G8 Renewable Energy Task Force

Final Report

July, 2001

Okinawa Summit Communiqué paragraph 66:

> "Working together and with existing institutions to encourage and facilitate investment in the development and use of sustainable energy, underpinned by enabling domestic environments, will assist in mitigating the problems of climate change and air pollution. To this end, the increased use of renewable energy sources in particular will improve the quality of life, especially in developing countries. We therefore call on all stakeholders to identify the barriers and solutions to elevating the level of renewable energy supply and distribution in developing countries. We invite stakeholders to join in a Task Force to prepare concrete recommendations for consideration at our next Summit regarding sound ways to better encourage the use of renewables in developing countries."

Executive Summary

Introduction

1. The Okinawa Summit in 2000 called for the formation of a Task Force to assess the barriers and to recommend actions to better encourage the use of renewables in developing countries. The G8 Renewable Energy Task Force, including members from the private and public sectors of both developing and developed countries, as well as multilaterals and non-governmental organisations, was formed and has carried out this vital and challenging work.

2. Our principal finding is that renewable energy resources can now sharply reduce local, regional, and global environmental impacts as well as energy security risks, and they can, in some circumstances, lower costs for consumers. For example, renewable energy technologies are often the lowest cost option for providing household- and village-scale power in rural areas of developing countries, and are increasingly competitive in certain on-grid conditions. Yet, creation of widespread commercial renewable energy markets faces significant challenges: mobilising private capital; developing and aggregating dispersed markets; extending financial services down to the retail level; building business and maintenance infrastructure; and scaling up manufacturing. Together, actions taken to overcome these barriers will drive down costs and further increase market size.

Providing Clean, Affordable, and Reliable Energy – A Key Element Towards Sustainable Development

3. Modern energy services are fundamental to all three pillars of sustainable development: economic, social, and environmental powering modern communications and computing, business and industry and health and education. Energy is an important ingredient in the modern economy, and must be evaluated in the context of the other aspects of development. In fact, modern energy services must be developed and deployed in concert with all aspects of the development process – e.g., energy and communications, energy and industry, energy and the environment, energy and agriculture, energy and education, and energy and public health and safety

4. In all situations, programmes to increase the efficient use of all forms of energy are essential and are a no regret option for both renewable and conventional energy forms alike.

5. The development needs of rural populations are high on the agenda of developing countries and the international community. Harnessing energy to serve human needs can free people from the limits of muscle power and can contribute towards achieving the agreed International Development Targets. Energy is required to satisfy those needs, just as much as it is required for populations in the more developed economies.

6. World energy has entered a period of profound change. Over the past decade, privatisation and liberalisation have opened energy markets around the world. The developing countries, in particular, have entered a period of rapid growth in energy use, with energy consumption likely to double over the next twenty years. Yet, unless steps are taken now to address the added demand, the energy services provided will likely fall short of meeting basic requirements for several billion people around the world. This growing demand increases pressure on the environment, natural resources, international trade and development, industrial competitiveness, and public health and welfare.

7. For the world to realise economic, political, and social development, all of the world's people should have access to affordable, modern energy services and the benefits they can provide, while protecting the environment and energy security. For some, especially the 2 billion in developing countries without modern energy, this implies a continuing role for donor assistance and subsidies from governments with G8 countries needing to take a lead role, as well as a need to further deepen linkages between the development process, economic development and

poverty eradication. Nonetheless, driving down costs will make it possible to serve many more people through a variety of technologies. Generally, promoting renewable energy can best be done through enlarging markets, increased, focussed R&D efforts, and stimulating the market environment in both developing and developed countries. Market creation would reduce costs and widen the provision of services. These are primarily private sector activities within an appropriate regulatory framework.

Renewable Energy – A Valuable Resource in the World's Energy Portfolio

8. Along with other energy options, renewable energy systems are a key part of the portfolio of energy solutions. For example, today, traditional biomass represents the most important source of renewable energy in the developing world, with a 36% share of total energy consumption. Used in a sustainable way, biomass and other renewables do not generate additional greenhouse gas emissions.

9. Renewable energy solutions offer many advantages. Since they use indigenous energy sources, they contribute to supply security by reducing reliance on energy imports. There are a variety of national situations in terms of needs and resources, but renewable resources are largely available in most developing and developed countries. Creating an enabling environment which contributes directly to local economic development. Renewable energy installations bring jobs, capital, and sources of revenue to local communities, often to rural areas where these benefits are needed most. In certain remote locations, where the electricity and/or fossil fuel infrastructure does not reach, renewable energy systems can be the only cost effective option. In addition, modern renewable energy systems generate far less air pollution and greenhouse gas emissions than fossil energy systems thus reducing the threat of climate change and health risks. Depending on the installation, renewable energy projects may be smaller in scale and not as technically complex to operate and maintain as conventional energy projects. For all of these reasons, renewable energy is a valuable resource in addressing the world's growing energy needs.

10. Renewables form a relatively small part of the commercial energy portfolio today, but the costs of developing, installing, and delivering renewable energy to consumers have been falling, due largely to improvements in system designs and manufacturing techniques. In many applications, particularly in those instances where gaining access to conventional energy systems is difficult or costly, the market share of renewable energy has been growing steadily in recent years.

11. Characterising the impact of cost reductions and market share increases is the "learning curve." Simply speaking, renewable energy manufacturers and developers gain valuable experience with each new installation. The level of industrial experience with conventional energy systems is many decades longer than that for renewable energy systems. With modern research, development, and technology transfer techniques at their disposal, the renewable energy industries have achieved progress. But because of this relative immaturity of some renewables, many industry analysts expect cost reductions and performance improvements to continue at a faster pace in the renewables sector, thus gaining greater competitiveness and increasing the likelihood that renewable energy uptake will expand in the future.

Barriers

12. To secure sustainable commercial success, renewables must overcome a number of key barriers, including:

- cost; although the cost of renewable energy is falling as volumes increase, in most cases it is not yet directly competitive with conventional alternatives;
- insufficient human and institutional infrastructure; limited capacity to support projects and markets, owing to a lack of experience and investment;
- high up front costs of renewables and other impediments to capital mobilisation; leading to inadequacies and shortfalls in financing programmes;
- weak incentives and inconsistent policies; the characteristics and benefits of renewables are not always adequately and fairly addressed in energy policy frameworks.

