
Ireland	53	64	118	125
Portugal	39	51	100	127
Other Europe	57	80	159	263
Total Europe	**4,793**	**6,553**	**12,972**	**17,361**
China	146	200	340	399
India	940	992	1,220	1,507
Japan	17	31	150	300
Total Asia[15] (approximately)	**1,103**	**1,223**	**1,710**	**2,206**
Total other continents/areas	**57**	**83**	**212**	**313**
World Total	**7,633**	**10,151**	**17,692**	**24,457**

Sources: UNDP, 2000 and Windpower Monthly

Currently, wind energy is generally developed in the industrialised countries for a number of reasons including growing environmental concerns and relatively high price of electricity generated. However, wind energy is also attractive in some developing countries as a cost-effective solution to rural electrification, due to its quick installation in remote rural areas where electricity is urgently needed, but neither grid nor fossil fuel is available. Owing to increasing scale of installation and steadily growing size and output of turbines, the

[15] Some Asian countries such as South Korea,, Sri Lanka and Taiwan, with a total capacity of 14 MW in 2002, are not included due to the inconsistent available data.

installation cost is continuously declining. Should the current growth rate continue, the installed capacity could reach up to 150 GW by 2010 (WEC, 2001a).

It is worth noting that installed capacity of wind power may not all turn into production of electricity at a full range, depending on a number of variables, such as varying wind resource, maintenance, management and scale of demand for specific area and time.

4.2 A brief analysis on CO_2 emission reduction: based on the proposal of Coalition for Renewable Energy

The implication of renewable targets is greatly dependent upon coverage of the defined renewable energy sources within the targets. The reduction of CO_2 emission depends on what type of fossil fuels is replaced by the renewables to provide the same amount of energy.

Taking the year 2000 as a baseline for renewable share in the energy mix and the same annual growth rate of TPES as the average value over the past 30 years (2.1% according to the IEA data), the following formula can be constructed. The current renewable energy ratio in the energy mix (R) in the below formula varies with the different definitions. The scope of covered renewable sources for R (baseline value) and the renewable target to be achieved by 2010 (Y) should be identical. Whether the targets can be realised depends on the achievability of the growth rate of renewable energy sources in question (X). CO2 emission reduction is functional to the replacement of different fossil fuels by the energy provided by achieved renewable sources.

$$Y= [TPES_{2000} * R *(1+X)^{10}] / [TPES_{2000} * (1+2.1\%)^{10}]$$

In this formula,

Y stands for the renewable target that will be achieved in 2010.

R is the current renewable energy ratio in the energy mix

$TPES_{2000}$ is the total primary energy supply in 2000 for the region in question;

X is the growth rate of renewable energy sources in question;

At the global level

Currently, the renewable share is 13.8% according to IEA data and in line with the EU's definition for renewable energy sources including large hydro and traditional biomass. The renewable definitions of IEA and the EU are compatible virtually, both including large hydro and traditional biomass and excluding non-biodegradable fraction of wastes.

Applying the aforementioned formula for calculation, R is 13.8%. The annual growth is about 3%, which is not that ambitious in the context of the world's rapid growing population.

At the EU level

Taking the 15% target as granted and the current 6% of Renewable Energy Sources (RES) in EU, it concludes that annual growth rate of RES would have to reach as high as 12%, compared to average 2% increase in the past 30 years (IEA, 2002b).

Chapter 5: Nordic Role in the Promotion of Renewable Energy in Developing Countries

For developed countries, renewable energy sources primarily serve as a means to diversify the national energy supply and a means by which the concept of sustainable development can be implemented and GHG emissions can be reduced. However, for developing countries, renewables play a very different role and is used in different ways. There is an apparent disparity of background motives and a resulting performance gap between the South and the North in terms of applying renewable energies. Therefore, it has become important to fill this gap with experiences gained in the developed world, suitable for developing countries.

In order to facilitate the gap-filling process, technology transfer and policy making must play key roles. Without policy support, renewable energy technologies will survive neither in developed countries, nor be transferred to developing countries. One way to bring down the cost of renewable energy technologies is to expand the potential users in developing countries, creating a benign circle.

5.1 Potential for adoption of renewable energy in developing countries

Energy is central to economic development. As reported in the World Energy Outlook 2002 published by IEA, there are around 1.6 billion people in the world mostly in isolated rural areas, who have no access to modern commercial energy of any sort; more than 2 billion people use fuel for cooking and heating from indigenous biomass such as fuelwood, dung and agricultural residues.

Furthermore, on account of economic development and rapid population growth, primary energy demand in developing countries has been increasing as fast as up to approximately 4% per year, twice the world average growth rate. (Johansson, Goldemberg, 2002). This may make true the forecast in the IEA's World Energy Outlook that there would still be 1.4 billion people lacking access to electricity and 2.3 billion people who still heavily rely on traditional biomass by 2030, if no effective policies are made.

As for other renewable energy sources, such as wind, solar energy and geothermal, the technical potentials do exist in developing countries. For example, a huge technical potential of wind power in some developing countries, such as Egypt and several other African countries and some Asian countries, has started to be explored. However, some argue that such new renewables seen as environmentally benign energy sources without external costs may be too costly at the current stage and that it would be unfair for developing countries to pay for expensive clean fuels. On the contrary, choosing renewable energy sources, such as PV application in Zambia and Morocco's rural electrification (see Box 1), are often the most cost-effective options for rural electrification compared to grid extension over a long distance. Production and operational costs for such renewable technologies have been falling steadily over the recent years along with increased experience or learning curve effects and increasing market shares. This trend is likely to continue as the scale-up of manufacturing and deployment is increasing. Other social and economic benefits of using off-grid renewable energy options, such as increased local employment, improved education status and health care situation, can be gained.

> **Box 1 Morocco: Rural Electrification Programme**
>
> With the aim of increasing the rural electrification ratio from 18% in 1995 up to 80% by 2006, Morocco has launched a national rural electrification program (PERG). The electricity utility ONE has conducted an assessment for the areas technically suitable for grid extension based on economic criteria. The assessment results have shown that the optimal option of electrification for some villages is to use off-grid solutions. It has been proven in these rural areas that it is more cost-effective to install solar home systems than connect to the extended grid. (Final Report on G8 Renewable Energy Task Force, 2001) (Jamrani, 2000)

Renewables hold great potential to provide energy services for households, communities and local small size industries, especially in remote rural areas where transmission and distribution of energy generated from fossil fuels can be difficult and expensive. Nevertheless, it must be realised that the way towards renewable energy promotion in developing countries is still very long and a number of key barriers must be removed with the efforts from national regimes and assistance from the international community.

Biomass

Although other forms of energy carriers are gradually being introduced into rural areas of developing countries, for example being electrified by either grid extension or off-grid systems such as stand-alone PV panels, biomass as an energy resource can hardly be replaced due to the following factors::

- Electricity expansion is at a slow pace at present;
- Electric appliances in rural areas of developing countries are not widely available, which in turn retard the development of rural electrification provided little interference from government is involved;
- Inferior quality of electricity limits the possibility of using electricity, particularly for industrial purpose;
- Affordability of modern energy services such as electricity;
- Load constraint with a large variation between peak load and average load.
- Rural industry relies on biomass for key productive activities such as fish-smoking, brick-making, charcoal making, tobacco curing, food processing and ceramics making;
- Broader, easier and cheaper accessibility to biomass resources.

Biomass will continue its important role in the energy mix in many developing countries for another 30 year period. In the WEC reference scenario[16], residential biomass demand in developing countries is projected to be 788 Mtoe in 2030, about 9% increase based on the 2000 level. As shown in the following table 4, in China, Indonesia and Latin America the share of the population relying on biomass for cooking and heating is projected to decline, partially because of the great progress in rural electrification and other modern forms of energy such as coal and kerosene.