Recommendations

13. The Task Force believes that the G8 should give priority to efforts to trigger a step change in renewable energy markets. Concerted action is needed, particularly to benefit the more than 2 billion people in developing countries who do not have access to reliable forms of energy. G8 Leaders are invited to make a political commitment now, building on their vision in setting up the Task Force. Action has to be taken on a sustained basis with particular emphasis on the next decade. With this in mind it is particularly important that discussions to promote renewables take place in fora such as the World Summit on Sustainable Development.

In order to address these barriers, the G8 is recommended to:

- **Reduce technology costs by expanding markets**

Recommended actions	**Partners** **Starting date**
A.1. G8 and other developed countries should implement existing and proposed national plans to expand domestic renewable energy markets in order to drive down costs and underpin the development of markets in developing countries. Governments should align policies with consumers' willingness to pay, using such nationally-chosen market mechanisms as portfolio quotas and incentive tariffs.	Other developed countries With urgent effect
A.2. The G8 countries should continue and expand support for R&D of renewable energy technologies that address all sectors of the energy economy—buildings, industry, transport, and utility energy services. Co-operation with developing countries on R&D will assist in technology transfer towards systems tailored for developing country use.	Private sector, IFIs, developing countries October
A.3. Working with both public and private sector participants, G8 countries should help develop and demonstrate renewable energy projects where: (i) renewables are a least cost option on a life cycle basis and/or (ii) renewables achieve protection of local and/or global environment at a reasonable cost. To that end, G8 and International Finance Institutions (IFIs) should help formulate well-defined subsidy programmes – particularly 'smart subsidies', which are temporary, competitively administered and performance-based.	Private sector, IFIs, developing countries October
A.4. G8 should place more trust fund resources with IFIs that can be accessed by private sector project developers on a cost-shared basis to assist with the development costs of renewable energy projects.	IFIs August
A.5. Global corporations are large consumers of energy, and are well-equipped to investigate renewables and strategies for cost-effective uses. G8 should encourage industry to make voluntary global commitments to procure and use renewables-based energy, recognising that policy frameworks encouraging renewables will strengthen such commitments.	Industry; civil society

- **Build a strong market environment**

Recommended actions	**Partners** **Starting date**
B.1. The G8 should use its influence to ensure that renewables are adequately considered as part of energy policy in assessing development priorities of countries participating in poverty reduction programmes. Institutional capacity should be strengthened in developing countries to support the development of comprehensive national renewable energy strategies with complementary private sector investment programmes within national planning processes for sustainable development, such as National Strategies for Sustainable Development, power sector reform, Poverty Reduction Strategy Papers, etc. In this context, technical assistance for capacity building is useful	IFIs, developing countries; private sector October
B.2. Consistent with a greater emphasis on energy and in particular on renewable energy, G8 countries and development institutions should establish a higher level of expertise in their development agencies and/or country offices on the role that energy policy choices can play in development.	ODA offices; IFI offices October

B.3. G8 should, on an expedited basis, provide support to renewable energy industries for the creation of joint ventures and other manufacturing, assembly, and distribution/installation capabilities in developing countries.	Industry October
B.4. G8 should expand the scope, visibility, and funding of innovative approaches that are currently assisting developing countries to develop renewable markets. Many approaches by the Global Environment Facility and associated development agencies, the World Bank/UNDP ESMAP program and many bilateral donors and private firms should be supported. G8 should also encourage aligned and concerted action among these organisations to replicate innovative approaches. G8 should expand support for assistance programmes and networks for capacity building, training, quality control and maintenance to ensure full life cycle benefits are obtained.	IFIs October
B.5. G8 should strengthen programmes that encourage sustainable forest management and an efficient use of fire-wood and other traditional resources.	Private banks, IFIs August

- **Mobilise financing**

Recommended actions	**Partners** **Starting date**
C.1. Recognising the importance of energy in sustainable development and poverty eradication, G8 should invite OECD to address energy issues including renewables in the context of the International Development Targets. They should invite annual reports on relative financial flows and donor assistance patterns to support renewable energy. ODA, bilateral and multilateral agencies should explicitly consider renewables for development projects and choose them when they are the least cost option on a life-cycle basis.	OECD/DAC August
C.2. Modern energy access and environmental considerations should be integrated into the IFI's energy sector dialogue and investment programmes. Thus, current instruments and agency programs should be adapted to provide increased support for renewable energy projects which, although economically attractive, may be small and have long pay back periods. Guarantee funds, refinancing schemes for local banks, ad hoc loan facilities to local small private operators, should be considered in this respect.	Developing countries; Private sector, IFIs October
C.3. The G8 should extend so called 'sector arrangements' for other energy lending to renewables and develop and implement common environmental guidelines among the G8 Export Credit Agencies (ECAs). This could include: identifying criteria to assess environmental impacts of ECA-financed projects, and establishing minimum standards of energy-efficiency or carbon-intensity for these projects; developing a common reporting methodology for ECAs to permit assessment of their local and global environmental impacts.	Private sector, OECD/ECA August
C.4. To improve the financial appeal of renewables projects, the G8 should call for proposals to mobilise "patient capital" from industry and private financiers through appropriate tax and other support schemes.	Private sector, civil society December
C.5. G8 countries should support access to renewables by the rural poor such as through strengthening micro finance organisations and competitive rural concessions. Through this, SMEs, NGOs and community assisted energy programs in the developing countries should look to access dedicated funds and adopt renewable energy applications with micro-financing opportunities.	Developing countries, Civil Society, SMEs, Private banks, IFIs. August

- **Encourage market-based mechanisms**

Recommended actions	**Partners** **Starting date**
D.1. G8 should ask the IEA to identify and analyse policies and measures related to renewables' competitiveness in the context of economic and societal costs and benefits of all energy options, monitor the deployment of renewables, and make such information widely available	IEA December
D.2. G8 should invite the IEA to support the evaluation of the benefits of national renewable certificate trading schemes, and evaluate the benefits of enhanced international collaboration.	IEA October

D.3. Renewable energy projects will benefit from any incentives to developing countries which may derive from negotiations on global climate change. G8 should support development of mechanisms such as emissions trading, joint implementation and the CDM, that are conducive to the support of renewable energy projects.	Developing countries August
D.4. G8 countries should take steps to remove incentives and other supports for environmentally harmful energy technologies, and develop and implement market-based mechanisms that address externalities, enabling renewable energy technologies to compete in the market on a more equal and fairer basis.	 August

14. Over the coming decade, concerted action by G8, other countries, the private sector, IFIs and others on the measures set out above could result in:

- a significant improvement in the efficiency of traditional biomass use for cooking purposes by up to 200 million people in developing countries;
- provision of access to electricity from renewable sources to up to 300 million people in rural areas of developing countries; and,
- service to up to 500 million people connected to electricity grids world-wide, 300 million of whom could be in developing countries. Such an achievement will depend on full implementation and reinforcement of already agreed and planned national market strategies to develop renewables markets in G8 and other countries, as well as the use of mechanisms arising from international agreements on climate change. Successfully marshalling market forces to serve people in the developed world will reduce significantly the costs of serving rural populations.

Such an outcome of serving up to a billion people in the next decade with renewables should be our goal and aspiration.

Costs

15. The benefits are clear, but what is the cost? In general, it is the cost of setting up a policy structure that rewards the benefits of renewables: a level playing field. Though there will be a higher cost in the first decade, measured solely in terms of the costs so far reflected in the market, successfully promoting renewables over the period to 2030 will prove less expensive than taking a 'business as usual' approach within any realistic range of real discount rates.

Take action now!

In forming this report we pay tribute to the work of Task Force members, Advisory Group members, people we have consulted during our extensive outreach programme, those who have made their views known through our web site and our Secretariat. We are grateful to all and believe that there are clear benefits in taking forward such work in a collaborative manner. We have drawn on the vast amount of expertise that exists on renewables and have been heartened by the enthusiasm for working together to achieve change.

Dr. Corrado Clini
Co-Chairman

Sir Mark Moody-Stuart
Co-Chairman

Preface

The G8 Summit held in July 2000 in Okinawa called for the establishment of a Task Force on Renewable Energy. In response, a Task Force of 33 members was formed with broad representation from the public and private sectors, from developed and developing countries, and from multilateral institutions and non-governmental organisations, chaired by Dr. Corrado Clini, Director General, Italian Ministry of Environment and Sir Mark Moody-Stuart, Chairman, Royal Dutch/Shell Group of Companies. The Task Force was aided by an Advisory Group consisting of 58 world's leading experts in renewables.

The Task Force met in Rome in September 2000, The Hague in November 2000, in Paris in January 2001, and in Tokyo in March 2001. This report is based on discussions about barriers and solutions at these meetings, as well as written inputs from the Task Force and the Advisory Group. In addition, several G8 Governments organised national consultations and workshops, and regional consultations were held in Asia, Latin America, Europe and in Africa.

The Report consists of two parts, the Final Report and Annexes. The Final Report presents the key findings of the Task Force. The first chapter of the Final Report sketches the wider context of sustainable development in which renewables ought to be considered. It outlines several scenarios of energy demand today and in the future. The Report outlines the implications of a "Business as Usual Scenario", where this demand is addressed by current forms of energy, concluding that this will result in an un-sustainable energy future. The Report also concludes that costs of some renewables have dropped significantly in recent years, creating widening competitive markets, so that renewable energy resources can now begin to contribute significantly to the energy portfolio.

Chapter 2 assesses regional energy needs and supply in four markets: (1) non-electricity markets in developing countries; (2) off-grid electricity markets in developing countries; (3) electric utility markets in developing countries; and (4) electric utility markets in developed countries. These sections highlight the particular merits of renewables in these markets, recognising that renewables should be considered as only one of the viable options to deliver electricity, heat and mechanical power.

Chapter 3 looks at conditions in the market, beginning with an analysis of factors stimulating and restraining expansion of renewable energy markets. The sections that follow then highlight how the G8 can manage these market forces through national plans, policy reform, financing tools and strategies, and through interaction and dialogue with developing countries, private sector, NGO's, and other stakeholders. Drawing on real experience illustrated by a number of Case Studies from developed and developing countries, this chapter sets the stage for designing an effective mix of incentives and mandates that amplify those forces propelling renewables into the market, while overcoming forces inhibiting market development. It concludes with the notion that despite existing efforts in the public and private sector, the market for renewables will remain limited unless coherent action is taken.

Chapter 4 contains recommendations and proposes specific actions to accelerate the deployment of renewables. Chapter 4 starts with a brief section summarising the four key barriers emerging from the previous chapters. It then formulates four principal recommendations in response to each corresponding barrier: to reduce technology costs by expanding markets; to build a strong market environment; to mobilise financing; and to encourage market-based instruments. Additionally, a set of actions is proposed grouped around these recommendations. The barriers, and therefore the recommendations to address them, are interrelated. The chapter concludes that it is for the G8 to decide whether and how to take the recommendations forward, suggesting an implementation strategy bringing together stakeholders, tracking developments, and sharing experience.

Chapter 5 of the Report analyses the implications in terms of costs and benefits of the implementation of the recommendations and actions. In other words, what does the world look like in a scenario where renewables are promoted, along the lines of the Report's recommendations? The analysis shows that it is possible to create the conditions to serve up to eight hundred million people with electricity for residential purposes from renewables in ten years. Additionally, the analysis also concludes that in that same timeframe, better cooking stoves can be provided up to 200 million people, improving health and productivity of rural populations, and reducing stresses on the environment. The chapter concludes that taking action on the recommendations will require a shift of resources toward renewables, but that those costs are recovered in future years and that significant movement toward sustainable development will result.

The Annexes contain in-depth analysis and detailed background information and statistics. The annexes include strategic pathway analysis, statistics on Official Development Assistance (ODA) for energy and renewable energy, a brief survey of subsidies, an overview of developing country national plans and developed countries' policies and measures, and a large number of Case Studies that were received from the members of the Task Force and Advisory Group. These Case Studies form an integral part of the Final Report, where most of them are presented in brief to illustrate and support key arguments and findings.

1 RENEWABLES – A KEY ELEMENT OF SUSTAINABLE DEVELOPMENT

1.1 Energy for Sustainable Development

Modern energy services are fundamental to economic, social, and political development and are essential in sustaining human life and improving human welfare. "Energy's importance in our daily lives derives simply from the fact that it provides essential human services, such as lighting, cooking, motive power, space heating and cooling, water pumping, and so on[1]." Energy services are required for virtually every commercial and industrial activity. Furthermore, adequate energy supplies can contribute to solutions to a broad range of social issues, including poverty eradication, slow down of population growth, reduction of urbanisation, and improvement of opportunities for women[2]. Harnessing energy to serve human needs can free people from the limits of muscle power, contributing towards achieving the agreed International Development Targets.