Due to factors like the increase of population in South Asia and Sub-Saharan Africa where basic energy needs will still be met by using traditional biomass, there would however be an increase of 238 million people or 9% by 2030 compared to 2.4 billion people in 2000 who will continue the traditional use of biomass that has not only various negative impacts on environment, social development but also causes many health problems for local inhabitants (IEA, 2002c).

Table 4: Number of people relying on biomass for cooking and heating in developing countries (million)

Regions	2000	2030*	2000-2030 (%)
China	706	645	-9
Indonesia	155	124	-25
Rest of East Asia	137	145	6
India	585	632	7
Rest of South Asia	128	187	32
Latin America	96	72	-33
Africa	583	823	27
Developing countries	2,390	2,628	9

Assuming that biomass use per capita is constant, at some 0.3 toe per capita, over the projection period. This figure is an average across all regions and countries. Analysis indicates that average per capita biomass use varies between some 0.24 toe in South Asia to nearly 0.4 toe in many countries in East Asia. See Tata Energy Research Institute et al. (1999) for a similar approach.

Source: IEA, World Energy Outlook, 2002.

The key to this issue is to find ways to modernise the use of biomass in developing countries. This would lead to increased energy efficiency, improvement of associated air pollution problems and facilitation of the sustainable use of the resources, as well as the enhancement of the competitive advantage in the marketplace. For example a study carried

[16] See more in the World Energy Outlook 2002.

out by Asian Regional Research Programme (ARRPEEC) shows that within selected countries[17] there is a large amount of biomass resources that can be saved through improved energy end-user technology, about 152 Mtoe of fuelwood and 110 Mtoe of agricultural residues that can be used additionally (ARRPEEC).

However, modernisation of biomass use is not a universal solution if nothing else is done. For example, the ownership of the biomass resources plays an important role in sustainability of the resource use, as the owners of the resources, such as forests, have incentives to sustain the forest resources. Therefore the question becomes what potential there is in developing countries to convert traditional biomass to modern biomass.

Box 2: Ethanol fuel for Brazilian transport sector

Brazil has become a world leader in ethanol-conversion technology, developed over nearly three decades. Brazil started to produce ethanol fuel derived from sugarcane as a way to reduce oil dependency and support Brazilian sugar farmers. A package of favorable policies were made to stimulate the emerging industry: 1) low interest loans; 2) guaranteed purchases at a reasonable price; 3) subsidizing pure ethanol for enhancing its market competitiveness; 4) sales tax incentives for ethanol vehicles during the 1980s. Furthermore, local R&D and technology dissemination facilitated to a large extent the production of ethanol fuels by providing improved technologies (Carvalho 1998). When a solid foundation was laid for further development of ethanol production, subsidies were reduced and eventually taken away resulting in cost cutting and productivity improvement. As of 1998, ethanol fueled one third of vehicles in Brazil.

In addition to ethanol production for transportation fuel, a number of new uses of sugarcane and ethanol residues such as electricity generation and chemical production could further expand modern bioenergy use in Brazil (Moreira 2000).

The key success factors can be summarized as following:

- Strong natural resource and industry base-sugar production;
- Government multi-faceted supports at different stages and private sector involvement;
- R&D leading to on-going technological improvement.

The gains are not limited to environmental impacts in terms of CO_2 reduction and improved urban air quality, social implications such as job creation and improved public health are also significant. (Geller, 2003a)

However, the situation changed significantly when the supports such as subsidies on bio-ethanol were phasing out as initially planned. The development has nearly stagnated. In addition, users were starting to concern about the total dependency on such potentially expensive transport fuels if and when subsidies were substantially reduced.

[17] Includes India, Nepal, Pakistan, Sri Lanka , China, Philippines.

5.2 Barriers to adoption of renewable energy in developing countries[18]

Barriers to adoption of renewable energies exist in both developed countries and developing countries. The multi-dimensional disparities among regions and countries make the analysis of barriers complex. Because of national differences, it is not possible to generalise various barriers. Some barriers are stronger in some countries, while weaker in others. In order to identify potential measures to remove barriers, it is therefore crucial to assess the weight of barriers in different countries. To gain an in-depth insight on barriers and their causes requires a broad and deep study on a country basis, which is beyond the scope for this study.

However, in order to give a schematic view of barriers to modern use of renewable energy sources in different types of developing countries, a preliminary assessment of barriers is made in the below table 5. A classification of developing countries is made in line with economic and technical development status, as follows (Bhagavan, 2003).

- **Type I**: Technologically advanced developing countries, with a well diversified and fairly comprehensive industrial, energy and R&D infrastructures such as Brazil, China, India, Malaysia, Mexico and South Africa;
- **Type II**: Technologically advancing developing countries, which are industrialising fairly fast, but are still quite limited in the diversification of their industrial, energy and R&D infrastructure, such as Chile and Thailand;
- **Type III**: Slowly industrialising developing countries, with still very limited infrastructure in industry, energy and R&D, such as Costa Rica, Egypt, Indonesia, Iran, Philippines and Vietnam;
- **Type IV**: Technologically least developed countries:
  - All of sub-Saharan Africa (excluding of course South Africa), such as Ethiopia, Tanzania, Zambia, Mozambique, Ghana, Ivory Coast, Senegal;
  - All of Central America and the Caribbean (excluding Costa Rica), such as Nicaragua, Honduras, El Salvador, Jamaica, Guyana;
  - Some of the Andean Countries of South America, such as Bolivia, Peru and Ecuador.
  - Southeast and South Asian countries, such as Cambodia, Laos, Bangladesh, Nepal;
  - All the Central Asian countries of the Former Soviet Union, such as Kazakhstan, Uzbekistan, Azerbaijan, etc.;
  - The Pacific Region, such as Fiji, Tonga and Vanuatu.

[18] This section is based primarily on an input by my colleague Dr M. R. Bhagavan.

Table 5: Schematic barriers assessment on a classified country basis

	Institutional barrier	Technical barrier	Economic barrier	Financial barrier	Information barrier	Capacity barrier
Type I	**	*	**	**	*	*
Type II	**	**	**	**	**	**
Type III	***	**	***	***	***	**
Type IV	***	***	***	***	***	***

**** : High;*
*** : Medium;*
** : Low.*

Due to the time constraint for this study, only generic barriers applicable to developing countries in general are touched upon here, rather than specific barrier analysis. Some barriers to adoption of renewable energy in developing countries are indicative of general lack of development, others more related to the lack of policies and development strategies and targets.

Policy, Institutional and Legal Barriers

The implementation of renewable energy systems is affected by policy and regulations related to for example rural development, rural electrification, planning and environmental protection. In many developing countries the institutional setting is weak. There is a general lack of planning capacity, resulting in the absence of energy plans and land use plans. This adds a considerable element of insecurity to renewable energy developers, who will have to make decisions on investments without knowing for example how the grid electrification of new areas will proceed.

In addition, developing countries often lack clear strategies and targets for renewable energy development and without such a signal of government commitment, investors may be unwilling to help develop a market for renewable energy. Developers of renewable energy programs also not seldom face long and complicated approval processes, as responsibility for renewable energy development often is divided between several different government agencies and the bureaucracy not uncommonly excessive.

Many developing countries are characterized by a weak legal system, with problems ranging from lack of appropriate legislation, little respect for the judicial system to weak legal enforcement. Investors may be discouraged by difficulties in upholding and enforcing contracts. When it comes to renewable energy, other important legal barriers can be uncertainties about taxation or the electricity tariff setting.