Key Fact: Working Definition of Renewables

For the purposes of this report, the Task Force considers renewable energy technologies to include solar, biomass and geothermal energy for electricity and heat, wind energy for electricity and mechanical services, and small hydro up to 50 MW for electricity. Additionally, the Task Force notes that use of renewable energy should always be undertaken in the context of overall energy planning, and that energy efficiency is fundamentally important. Further, the Task Force recognises that policies to stimulate greater use of renewables can also enhance markets for other emerging technologies, such as fuel cells, that can offer improved energy and environmental performance. Newer renewable energy technologies, such as ocean energy from waves and currents, look promising for the future, but are not included in the analysis.

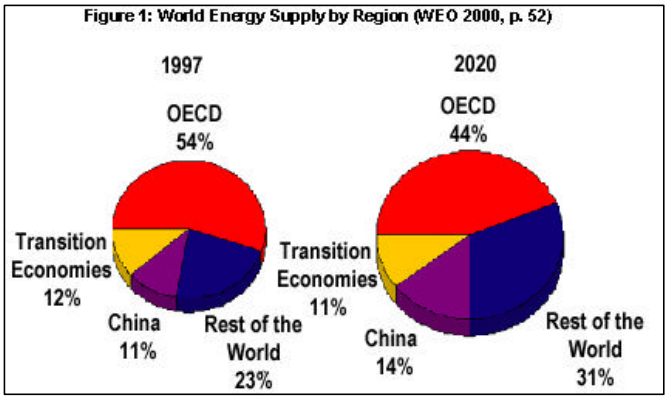
Energy is the lifeblood of modern societies, and is a pre-requisite for the welfare and well-being of all people. But, despite admirable accomplishments in providing energy for human purposes, it is increasingly clear that current energy systems are unable to provide needed energy to all people in a sustainable and affordable way. There is a growing realisation that new patterns of energy supply and consumption are needed to move toward greater sustainability, and that renewables is a key element of that pathway.

Sustainable development is understood to mean "development that lasts". The definition adopted in this report is the one included in the Brundtland Report "Our Common Future"[3] as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". Sustainable energy systems are integral to sustainable development, significantly impacting the economy, development issues and the environment.

1.2 Current Energy Trends

With continued population and economic growth, global energy demand is growing rapidly. The developing countries, in particular, have entered a period of rapid growth in energy use, with energy consumption likely to double over the next twenty years.

Figure 1: World Energy Supply by Region (WEO 2000, p. 52)



According to IEA World Energy Outlook-2000 projections, world total primary energy supply is expected to increase by 30% by 2010[4] relative to 1997 and by nearly 60% by 2020. Total world energy supply is expected to increase from 8,610 Mtoe in 1997 to 13,529 Mtoe in 2020. Figure 1 demonstrates that today, slightly more than one billion people in the industrialised countries consume about 54% of the total energy supply, while about five billion

[1] UNDP 2000, p.1-1
[2] WEA 2000b, p. 9
[3] Brundtland 1987
[4] WEO 2000, p. 61

people in developing and transition economies consume the remaining 46%[5]. By 2020, the share of the OECD countries in world energy supply is expected to decline to 44%.[6]

The world demand for electricity grows more rapidly than demand for any other end-use. With an annual average growth rate of 2.8%, electricity demand will almost double between 1997 and 2020[7]. For this period, growth of electricity demand in developing countries is projected to be 4.6% annually, versus 1.6% growth in the OECD[8]. Nevertheless, the per capita electricity consumption in the developing world in 2020 will still be only one sixth of that in OECD countries. By then, 80% of the world's population will consume just over 44% of global electricity output.

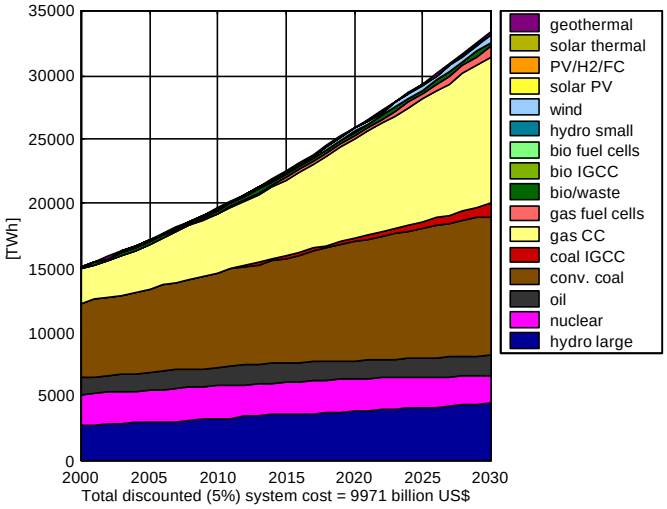
This growing electricity demand cannot be met by traditional fossil-fuel based energy systems without strongly increasing the pressure on the environment, natural resources, public health and welfare, and international relations. Along with a greater emphasis on energy efficiency measures, it is widely expected that renewables will play an increasingly important role in the world's energy portfolio.

In a "Business As Usual" scenario in Figure 2, the share of renewables in electricity consumption will remain small in 2030 based on energy policies in place in mid-2000. This scenario is consistent with the IEA World Energy Outlook 2000 reference scenario[9], and establishes a baseline to compare the impacts of various policies to stimulate more rapid growth of renewable energy markets. In the baseline scenario, renewables are the fastest growing of all the energy types, increasing at an average 2.8% annually. Nonetheless, due to the small base upon which they start (2% of the portfolio), their share only increases to 3% of the overall energy portfolio in 2020.

There are a number of conclusions to be drawn from this Business As Usual scenario:

- significant renewable energy markets will not result from a "business as usual" approach;
- fossil dependency will grow, leading to more serious price and supply vulnerabilities;
- improved energy services are not likely to reach currently unserved populations; and
- a significant increase in fossil energy use will cause serious environmental consequences.

Figure 2: Fuel Shares in World Total Electricity Consumption



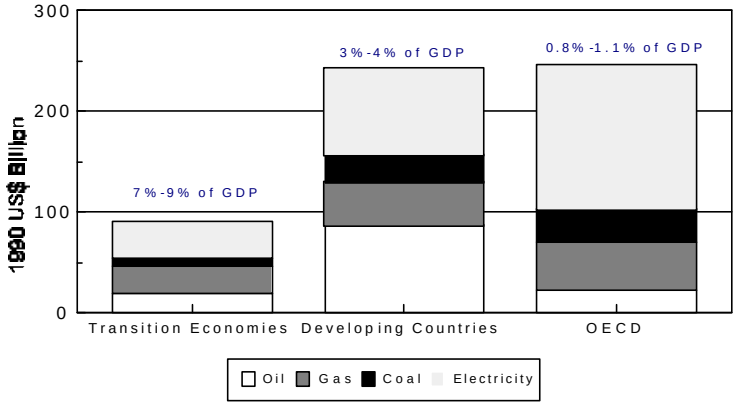
In short, a Business As Usual scenario will not result in a sustainable energy future. Sustainable energy supply should enable all of the world's people to access affordable energy services while protecting the environment and ensuring energy security. Because of their many benefits, renewable energies must have an important and growing share in the future energy supply system.

[5] The two billion poorest people (US$1000 annual income per capita or less), a small but growing share of whom live in shanty towns with most still scattered in rural areas, use only 0.2 toe of energy per capita annually whereas the billion richest people (US$22000 annual income per capita or more) use nearly 25 times more at 5 toe per capita annually.
[6] These figures do not include traditional biomass, which today accounts for about 34% of total primary energy demand in developing countries (see Section 2.1).
[7] WEO 2000, p.61
[8] WEO 2000, p.64
[9] For the purposes of later analysis, the Business As Usual scenario from WEO 2000 has been extrapolated to 2030. Further adaptations are explained in Annex 1 and Section 5.

1.3 Financial Flows to Energy

The world's energy infrastructure has entered a period of profound change. Over the past decade, privatisation and liberalisation have opened energy markets to increased competition around the world. Governments are increasingly withdrawing from direct provision of energy services, a role which is now taken on by the private sector. There are numerous studies quantifying both public and private investments in the energy sector to fulfil growing energy demand. Annual investment requirements for energy as a share of GDP are much larger in transition economies and developing countries than in the OECD (see Figure 3 [10]). Although the lion's-share of these financial flows come from the private sector, governments support for conventional energy technologies remain in place in both developed and developing countries (see Annex 3). For example, in the US, total energy-related subsidies from direct expenditures and income tax credits in 1999 totalled about US$3.5 billion, of which only US$59 million was directed to renewables[11].

Figure 3: Average Annual Investment Requirements by Fuel and Region: 1990-2020



Similarly, coal prices have been subsidised in Germany, Spain, Japan and France, totalling US$6 billion[12]. A recent report regarding subsidies in six developing countries and Russia calculates that total annual subsidies to fossil fuels amounted to about US$50 billion[13].

1.4 Setting Priorities within the context of Sustainable Development

While critical to modern economies, energy systems for sustainable development must be developed and deployed with careful consideration of their economic, social, and environmental impacts, which are intrinsically linked. Economies can only grow if they are not threatened by environmental catastrophe or social unrest. Environmental quality can only be protected if basic economic needs are fulfilled and individuals take responsibility for public goods. Finally, social development rests on economic growth as well as a healthy environment. Energy policy makers now acknowledge that energy is a key element affecting sustainable development.

The three pillars of sustainability have not historically carried the same weight in the thinking of the global community. The focus has changed as our knowledge of the impacts of energy use grew, and our energy usage continues to climb. Over the past several decades, issues related to secure, low cost availability of energy (primarily oil) have dominated the international energy-related discussions in OECD countries. In more recent years, attention to the impacts of energy use on both local environments (i.e., air and water pollution) and the global environment (i.e., climate change) have been increasing, with a continuing strong focus on energy security.

Developing countries, which account for a large and rapidly growing share of global energy demand, have their own sustainable development priorities. For more than 2 billion of the world's people[14],

[10] IEA 1999a- based on the WEC projections (Case B)
[11] IEA 2000c
[12] In addition, almost 10 billion US$ was spent on social and other programs related to coal sector reform. IEA 1999.
[13] Calculations are based on 1998 prices and quantities. WEO 1999
[14] ESMAP 2000

acquiring basic energy services, such as lighting, water pumping, heating and cooking remains an urgent need. Further, developing countries don't always have adequate financial resources to purchase the most advanced technologies, from an environmental and efficiency perspective. The net result is both a steadily increasing gap between the "rich and "poor" of the world (both within and between countries), and a deterioration in the quality of the environment. Nevertheless, the overriding consideration for developing countries is the need to eradicate poverty — where 2.8 billion people live on less than two dollars a day and 1.2 billion on less than one dollar per day[15]. Eradication of poverty is a long-term goal of social and economic development, with clear benefits for environmental protection.

1.5 Renewable Energy and Sustainable Development

Use of renewable energy addresses all three of the pillars of sustainable development: economic progress, development and social improvement, and an improved environment.

1.5.1 The Economic Case for Renewables

Over the past decades conventional energy options, largely based on fossil fuels, were seen as economically more attractive than renewables. However, the economic case for renewables is improving rapidly, particularly when its environmental and other social values are taken into account.

Case Study 1 Morocco: Rural Electrification Programme

Morocco has set up a rural electrification programme with the aim of increasing rural electrification from 20% in 1995 to 80% by 2006. The electricity utility ONE has assessed the areas where grid connection is the best option through the use of economic criteria. A cost per household for the grid connection of each village is calculated. The households which exceed the economic limit for grid connection are then identified as potential candidates for off-grid electrification. In these rural locations it is more economic to install solar home systems than to provide a connection to the grid.

Some renewable energy technologies are maturing rapidly and are increasingly cost competitive. For example, wind, small-hydro and geothermal power are already competitive in many wholesale electricity markets. Other technologies, such as solar PV, solar water heaters, and biomass are often the most cost-effective options to provide energy services in off-grid areas in developing countries (see Case Study 1). Biomass-fired combined heat and power plants are already widely used in several European countries. In developed countries solar powered devices, such as emergency roadside telephones and railroad crossing signs, can be found in remote as well as urban areas. Such applications tap into the so called 'niche markets'. Other competitive market examples include green electricity markets, which respond to consumers' willingness to pay a premium for environmentally superior, clean energy services.