Financial Barriers

A key constraint to adoption of renewable energy technologies in developing countries is the lack of access to capital. Developers of renewable energy systems often face difficulties in getting access to long-term credits with low-rate interest, which may pose a major impediment for renewable energies to market penetration, even in developed countries. Among the various causes that contribute to the formation of this barrier the key ones are:

- In most cases, renewable energy projects are capital intensive as investment per unit of energy is usually higher than conventional energy sources;
- For almost all types of new renewable energy investment (excluding large hydro power), the scale of production and investment is so small, compared to conventional energies, that it is difficult to attract traditional lenders' interest;
- There are high risks, difficult to be accurately assessed, associated with technological immaturity and unpredictable government energy policies;
- Financial institutions in developing countries lack understanding of the renewable energy projects and their potential benefits.

For the end users, especially the poor in developing countries, it can be excessively difficult to find financing for a renewable energy system. Typically, renewable energy technologies often carry high installation costs but low running costs, which causes a problem in rural areas where access to micro-financing is not available, household savings small and the income irregular. Renewable energy options are therefore difficult to market if no innovative financial schemes, such as revolving funds are created, even though the rural dwellers are keen to and willing to pay for modern energy that can be provided by such PV, wind mills or pico, mini-micro and small hydro power.

Economic Barriers

The economics of renewable energy technologies is often perceived as poor. This is often due to traditional pricing structures, which do not internalise social and environmental costs and other externalities of energy provision and use. Externalised costs of conventional energy sources that have to be borne by the society accordingly distort the energy market.

In addition, subsidies ranging from direct subsidies of for example coal and kerosene prices to investments in costly grid extensions, make it difficult for renewables to compete. For example, as electricity prices often do not reflect the full cost of electricity grid extension in rural areas of developing countries, there is lack of incentives to take renewable technology options such as PV systems[19] into consideration even though it may be more cost effective to use off-grid renewable energy sources compared to grid extension in some rural areas, if the calculation is made based on actual costs.

Technical Barriers

Within the category of technical barriers, different renewable energy technologies present distinct barriers related to technical issues. Technology-based barrier analysis could be

[19] PV system, compared to grid extension, holds the advantages of 1) lower initial investment; 2) little transmission loss; 3) less externality.

more specific in this regard, but is excluded in this study due to the complexity of technicalities. An attempt to present technical barriers with regards to possibilities to transfer modern renewable energy technologies to developing countries is made below.

One of the fundamental barriers in transferring technology to developing countries is that the technology being transferred is not appropriate to the local context and demands, or is not adapted to the local environment. For example, renewable energy technologies from developed countries may not be well adapted to different types of biomass or other more harsh wind conditions perhaps including sandstorms. Barriers for technical success of a project are often lack of capacity to operate and maintain equipment properly and lack of spare parts. The surrounding infrastructure also affects the potential of a project to succeed technically, as does the access to required renewable energy sources.

Some renewable technologies lack standardization and quality control. For example, the development of the PV market in Africa has been hampered by poor quality of products. Systems can be improperly assembled or installed causing reduced performance. Poor installation, maintenance and repair capability for rural PV systems has been noted as a serious problem in Kenya, Zimbabwe and South Africa.

Information Barriers

In developing countries, there is often a lack of information on the potential renewable energy sources available, as well as on the energy needs of communities and industries. The low awareness among consumers of potential services that can be met with renewable energy technologies, makes it difficult for them to present demands. Marketing is difficult, as it may have to be done in a time-consuming face-to-face communication, for lack of access to TV and other media.

There is also a lack of information among potential renewable system installers about constraints of different technologies, which leads to in many cases the wrong choice of technology for the service need and local condition. There is often no industrial association or other co-ordinating body that can help to develop networks of actors in the renewable energy sector. Lack of information about manufacturers, dealers and suppliers hinders the establishment of fruitful partnership and thereby the market development.

Consumers may lack credible information on performance, reliability or economic merit of the renewable energy technology. Obtaining this information can cost both time and money.

Capacity Barriers

The limited availability of skilled professionals in all areas, from government policy making and planning to technical service of installations, acts as a barrier to the development of renewable energy in developing countries. Many potential installers and developers are not familiar enough with the different technologies, which may lead to inappropriate technology choices. The lack of technically trained staff that can carry out installations, operation and maintenance can be a main barrier to successful deployment of a technology.

5.3 Experiences of Nordic countries

Many modern renewable energy technologies[20] have been developed and applied in Nordic countries, resulting in a fairly large share of renewables in the TPES of almost every country, as shown in Table 6. This could be explained not only by abundant natural resource endowments, but also by successful promotion strategies with a sound combination of regulatory measures and financial and economic incentives adopted.

In this section, selected Nordic countries with successful experiences or lessons learned are presented.

Table 6.: Renewable share in Nordic Countries

	Renewables* (Mtoe)	**Renewables/TPES (%)**	Major technologies
Demark	1.97	10.1%	**Biomass and Wind**
Sweden	15.06	31.7%	**Hydro and biomass**
Norway	13.53	52.8%	**Hydro**
Finland	7.8	23.5%	**Hydro and biomass**
Iceland	2.49	72.6%	**Hydro and geothermal**

* Renewables do not include industrial waste, non-renewable municipal solid waste and pumped storage production

Source: IEA, Renewables Information 2002 (IEA, 2002d).

Biomass Energy--- Sweden

Sweden is a world leader in bioenergy technology development and application. Although the share of biomass contribution to the Swedish total energy supply, accounting for 15% of TPES (STEM, 2001), is not so significant compared with some African countries, what is significant in Sweden is the sustainable way of using biomass. This is reflected by:

- Approximately 90% of the biomass is used in a modern way, including the use of Combined Heat and Power (CHP) where the heat production dominates (STEM, 2001);
- Biomass resource use is managed in a sustainable pattern for example the annual growth of forest biomass exceeds the annual harvest (National Forest Statistics, 1997-2001). In addition, other forms of biomass such as agricultural residues and energy crops for example salix and imported biomass resources are becoming more important for energy production.

[20] Modern renewable energy technology refers to the latest advanced technologies such as the biomass-driven BIGCC, wind power generated with modern turbines, solar PV, etc..

Driven by expanding markets, as well as national and EU supporting policies, improved biomass technologies in Sweden has not only led to a progressive increase of energy conversion efficiency, but also a expansion in domestic and regional markets.

In the trajectory of bioenergy development in Sweden, three important stages should be highlighted as experiences gained:

- Establishment and maintenance of a sustainable biomass resource base achieved by the following approaches: 1) good resource planning based on careful estimates on availability of wood fuel for energy production and traditional forest industry; 2) exploration of possibilities to produce energy crops, as either an alternative or supplementary source to the conventional energy resources; 3) use of waste and international trade opening up a new way to feed the biomass energy generators.
- Demonstration of new technologies and systems: this is a key step to: 1) prove operationality of a technology or system; 2) gain competence and experiences for further improvement; 3) create an opportunity for different actors to actually cooperate with each other including with research institutions.
- Formation of markets: efforts to disseminate the technology resulting in a decrease in production costs and a gain in market competitiveness.