Prices for renewables have been falling steadily as market shares continue to increase. The markets for renewable energy technologies are the fastest growing energy markets in the world today, driven largely by wind turbines and photovoltaics, both growing at more than 25 per cent annually over the past six years[16]. This trend is driven in part by *experience* or *learning* curve effects that are well recognised in most industries. Renewable energy manufacturers and developers gain valuable experience with each new production facility and installation. R&D investments expedite and enhance this learning experience and help to further reduce the technology costs. The case of Japan (Case Study 2) demonstrates the importance of R&D and market incentives to drive down the costs of renewables. Most G8 governments are lowering the costs of market entry by financial incentives linked to market deployment, complemented with R&D.

Case Study 2 Japan: Importance of R&D to stimulate the learning effect

In June 1998, with PV generation costs three times as high as conventional electricity, Japan set a target of 5000 MWp of newly installed PV capacity by 2010, and established an R&D Programme, - Development of Technology for Practical Application of PV Power Generation Systems- to drive down PV costs thereby helping to insure that the target will be met.

To date the R&D programme has been very successful, with approximately 200 MW of PV installed in the first 18 months. Over ten thousand residential systems have been installed annually as a result of the subsidies. The programme has achieved economies of scale and as a result, significant price reductions: it reduced costs of installed residential PV systems from US$30 in 1993 to US$8 per peak Watt in 1998.

[15] World Bank 2000b

[16] Annual growth rates for PV and wind are based on data from PV News Vol.20, No.2 (March 2001) and the American Wind Energy Association "Global Wind Energy Market Report 2001"(www.awea.org)

A new fund to accelerate deployment of renewables

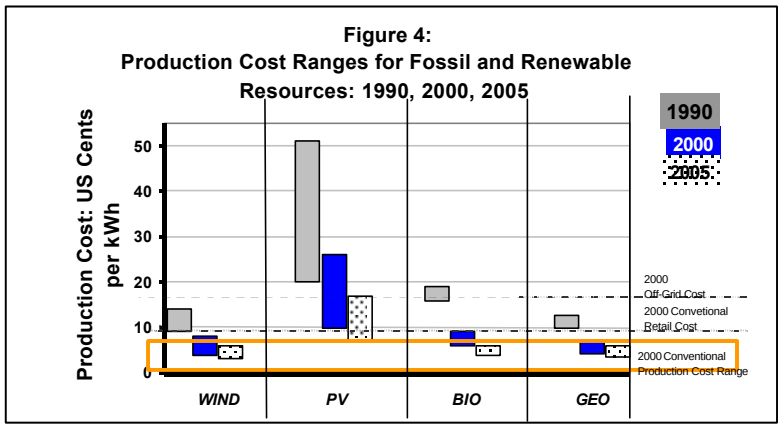
"Green technologies are on the verge of becoming one of the next waves in the knowledge economy revolution....
...I believe the role of Government is to accelerate the development and take up of these new technologies until self-sustaining markets take over. The Government's programme for incentivising renewables will create a new market worth over £500 million through the Renewables Obligation, Climate Change Levy exemptions and the Non Fossil Fuel Obligation. We have already announced £100 million to support offshore wind and energy crops....Today I can announce a further £100 million .... This new money will help us to promote solar PV, give a boost to offshore wind, kick start energy crops, and bring on stream other new generation technologies. This investment in renewable energy technology is a major down-payment in our future, and will help open up huge commercial opportunities for Britain."

Source: Speech by UK Prime Minister Tony Blair: 'Environment: the next steps' (6 March 2001) Reuters

The market share of renewable energy has been growing steadily in recent years, especially where access to conventional energy systems is difficult or costly. Industry analysts expect performance improvements and cost reductions to continue, thus increasing the likelihood that renewable energy markets will expand in the future. Experience to date has served to significantly drive down the cost of renewables-based energy systems. Figure 4 shows the costs of renewables-based electricity for four technologies (wind, PV, biomass and geothermal) at three points in time – 1990, 2000 and 2005 (projected). Cost ranges for the four technologies are shown by the shaded blocks.

These costs are compared in Figure 4 with the costs for conventional generation in the year 2000: central station production (busbar) costs, off-grid (niche market) production costs, and conventional retail prices. For the year 2000, conventional energy production costs are in the range of 2 – 4 US cents (USC), while retail and off grid-costs cost approximately 8 USC and 14 USC, respectively. A decade ago, in 1990, renewables were not competitive with conventional production (busbar) costs and retail costs, although wind was close. Ten years later, the effect of experience driven cost reductions is clear: in the year 2000, both windpower and geothermal costs are lower than conventional retail cost and approach the production (busbar) cost level. This indicates that wind and geothermal power can now compete in some wholesale markets. PV is also cost competitive with off-grid niche market applications and some retail situations. Further significant cost reductions are expected as we move further into the 21st century.

Figure 4:
Production Cost Ranges for Fossil and Renewable Resources: 1990, 2000, 2005



Key Facts: Economic benefits of renewable energy

- Continuing cost reductions occur through increasing scale of manufacturing and deployment
- Costs are not affected by swings in fossil fuel prices
- Modularity, low operating costs
- Installation of distributed generation units helps reduce pressure to build new power grid generating capacity and transmission lines
- Very short construction times give much greater flexibility in energy planning and investment
- Local employment and income generation result from manufacturing, project development, servicing, and utilisation

The production cost comparisons of Figure 4 produce a relatively narrow interpretation of economic performance since these comparisons are purely cash flow based, and hence ignore valuable strategic and socio-economic values that are associated with renewable energy. In a restructured electricity industry, some of the unique characteristics of renewables, including their modularity, flexibility, and low operating costs will likely be more highly valued. Moreover, integrated into the local grid, some renewables can offset peak loads and delay the need for transmission and distribution system expansion. These values will be increasingly taken into account in project finance as policies are established for distributed generation and as utilities realise opportunities for cost savings.

Increasing the share of renewables in the energy portfolio reduces the impacts of imported fossil fuels; such diversification mitigates risks, in particular risks of price swings of fossil fuels. Future costs of renewable electricity can be predicted with greater accuracy, as most of the costs are incurred up-front and operating costs are typically not dependent on fuels. For example, the Texas Renewable Portfolio Standard (Case Study 3) was established mainly because Texas had become a net importer of energy. The goal of the Texas RPS is to build a large market for wind, solar and other renewables to reduce energy imports into the State and enhance Texas' energy security.