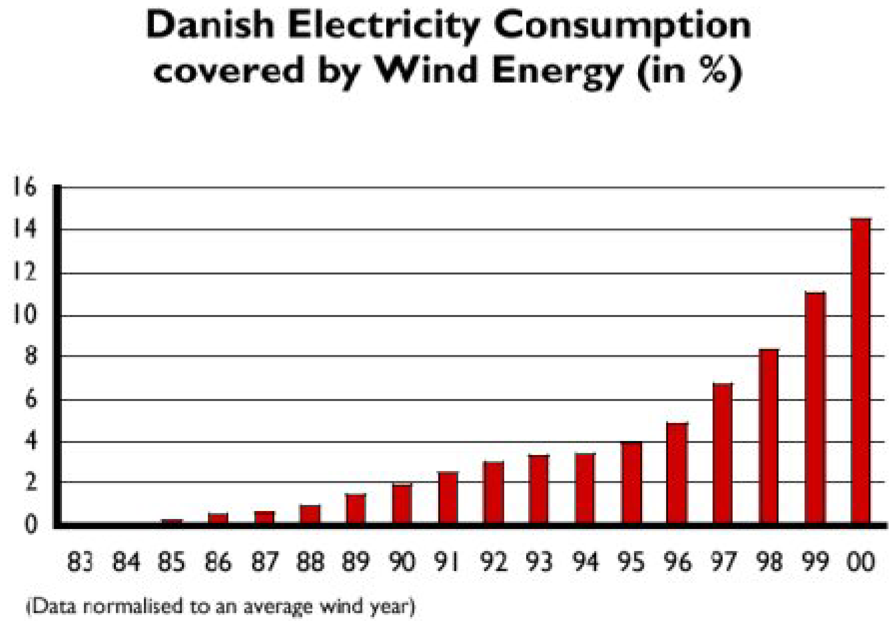
Wind Power - Denmark

Although biomass has the largest share in the Danish renewable energy mix, the spotlight is often on wind energy due partially to the rapid development in recent years.

Demark's installed wind power capacity reached 2,525 MW by 2002, accounting for 9% of the world total accumulative installed capacity and covering nearly 18% of Danish electricity consumption (EWEA, 2002). Although Demark is not the largest user of wind power, it is the biggest wind turbine producer in the world possessing half of the world market share.

The success in Danish wind power development is attributable to a number of political actions and financial support schemes (feed-in tariffs). Among them, a consistent energy policy during the past 15 years in favour of wind energy may be the most significant. Moreover, the Electricity Reform Agreement required 20% of electricity to be generated from renewable energy sources before the end of 2003, and wind power is expected to make a major contribution to achieving this target. The long-term targets with 23% of electricity production from wind resource by 2010 and 60% by 2030 have been set in Energy 21, a guiding energy policy in Denmark. Associated with various promotional schemes, this has given the confidence for different actors involved to invest in this sector resulting in increased market penetration at a fairly fast pace as illustrated in the Figure 7.

Figure 7.



Source: The Danish Wind Turbine Manufacturers Association.

The wind energy case in Denmark has presented an example that alternative energy sources can be commercially viable under the consistent support from government. Electricity produced from wind energy is currently not only environmentally friendly but also in some cases competitive compared with conventionally generated electricity. (Wind Energy, 2002; IISD, 2002).

Hydro Power and Other Renewables - Norway

Norway has been heavily reliant on hydro electricity more than one century mainly due to the abundant hydro resource and legislative and institutional systems in favour of development of hydropower. Norway has become the largest hydropower producer in Europe and the sixth largest in the world, in parallel to an expert country in statutory regulation and management of hydro resources.

Norway's hydro power supplied 99% of the total electricity consumption throughout 1990s. By 1999, it was estimated that only about 63% of the economic potential of 180 TWh had been exploited. The cost for further development of hydro electricity is still lower than thermal power (WEC, 2001b). On account of the abundant and cheap hydro energy, electricity consumption per capita in Norway keeps the world record, twice that of the US.

A typical inherent feature of hydropower in Norway is seasonal variation of water flows, dry period in winter when huge demand of electricity is needed for heating. In addition, the 1996 severe drought in Norway has shown how vulnerable an energy system without balanced sources could be. A number of policy schemes such as tax exemption and subsidies, thereafter, played an important role in encouraging investments in non-hydro renewable energy, such as wind, biomass, geothermal, solar energy and heat pumps. In addition to an exemption from the investment tax, 25% direct state subsidy for waste-to-energy, the tax on final waste disposal is exempted; and for wind power, the tax on electricity is halved. Despite the fact that combustible renewables for heating has a more promising future due to relatively high oil prices in Norway, a large number of uncertainties caused by various reasons in this sector held back the pace of development of non-hydro renewables in the 1990s (OCED, 2001).

Biomass CHP - Finland

Combined heat and electricity production (CHP) based on local fuels accounts for the bulk of bioenergy production in Finland. Due to utilization of CHP electricity produced from biomass represents over 10 % of total electricity consumption, a record figure in the world. A technology closely linked with large-scale cogeneration is fluidized bed combustion (FBC). FBC boiler technology has been scaled down for application in small-scale biomass fired CHP plants (<5-10 MWe) as well. Grate firing of biomass has traditionally been used for small heating applications (under 5 MWth). Small-scale CHP offers an environmentally sound way to produce energy for local use from locally available fuels.

Finland has a long tradition of using biomass CHP technologies. The first industrial cogeneration plants were built at the turn of the 1920s and 1930s, followed by the first district heating plants in the 1950s.

In larger plants, FBC technology developed in Finland in the 1970s for the combustion of biomass and other low-grade fuels, has become the dominant technology. At the same time fuel-handling technologies have been developed and a lot of effort has been focused on utilizing wood residues from the forest industry. In recent years, the use of forest residues has been increasing. Integrating the fuel and raw material supply chains has reduced cost of fuel procurement.

In Finland, great emphasis has been given to wood-based fuels in the development of energy technology.

As a result of R&D activities, the production cost of fuels from forest residues has been reduced considerably, resulting in a rapid increase in the use of forest chips in recent years.

In addition to machine development, the focus has been on reducing harvesting and transportation costs by improving logistics and applying modern information technology solutions within the supply chain.

Also, increased know-how in combustion technologies has enabled efficient and environmentally acceptable utilization of low-grade fuels. The development of fluidized bed combustion technology during the last 20 years provides a good example.

Finland is a trendsetter in combined heat and power production, with CHP plants accounting for over 30 per cent of the total electricity production both in industry and larger municipalities.

Technological competitiveness has resulted in rapid growth of energy technology exports. The total value of exports increased almost fourfold throughout the 1990s, reaching EUR 3 billion in 2002.

Geothermal Energy - Iceland

Geothermal energy plays an important role in the energy supply of the country. It provides about 50% of the total primary energy supply (Ragnarsson, 2000). Iceland has a long history of using geothermal energy. Three decades ago, half of the Icelandic population already benefited from geothermal district heating systems. Nowadays, about 86% of all houses are heated with geothermal water. The economic benefits of geothermal heating are as high as approximately 100 million US$ by reducing imported oil per year. (Lund et al., 2001)

Based on experiences derived from the extensive use of geothermal energy in Iceland, the Geothermal Training Programme of the United Nations University (UNU) was established in Iceland in 1979 and operated within the Geothermal Division of Orkustofnun, the National Energy Authority (NEA) of Iceland. This six-month programme aims to assist developing countries with significant geothermal potential to build up groups of specialists that cover most aspects of geothermal exploration and development. Opportunities of intensive on-the-job training in the specialized fields are given to qualified university graduates and practitioners engaged in geothermal work in developing countries and the countries with transition. The scope of specialized fields covers almost all the geothermal related science and engineering including geological exploration, borehole geology, geophysical exploration, borehole geophysics, reservoir engineering, chemistry of thermal fluids, environmental studies, geothermal utilization, and drilling technology.

During 1979-2002, 279 scientists and engineers from 39 countries have completed the training courses, and over 70 have received shorter training (2 weeks to 4 months).

5.4 Potential role of Nordic Countries in facilitating uptake of renewable energy in developing countries

The objective of this section is to explore how the Nordic countries can promote renewable energy sources in developing countries.

Prior to getting into the analysis of the potential role that Nordic countries can play in facilitating uptake of modern renewable energy use in developing countries, a number of possible policy options available to developing countries are presented below.

Possible policy options - selected examples

Strengthening the institutional framework is a key step to creating sustainable renewable energy markets in developing countries. The establishment of long-term sustainable renewable energy technologies markets in developing countries primarily depends on the success in building an infrastructure framework integrating renewable energy technologies as one of other technical options for providing electricity services leading on to a financially viable distribution, financing, construction and operation and maintenance structure.

The fundamental functions needed in an environment that enables renewable energy technologies to compete on the same terms as other options are:

- Regulation and Planning
- Installation/construction and Maintenance
- Operation and Use
- Facilitation of Implementation
- Customer Education

The agents that are needed to fulfil each of the defined functions are identified in the following table 7:

Table 7: Functions of Agents

Function:	Agent:
Regulation and Planning	Public Authority
Installation and Maintenance	Service Provider (private, public, local, NGO, …)
Operation and Use	End-users federated in a form of loose or tight end-user association (cooperative, local council, etc.)
Facilitation	A private entity can be contracted by the regulator or the public authority, with or without delegation of some regulatory responsibility; the function can also be ensured by staff from the regulator itself
Customer Education	Service Provider or Public Authority

For sustainable renewable energy markets to develop every part of the institutional framework needs to be functioning properly: if one part is weak, the market may not develop. So defining the roles in each particular country and building capacity amongst the actors to perform their roles is an important area for support.

Favorable financing can be an important tool facilitating the diffusion of renewable energy technologies. Micro-credit and revolving loan programs support the adoption of solar home energy systems in many developing countries. In India for example, 10-year loans carrying low interest are made available through PV dealers, as part of India's renewable energy development program, with around 400 000 households using solar lanterns or PV lighting systems as a result (Geller, 2003). Similarly, in Bangladesh, Grameen Shakti, part of the Grameen Bank group, is supplying and financing solar systems for households by providing loans to women, who use the solar systems to facilitate income generating activities. Experience show that minimizing transaction costs, by using established structures such as rural credit cooperatives, is important as well as a carefully designed scheme to support good quality renewable technologies. Also, other renewable energy technologies have benefited from low-interest schemes, such as the program for small-scale wind power system in Inner Mongolia.

Renewable energy technologies, other than hydropower and traditional biomass, are still too costly for many poor families in rural areas. However, distributed renewable energy technologies are in many instances the least cost option for creating access to electricity in rural areas. In addition, if all environmental and social costs are taken into consideration when comparing options, renewable energy also has an added advantage. It could therefore be justified to provide financial incentives to establish and build markets. As renewable energy technologies become mature, the subsidies should be gradually reduced to allow for competitive forces to set in, such as the German feed-in tariff system. It is important that the financial incentives established are perceived as predictable. Most industrialized countries provide financial incentives for renewable energy through, tax credits, feed-in tariffs, or low-interest loans. For example, in Sweden and Denmark, energy and carbon taxes, in combination with tax breaks on biofuels have contributed to rapidly increasing bioenergy use for heat production.

Information dissemination and training may serve as an effective measure to promote renewable energies when it is combined with other policies, such as financing, regulations and economic incentives. For example, China has set up a network of local information dissemination and training centres as one integral part of its overall strategy to promote renewable energy options such as biogas digesters, small-scale turbines (Martinot et al., 2002). A similar centre was set up in India as well.

Box 3: China's Cookstove Development Program

Between 1982 and 1992, around 130 million improved cookstoves were installed in rural areas in China. Most of the stoves are fueled with biomass, either wood or crop residues. The national program consisted of i) R&D through a network of research institutions, ii) Rural Energy Offices conducting training, promotional activities and monitoring, iii) training of rural energy companies that manufacture, install and service improved stoves, iv) low-interest loans and tax incentives to assist companies, v) subsidies for stove purchases. The benefits for the rural households were in terms of fuel savings, improved air quality and convenience motivated the cost of USD 9. Fuel savings averaged 25% and most stoves have remained in use.

The main lessons learned from this program are that private companies can be important carriers of new technology if properly trained and supported by financial incentive programs and that rural household are willing to pay for improved energy technology if the benefits are significant. Equally important was the lesson that quality control can be achieved even in very decentralized schemes. (Geller, 2003b)

Nordic role

There is a large and growing energy demand in developing countries. There is a large potential for renewable energies to meet this demand, as various technologies are available worldwide. As section 5.3 shows, there are a number of technical advantages in Nordic countries. How to bring together the experience developed in Nordic countries and the potential renewable energy users in developing countries becomes an issue. The key seems to lie in non-technical factors, rather than the technologies themselves.

The most important is to create an enabling environment in developing countries in favor of using renewable energy options. This may stimulate local entrepreneurs to explore the market opportunities. To create such an enabling environment, financial institutions is a crucial component, which must be interested in and willing to provide financial support to the renewable energy development and dissemination.

In addition to advanced technologies of renewable energies, Nordic countries have experiences and expertise in how to develop the renewable energy systems. Through further in-depth study on specific regions or countries and in combination with Nordic technical and non-technical experiences, Nordic countries may be able to provide a strategic development plan of renewable energy sources in targeted countries. This could act as a starting point for further actions.

Annex I Joint Declaration

BY BULGARIA, CYPRUS, CZECH REPUBLIC, ESTONIA,

THE EUROPEAN UNION, HUNGARY, ICELAND, LITHUANIA, MALTA, NEW ZEALAND, NORWAY, POLAND, ROMANIA, SLOVAKIA, SLOVENIA, THE ALLIANCE OF SMALL ISLAND STATES, SWITZERLAND AND TURKEY

"THE WAY FORWARD ON RENEWABLE ENERGY"

1. We express our strong commitment to the promotion of renewable energy and to the increase of the share of renewable energy sources in the global total primary energy supply. We fully endorse the outcome of the World Summit on Sustainable Development, considering it a good basis for further international cooperation, and intend to go beyond the agreement reached in the area of renewable energy.

2. Increasing the use of renewable energy is an essential element to achieve sustainable development at national and global level. Renewable energy can provide important new ways to reduce pollution, diversify and secure energy supply and help provide access to energy in support of poverty eradication. Furthermore, the burning of fossil fuels is the biggest source of greenhouse gas emissions and these emissions need to be reduced to mitigate the adverse effects of climate change in order to achieve the ultimate objective of the United Nations Framework Convention on Climate Change to prevent dangerous climate change.

3. We commit ourselves to cooperate in the further development and promotion of renewable energy technologies. Recognising the sense of urgency as expressed in paragraph 19(e) of the Johannesburg Plan of Implementation, we will work together to substantially increase the global share of renewable energy sources, with regular review of progress, on the basis of clear and ambitious time bound targets set at the national, regional and hopefully at the global level.

4. We have adopted, or will adopt, such targets for the increase of renewable energy and we encourage others to do likewise. We are convinced that this will help to implement the necessary policies to deliver a substantial increase in the global share of renewable energy sources. Such targets are important tools to guide investment and develop the market for renewable energy technologies.

5. We commit ourselves to working with others to achieve this goal, especially through the partnership initiatives being taken which could contribute to expanding the use of renewable energy, as well as forthcoming international conferences on renewable energy.