Case Study 3 Texas Portfolio Standards

Under the Renewables Portfolio Standard (RPS) in Texas retail electricity suppliers have a requirement to include a specified percentage of renewables in their generation portfolio. The policy is backed up by annual renewable energy generation targets. Texas has set targets increasing to 2,880MW of renewables to be installed by 2009; this includes the addition of 2000MW from new renewable generating projects. Wind energy is currently dominating the new installed capacity of renewables with supply costs of around 3 cents/kWh (which includes a 1.7 cent/kWh federal production tax credit).

Projections show that the first year target of 400MW of new capacity to be installed during 2002 and 2003 will be exceeded significantly. The key factors considered to be contributing to the success of the policy are clear renewable energy targets, clear renewable resource eligibility requirements, stringent non compliance penalties, a Tradable Renewable Energy Certificate system that encourages flexibility and minimises costs, and a dedicated regulatory commission that fully involved numerous stakeholders during the detailed design of the policy.

A major lesson from Texas is that, while the RPS is new and relatively untested as a policy tool, it has the potential to cost-effectively support the establishment of a robust renewable energy market.

In contrast to large-scale centralised fossil fuel power plants, renewables contribute to the local economy through both manufacturing and project development. Some studies have indicated that renewable-based energy requires more labour input per unit of energy produced than conventional sources because renewable energy is manufactured energy and capital-intensive rather than fuel-intensive[17].

Additionally, renewables are often dispersed into local communities, where project level jobs and revenues from site leases can enhance the local economy. This can be seen in the mid-west of the United States, where an alliance has formed between farming communities and wind developers who pay leasing fees for good wind sites. The case of the Sahel (see Case Study 4 in Annex 7) also illustrates that renewables can create jobs.

[17] Renner 2000

1.5.2 The Development Case for Renewable Energy

At a time when many people in developed countries take it for granted that electricity will be there when they flip a light switch or turn on a radio or television, and when increasing numbers take access to the Internet equally for granted, at least two billion people—a third of the world's population—live without the benefits of electricity or other modern energy forms. Most of these people—a substantial and growing portion of the world community—live in areas of developing countries that are too remote or too expensive to connect with an electrical grid. Both governments and the development community alike are growing increasingly interested in renewable energy as the key to supplying these distant communities with reliable power. Renewable energy provides important social and economic benefits in rural areas. For households, small industry, agriculture, schools, medical clinics, and community centres, renewable energy can power lighting, communications, computers, water pumps, wood and metal tools, sewing machines, refrigeration, and more, both cost-effectively and reliably. Biomass is also an important source of fuel for heating, cooking and lighting. "Bringing it close to home" has the added benefits of creating badly needed local jobs and business opportunities. The case of Greenstar (Case Study 5) demonstrates how renewables can serve sustainable development needs.

Case Study 5: Greenstar: an example of how renewables serve sustainable development needs

Greenstar delivers solar power, health, education and environmental programmes to small villages in the developing world – and connects people in those villages, and their traditional culture, to the global community. To deliver these services efficiently and quickly, Greenstar has designed a portable community centre. Solar power generated by large photovoltaic panels makes it possible to drive a water purifier, a small clinic, a vaccine cooler, a classroom, a digital studio and a satellite or wireless link to the Internet. Greenstar is a profit making business that works with the people of each village to develop an E-commerce web site, employing local musicians, teachers and art professionals. Villagers own the Greenstar Village Centre themselves, and become shareholders in Greenstar.

1.5.3 The Environmental Benefits of Renewables

The amounts people pay for electricity in retail markets often fail to account for the socio-environmental costs that power generation imposes on society, e.g., costs associated with health impacts of local pollution or global warming. These costs are known as "external costs", or "externalities", though they are intrinsic to every kind of energy use. Renewables are not entirely pollution-free and produce some environmental impacts. Such issues as land use, containment of toxic materials used in manufacturing, and visual intrusion (of large wind machines) must be addressed when renewable energy projects are proposed.

Renewables and climate change:

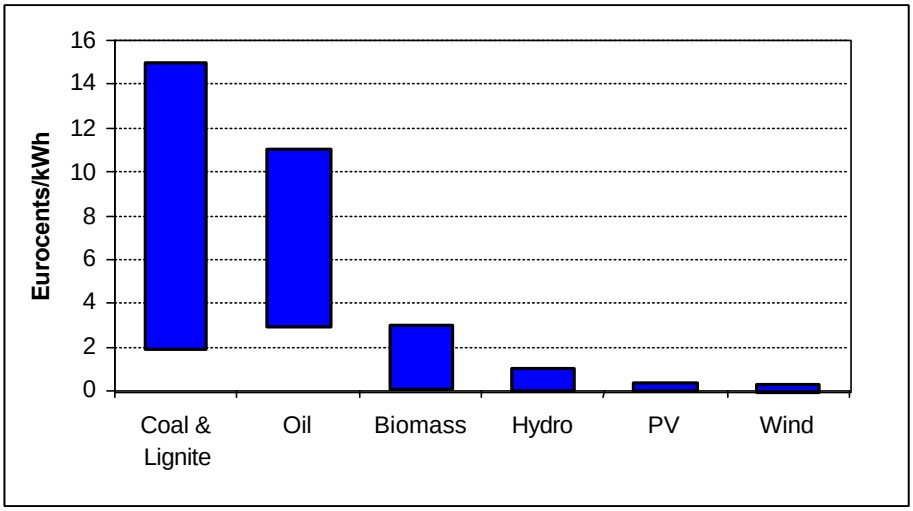
In a recent report* the Intergovernmental Panel on Climate Change (IPCC) highlights the importance of introducing technologies with improved environmental performance to mitigate climate change. The report predicts an impact on the renewable energy companies from shifting priorities and resources to reduce carbon in the atmosphere:

"For the crucial energy sector, almost all greenhouse gas mitigation and concentration stabilisation scenarios are characterised by the introduction of efficient technologies for both energy use and supply, and of low- or no-carbon energy (sources)." … "Other industries including renewable energy industries and services can be expected to benefit in the long term from price changes and the availability of financial and other resources that would otherwise have been devoted to carbon-intensive sectors."