Annex II Geographical Coverage (IEA)

OECD	Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, the Slovak Republic, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States.
Middle East	Bahrain, Islamic Republic of Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Syria, United Arab Emirates and Yemen.
Former USSR	Armenia, Azerbaijan, Belarus, Estonia, Georgia, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Republic of Moldova, Russia, Tajikistan, Turkmenistan, Ukraine and Uzbekistan.
Non-OECD Europe	Albania, Bosnia-Herzegovina, Bulgaria, Croatia, Cyprus, Gibraltar, the Former Yugoslav Republic of Macedonia (FYROM), Malta, Romania, Slovenia and the Federal Republic of Yugoslavia.
China	People's Republic of China and Hong Kong (China)
Asia	Afghanistan, Bangladesh, Bhutan, Brunei, Chinese Taipei, Fiji, French Polynesia, Kiribati, DPR of Korea, India, Indonesia, Malaysia, Maldives, Myanmar, Nepal, New Caledonia, Pakistan, Papua New Guinea, Philippines, Samoa, Singapore, Solomon Islands, Sri Lanka, Thailand, Vanuatu, Vietnam and other Asia.
Latin America	Antigua and Barbuda, Argentina, Bahamas, Barbados, Belize, Bermuda, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominica, Dominican Republic, Ecuador, El Salvador, French Guyana, Guatemala, Grenada, Guadeloupe, Guyana, Haiti, Honduras, Jamaica, Martinique, Netherlands Antilles, Nicaragua, Panama, Paraguay, Peru, St. Kitts-Nevis-Anguilla, Saint Lucia, St. Vincent-Grenadines, Surinam, Trinidad and Tobago, Uruguay, Venezuela and other Latin America.
Africa	Algeria, Angola/Cabinda, Benin, Botswana, Burkina-Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Congo, Dem. Rep. Of Congo, Cote d'Ivoire, Djibouti, Egypt, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Libya, Madagascar, Malawi, Mali, Mauritania, Mauritius, Morocco, Mozambique, Namibia, Niger, Nigeria, Réunion, Rwanda, Sao Tome-Principe, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, Sudan, Swaziland, United Republic of Tanzania, Togo, Tunisia, Uganda, Zambia, Zimbabwe and other Africa.

Annex III Persons Contacted

Mr. Thomas Verheye, Principal Administrator of DG Environment, Climate Change Unit, European Commission, Tel: +32 2 295 9639; Fax: +32 2 296 9970; E-mail: thomas.verheye@cec.eu.int

Mr. Johan Vetlesen, Contact at Norway Mission to the EU, tel: +32 2 234 11 45; E-mail: johan.vetlesen@mfa.no

Mr. Poul Erik Morthorst, Senior Research Specialist of Systems Analysis Department of Risk National Laboratory, tel: +45 4677 5106; fax: +45 4677 5199; E-mail. p.e.morthorst@risoe.dk

Professor Thomas B. Johansson, Director of International Industrial Institute for Environmental Economics, tel: +46 46 222 02 22; Fax: + 46 46 222 0210; E-mail: Thomas.B.Johansson@iiiee.lu.se

Mr. Eirik Midtsundstad, Norwegian Ministry of Petroleum and Energy, tel.: +47 22 24 63 34; Email: eirik.midtsundstad@oed.dep.no

Mr. Viggo Iversen, Enova SF (Norway), tel.: +47 73 19 04 45; Email: viggo.iversen@enova.no

Ms. María Hildur Maack, environmental manager, Icelandic New Energy, tel.: +354 588 03 10 /fax: +354 588 03 15; Email: maria.maack@newenergy.is

Ms. Ingunn Ettestol, Enova SF (Norway) Email: ingunn.ettestoel@ENOVA.NO

References:

Abderrahim, J. 2000. The Morocco General Rural Electrification Programme, [On-line] available: http://wire0.ises.org/wire/doclibs/AUtilSEREA.nsf/id/2CCD4914FC7F3987C125692000337B91/$File/Jamrani+proceedings.pdf

ARRPEEC Program Report, Energy, Environment and Climate Change Issues: A Comparative Study in Asia. Co-ordinated by AIT. P. 2

Aznar, M.P., et al., 2001. A new 7-lump model for catalytic tar (from biomass gasification) elimination. In Proceedings 1st World Biomass Conference, In *Proceedings 1st World Conference & Exhibition on Biomass for Energy & Industry*, (Ed. By S. Kyritsis, A.A.C.M. Beenackers, P. Helm, A. Grassi & D. Chiaramonti), James & James.

Bartle, A. 2002. Hydropower potential and development activities. Energy Policy, V. 30 (2002) p. 1231-1239.

Bhagavan, M. R., 2003, Technological Leapfrogging by Developing Countries, in UNESCO's Encyclopaedia of Life Support Systems, EOLSS Publishers, Oxford, 2003, Online available: www.eolss.net

Brazilian Energy Balance, 2002. Brazilian energy profile. Sources: Brazilian Energy *Balance 2001, CENBIO (2002),* Patusco (2002)

Bundesministerium für Umwelt, 1999. *Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit* – BMU (1999): Erneuerbare Energiern und nachhaltige Entwicklung. Berlin

Carvalho 1998. The role of Copersucar in Improving Technology for Ethanol Production from Sugar Cane in Sao Paulo. Paper presented at the STAP Workshop on Technology Transfer in the Energy Sector, Amsterdam, Jan. 19-20.

Cassedy, 2000. Biomass energy. Prospects for Sustainable Energy: A Critical Assessment. Cambridge University Press, UK. P.67-105

Commission of the European Communities, 2001. Communication from the Commission to the Council, the European Parliament, the Economic and Social Committee and the Committee of the Regions on the Implementation of the Community Strategy and Action Plan on Renewable Energy Sources (1998-2000). Brussels, 2001. COM (2001) 69 final

Corella, J., et al., 2001. Testing commercial full-size steam reforming catalysts for tar elimination in biomass gasification at pilot scale. In Proceedings 1st World Biomass Conference, In *Proceedings 1st World Conference & Exhibition on Biomass for Energy & Industry.* (Ed. By S. Kyritsis, A.A.C.M. Beenackers, P. Helm, A. Grassi & D. Chiaramonti), James & James.

Crill et al. 2000. Role of Peat in Finnish Greenhouse Gas Balance. Ministry of Trade and Industry research reports 20/2000, Helsinki.

Danish Energy Authority, 2002. [On-line] available:
http://www.energistyrelsen.dk/sw1100.asp

ENERGIE, 2000. Chapter 2: Small Hydro Plants.. STUDIO FROSIO, 2000, Italy.

EU Energy, 2002. *Energy: Let us overcome our dependence* Luxembourg: Office for Official Publications of the European Commonalities. 2002. ISBN 92-894-1349-2

EU, 2002. European Union is fully committed to reducing trade-distorting farm subsidies. [On-line] available: http://www.ecdel.org.au/whatsnew/WSSD_press%20release4.htm

Europa, 2003. [On-line] available:
http://europa.eu.int/comm/environment/climat/johannesburg.htm

European Commission, 1997. Energy for the Future: Renewable Sources of Energy-White Paper for a Community Strategy and Action Plan. COM(97)599 final (26/11/1997)

EWEA, 2002. On-line: http://iisd1.iisd.ca/greenbud/winden.htm, windpower, on-line:
http://www.windpower.org/articles/energypo.htm

Final Report on G8 Renewable Energy Task Force, 2001. p. 13-15. [On-line] available:
http://www.renewablestaskforce.org/pdf/G8_report.pdf

Frey, Gary W., 2002. Fred and Linke, 2002. Hydropower as a renewable and sustainable energy resource meeting global energy challenges in a reasonable way. *Energy Policy*. V. 30 (2002). P. 1261-1265.

Geller, Howard, 2003a. Market Transformation. *Energy Revolution: Policies for a sustainable future*. Island Press, Suite 300. Washington DC. P. 117-122.

Geller, Howard, 2003b. Market Transformation. *Energy Revolution: Policies for a sustainable future*. Island Press, Suite 300. Washington DC. P. 108-110.

Goldemberg, 2003. Goldemberg and Coelho, 2003. Renewable energy-traditional biomass vs. modern biomass. Energy Policy. Article in press.

Goldemberg, José 2002. The Brazilian Energy Initiative - Perspectives after Johannesburg. Paper prepared for the Third Meeting of the Global Forum on Sustainable Development (GFSE-3) 27-29 November 2002, Graz, Austria. [On-line] available:
http://www.gfse.at/papers/Final%20JG%20Graz%20Nov%20021.doc]

Green, David 2002. Johannesburg Deliverables? [On-line] available:
http://www.worldenergy.org/wec-geis/global/downloads/bea/DavidGreen.pdf

Gross, R., Leach, M., Bauen, A., 2003. Progress in renewable energy. Environment International 29, p. 105-122.

Hayes, P., Smith, K.R. (Eds.), 1994. The Global Greenhouse Regime: Who pays? Earthscan, London, 1994.

IEA, 1998a. The Role of Bioenergy in Greenhouse Gas Mitigation, Position paper, IEA Bioenergy Task 25. [On-line] available: http://www.ieabioenergy.com/library/28_ppcop4.pdf

IEA, 2000. *World Energy Outlook 2000*. International Energy Agency, Paris, 2000.

IEA, 2002, and UNDP, 2000: World Energy Assessment. P. 222

IEA, 2002a. Renewables in Global Energy Supply: An IEA Fact Sheet, OECD/IEA. [On-line] available: http://www.iea.org/leaflet.pdf

IEA, 2002b. Sources on-line available: http://www.gfse.at/papers/Final%20JG%20Graz%20Nov%20021.doc

IEA, 2002c. *World Energy Outlook 2002*. Chapter 13: Energy and Poverty. Head of Publications Service, OECD/IEA, 2002. p. 365-395.

IEA, 2002d. Renewables information 2002-*with 2000 data*. OECD/IEA, 2002. p. 149.

IEA, 2003a. Renewables Information 2003. OECD/IEA, 2003. p. *v*.

IEA, 2003b. International survey - Record growth. OECD/IEA, [On-line] available: http://www.oja-services.nl/iea-pvps/pvpower/15_05.htm

IEA,1998b. Greenhouse Gas Balance of Bioenergy Systems. IEA Bioenergy Task 25. [On-line] available: http://www.ieabioenergy.com/library/26_greenhouse.pdf

IISD, 2002. Wind Energy in Denmark. [On-line] available: http://iisd1.iisd.ca/greenbud/winden.htm

International Journal on Hydropower and Dams, 1995. "*World Atlas of Hydropower and Dams"*, in International Journal on Hydropower and Dams, January 1995, p.65

Johansson, T. B, Goldemberg, J. (editors), 2002. Energy for Sustainable Development-A Policy Agenda, United Nations Development Programme, NY. 2002. p. 28.

Joint Declaration, 2002. Declaration: The Way forward on Renewable Energy. 2002. [On-line] available: http://europa.eu.int/comm/environment/wssd/energy_declaration.pdf

Kartha, Leach, Johnson, 2000. Advancing Modern Biomass Energy. Draft report for Energy Sector Management Assistance Programme of the World Bank. Unpublished. P. 2

Kishore, V.V.N., Bhandari, M.P., Gupta, P., 2004. Biomass energy technologies for rural infrastructure and village power-opportunities and challenges in the context of global climate change concerns. Energy Policy 32, p. 801-810.

Lund, W.J., et al., 2001. World-wide direct use of geothermal energy 2000. Geothermics, Vol. 30, 2001, p. 29-68.

Majot, Juliette, 1997. *Beyond Big Dams.* International Rivers Network, Berkeley, 1997. p. 20.

Martinot et al., 2002. Martinot, E.,A. Chaurey, D.Lew, J. Moreira, and N.Wamukonya. 2002. Renewable Energy Markets in Developing Countries. *Annual Review of Energy and the Environment 27*.

Meyer, 2003. Meyer, Niels I, 2003. *European schemes for promoting renewables in liberalized markets*. Energy Policy, Vol. 31 (2003), p. 665-767.

Ministry of Economic Affairs 1999: 11 pp., Groencertificatenbeheer 2001. Renewable energy in progress 1999. Progress report, The Hague.

Ministry of Petroleum and Energy of Norway, 2002. Energy Generation Section, *The Energy Sector and Water Resources in Norway 2002*, p.26. On-line: http://odin.dep.no/archive/oedvedlegg/01/02/Facts026.pdf)

Moreira, J.R., 2000. Sugarcane for Energy: Recent Results and Progress in Brazil. Energy for Sustainable Development 4 (3): 43-54.

National Forest Statistics, 1997-2001. [On-line] available: http://www.skogssverige.se/skog/skogen/eng/kortfakta.cfm

OCED, 2001. Environmental Performance Reviews: Norway. p129-149; p 42-44

OECD, 1998. Benign Energy?-*The Environmental Implications of Renewables*. P. 73-74

Paish, Oliver 2002. Small hydro power: technology and current status. *Renewable & Sustainable Energy Reviews*. V. 6 (2002). P. 537-556.

Pasztor, Janos, Kristoferson, Lars A. (editors) 1990. Modern wood fuels. Bioenergy and the Environment. Westview Press, Inc. Oxford. P. 49-80.

Pirche, W, 1993, "36,000 Dams and Still More Needed", *Water Power and Dam Construction*, May, p. 15-18.

Ragnarsson, A., 2000. Geothermal Development in Iceland 1995-1999. Proceedings World Geothermal Conference 2000, Kyushu-Tohoku, Japan, June 10th, 2000.

Reiche, Danyel, 2002. Handbook of Renewable Energies in the European Union. Peter Lang GmbH, Germany. 2002. p. 227.

Robert Gross, 2003. Gross, Leach and Bauen, 2003. Progress in renewable energy. *Environment International*, V.29 (2003), p.105-122.

Rudd, JWM et al. (1993), *"Are Hydroelectric Reservoirs significant sources of Greenhouse Cases?,"* Ambio, V. 22, No. 4, June

Simell, P., and Kurkela, E., 1997. Tar removal from gasification gas. In Biomass Gasification and Pyrolysis, State of the Art and Future Prospects, (Ed. By M. Klatschmitt and A.V.Bridgwater), Cpl Press Newbury.

STEM, 2001. Energy in Sweden; facts and figures 2001. Swedish National Energy Administration, Eskilstuna, Sweden

The Brazilian Energy Initiative, 2002. *Support Report for THE BRAZILIAN ENERGY INITIATIVE to the WORLD SUMMIT ON SUSTAINABLE DEVELOPMENT* in Johannesburg, South Africa, 26 August to 4 September 2002 [On-line]available: http://www.brasilemb.org/BEI_suprep.doc

The Energy Sector and Water Resources in Norway 2002, Ministry of Petroleum and Energy of Norway.

The World Bank, 2002a. Mini-hydros. [On-line] available: http://www.worldbank.org/html/fpd/em/hydro/mh.stm

The World Bank, 2002b. Energy and the Environment. Energy and Development Report 2001. Published by the World Bank's Energy and Mining Sector Board and the Energy Sector Management Assistant Programme (ESMAP). Washington DC.

UK Government, 2002. Chapter 7: Renewable Sources of Energy. *Digest of United Kingdom Energy Statistics 2002*. [On-line] available: http://www.dti.gov.uk/energy/inform/dukes/dukes2002/07main.pdf

UN, 2002. Report of the World Summit on Sustainable Development. United Nations, New York, 2002. p. 142-143.

UNDESA, 2002. [On-line] available: http://www.johannesburgsummit.org/html/documents/summit_docs/2009_keyoutcomes_commitments.pdf

UNDP, 2000a. World Energy Assessment 2000.

UNDP, 2000b. Energy and the challenge of sustainability. World Energy Assessment 2000.

UNFAO, 1997. Proceedings of the Regional Expert Consultation on Modern Applications of Biomass Energy. Regional Wood Energy Development Programme in Asia. Kuala Lumpur, Malaysia.

United Kingdom, 1998. [On-line] available: http://www.agores.org/Publications/EnerIure/Unitedk21.pdf

US Dept. of Energy/IEA, 1992 figures, quoted in Gleick, PH (op cit.), pp.267-299

US, 2002. US oppose setting targets for renewable energy, 2002. [On-line] available: http://www.gcrio.org/OnLnDoc/pdf/renewable_energy020828.pdf

USEPA, 2002. Clean Energy. 2002. [On-line] available: http://www.ucsusa.org/clean_energy/renewable_energy/page.cfm?pageID=109

USEPA, 2002. Renewables Portfolio Standards, 2002. [On-line] available: http://yosemite.epa.gov/oar/globalwarming.nsf/UniqueKeyLookup/SHSU5BVPC6/$File/renewablesportfoliostandards.pdf

WEC, 2001a. *Survey of Energy Resources (19th edition)*. Wind Energy. World Energy Council, 2001. [On-line] available: http://www.worldenergy.org/wec-geis/publications/reports/ser/wind/wind.asp

WEC, 2001b. Norway: Extract from the Survey of Energy Resources 2001. [On-line] available: http://www.worldenergy.org/wec-geis/edc/countries/Norway.asp

WEC, 2002. *Executive Assembly Cairo, Egypt - October 2002.* [On-line] available: http://www.worldenergy.org/wec-geis/wec_info/structure_organisation/eacairo/RTreg.asp

WEC, 2003. *WEC Statement: Renewable Energy Targets* 2003. World Energy Council, 2003. United Kingdom. [On-line] available: http://www.worldenergy.org/wec-geis/global/downloads/stat2003en.pdf

Wind Energy, 2002. Wind Energy Policy in Denmark Status 2002. [On-line] available: http://www.windpower.org/articles/energypo.htm

Other Internet references:

http://www.iea.org/impagr/imporg/ann_reps/wind/japan.pdf

http://www.hagstofa.is/template_db_frameset_en.asp?PageID=686&ifrmsrc=/uploads/files/lh2002/L020801.xls&Redirect=False

http://www.eurorex.com/viewcountry.asp?viewL3=N&countryID=13

http://www.bmu.de/reden/rede_wolf030206.php?vers=text

http://www.jrc.es/cfapp/eneriure/Reports/FRA%20ele.pdf

http://members.recs.org/documents/phil.moody/PRESS_ARTICLE_-_EUROPEAN_REPORT_21_SEPTEMBER_02.JPG

http://www.bp.com/centres/energy2002/renewables/index.asp

http://www.ecd.dk/windsector/wind-statis.html

http://geoheat.oit.edu/bulletin/bull17-4/art30.htm

http://www.os.is/unugtp/intro.html

http://europa.eu.int/comm/energy/res/sectors/doc/bioenergy/km_tyrol_tony.pdf

Obtain your Nord and TemaNord reports from:

BELGIUM & LUXEMBOURG
Jean de Lannoy
Avenue du Roi, 202, 1190 Brussels
Tel +32 (0)2 538 5169 Fax +32 (0)2 538 0841
jean.de.lannoy@euronet.be

CANADA
Renouf Publishing Company Ltd
5369 Canotek Road, Ottawa, Ontario K1J 9J3
Tel + 1 (613) 745 2665 Fax + 1 (613) 745 7660
order.dept@renoufbooks.com
www.renoufbooks.com

CHINA
C N P I E C
Europe Division 16 Gongti East Road, P.O. Box 88, Beijing
Tel +86 10 50 66 688-8 Fax +86 10 50 63 101

DENMARK
Svensk-Norsk Bogimport A/S
Esplanaden 8 B, 1263 København K
Tel +45 33 14 26 66 Fax +45 33 14 35 88
snb@bog.dk
www.snbog.dk

ESTLAND
Astro Raamatud AS
Pärnu mnt 142, 11317 Tallinn
Tel +372 654 8485 Fax +372 654 8475
book@astro.ee

FAROE ISLANDS
H.N. Jacobsens Bókahandil
Postboks 55, 110 Tórshavn
Tel +298 31 10 36 Fax +298 31 78 73
hnj-bokh@post.olivant.fo

FINLAND
Akademiska Bokhandeln
PB 128, Centralgatan 1, 00101 Helsingfors
Tel +358 9 12141
akatilaus@akateeminen.com
www.akateeminen.com

FRANCE
Librairie LAVOISIER
14, rue de Provigny, 94236 Cachan Cedex
Tel +33 (1) 4740 6700 Fax +33 (1) 4740 6702
group@lavoisier.fr
www.lavoisier.fr

GERMANY
UNO-Verlag GmbH
Am Hofgarten 10, 53113 Bonn
Tel +49 (0)228 949020 Fax +49 (0)228 9490 222
info@uno-verlag.de
www.uno-verlag.de

HUNGARY
Euro Info Service
PO Box 1039, 1245 Budapest
Tel +36 (1) 329 2487 Fax +36 (1) 349 2053
euroinfo@euroinfo.hu

ICELAND
Mál og Menning
Laugavegi 18, 101 Reykjavik
Tel +354 (9)515 2500 Fax +354 (9)515 2505
verslun@mm.is

LATVIA
Jana Rozes Gramàtnica
Kr. Barona iela 5, 1011 Riga
Tel +371 (0)2 284288 Fax +371 7 370 922

LITHUANIA
Penki Kontinentai
A. Stulginskio 5, 2001 Vilnius
Tel +370 (5) 2664540 Fax +370 (5) 2664565
books@5ci.lt
www.books.lt

NORWAY
Akademika A/S
Postboks 84 Blindern, 0314 Oslo
Tel +47 22 85 30 30 Fax +47 22 85 30 80
bloken@sio.uio.no
www.akademika.no

ROMANIA
Euromedia s.r.l.
Str Dionisie Lupu nr 65, 70184 Bucuresti
Tel + 40 1 614 06 64 Fax + 40 1 312 96 46

SWEDEN
Fritzes
Kundservice, 106 47 Stockholm
Tel +46 (0)8 690 9190 Fax +46 (0)8 690 9191
order.fritzes@nj.se
www.fritzes.se

THE NETHERLANDS
De Lindeboom Internationale Publicaties b.v.
M.A. de Ruyterstraat 20 A, NL-7482 BZ Haaksbergen
Tel +31 (0)53 5740004, Fax +31 (0)53 5729296
books@delindeboom.com
www.delindeboom.com

UNITED KINGDOM
The Stationery Office
P.O. Box 276, London SW8 5DT
Tel +44 870 600 5522 Fax +44 870 600 5533
customer.services@tso.co.uk
www.tso.co.uk/bookshop

USA
Bernan
4611-F Assembly Drive, Lanham MD 20706-4391
Tel +1 (301) 459 7666 Fax +1 (301) 459 0056
query@bernan.com
www.bernan.com

ÅLAND
Lisco bok- och pappershandel
Skarpansvägen 25, Box 8, 22101 Mariehamn
Tel +358 (0)18 17 177 Fax +358 (0)18 19 771
info@lisco.fi

21-04-04