Figure 5 presents the findings of a study on externalities of power generation comparing renewables to conventional energy from the European Commission's ENERGIE Programme (European Union 5th Research and Technological Development Framework Programme). It shows estimated external costs per kWh of electricity generated from several energy sources (including quantified external costs of global warming, public health, occupational health, and material damage) and demonstrates the high socio-environmental costs of using fossil fuels, especially coal and lignite. Compared to conventional technologies, renewable energy technologies provide energy services with vastly reduced local and global environmental impacts.[18] This fact is well-studied and clearly understood by policymakers, businesses, and the public at large.

[18] * Intergovernmental Panel on Climate Change "Climate Change 2001: Mitigation", Summary for Policymakers, March 2001

Figure 5: External costs for electricity production in the EU in Eurocent/kWh. Source: Data from the European Commission - ENERGIE Programme (European Union 5th Research and Technological Development Framework Programme).



2 REGIONAL ENERGY NEED AND SUPPLY

Energy needs are closely intertwined with the level of economic activity and therefore vary significantly in different parts of the world. No country has been able to develop its economy beyond subsistence level without access to any more than a minimum level of modern energy. The next sections assess the energy needs in the following different markets:

- Non electricity markets in developing countries;
- Off-grid electricity markets in developing countries;
- Grid markets in developing countries; and
- Grid markets in developed countries.

The sections highlight for each of these markets the energy needs, the particular merits of renewables in meeting these needs in a sustainable way, as well as the key barriers to deployment of renewables in these markets. It should be recognised that renewables should be considered as only one of the viable options to serve electricity, cooking and heating needs, recognising that in some cases other available options are more appropriate. The importance of complementary energy efficiency measures should also be emphasised.

2.1 Cooking and heating in rural areas

The majority of the population living in those parts of the world where there is no access to modern energy, i.e., those living "off-grid," rely on traditional biomass (fuel-wood, dung, rice husks, other forms of 'bio-fuels') to satisfy their cooking and heating needs.

On average, traditional biomass accounts for 34% of total primary energy consumption in developing countries and represents more than 90% of total energy demand in many developing countries[19]. This makes biomass the single most important source of energy in rural areas.

Annex 1 (sub B) summarises biomass demand for cooking and heating, and calculates that the total non-commercial (self-gathered combustible renewable and waste) energy demand in 1997 in developing countries is close to 900 Mtoe.[20] Many households in both rural and urban areas, even those that already have access to electricity, are expected to continue to rely on traditional biomass as their primary energy source for cooking. Currently households typically use three stones or a hole in the ground to cook food, or use LPG or kerosene cooking stoves.[21] The challenge is to ensure a more efficient and sustainable use of biomass, while avoiding problems associated with deforestation.

2.1.1 Dimensions of the current use of traditional biomass

The abundant traditional usage of biomass leads to serious environmental, economic and health problems.

Health and quality of life

Current use of traditional biomass affects quality of life and health. The burning of biomass seriously damages people's health, especially the health of children and women who are often responsible for cooking in most developing countries. In India the pollution from current indoor cooking technologies are estimated to cause 5-6 percent of illness-related deaths.[22] Exposure to smoke and soot has recently been estimated to cause as many as 4 million premature deaths each year, 40 million new cases of chronic bronchitis, and widespread cases of other

Key Fact: Indoor pollution and health

A Billion People Breathe Dangerous Indoor Air (WHO strategy meeting on Air Quality and Health, Geneva, September 2000). As many as one billion people, mostly women and children, are regularly exposed to levels of indoor air pollution exceeding World Health Organisation (WHO) guidelines by up to 100 times. The highest air pollution exposures occur in the indoor environment, particularly in developing countries.

[19] FAO 1999
[20] WEO 2000, p. 59
[21] Renewable energy should be considered as only one of the viable options to serve cooking and heating needs, recognising that in some cases other available options are more appropriate.
[22] WEA 2000a, p.69

respiratory illnesses.[23] Nearly 60 percent of deaths are those of children under the age of five, the result of exposure to dirty cooking fuels because of the lack of access to modern energy. While estimates vary, the economic costs of air pollution are substantial. It was recently estimated that the economic losses due to the millions of cases of respiratory illnesses from indoor and outdoor exposure, which cause reduced productivity and lower life expectancy, amount to at least US$ 350 billion per year, or 6 percent of the GNP of developing countries.[24] Acute respiratory infections ranked 4th in the share of the burden of diseases in sub-Saharan Africa (accounting for 7% of the total).[25]

Productivity and economic growth
On average, women in developing countries spend 9-12 hours and men about 5-8 hours per week gathering wood and dung.[26] In deforested areas where these fuels are more scarce, women spend up to 2.5 hours[27] each day collecting about 6 kg of fuel-wood to provide the household with energy. Improved cookstoves in these households would allow more time for agricultural or other business activities.

Environment
With current technologies, the use of traditional biomass damages the environment, which can further exacerbate poverty. The search for fuel-wood and dung can result in local environment problems like deforestation and declining soil fertility. Globally, forest resources are abundant and should suffice to meet needs in the foreseeable future. However, the situation varies greatly between geographical areas : while new plantations by and large compensate for forest losses in Asia, deforestation continues to accelerate in South America and Africa, particularly in some dry tropical zones and in the Mediterranean Basin and around large cities that create a specific pressure on wood resources. This eventually forces people to spend even more time gathering further away, and at the same time reduces the productivity of land and leads to desertification. As a result, mudslides, causing great damage and loss of life, have become increasingly common in rural areas.

2.1.2 Overcoming barriers to improved use of traditional biomass

How then can we do better, and ensure more efficient and sustainable use of biomass?
A first step towards more sustainable use of biomass is to increase the efficiency of current technology by exploiting new energy conversion technologies. Advanced biomass-cooking stoves with chimneys can potentially reduce fuel consumption by 40% or more[28], removing most harmful indoor emissions.

These advanced cooking stoves are becoming increasingly affordable and a cost-effective way to reduce CO2 emissions (US$4 per avoided ton of CO2 according to the FAO).[29] Chimneys can significantly reduce health impacts from indoor smoke emissions, perhaps preventing death for most of the 3.5 million people that are expected to die prematurely each year over the next 20 years as a result of indoor pollution.[30] As people (particularly women and children) will spend much less time on collecting bio-fuels, they will be able either to spend more time on education or more productive work.

[23] World Bank 2000a, p. 25
[24] World Bank 2000a, p. 27
[25] WHO 1999
[26] WEA 2000a, p70. This is based on an analysis in four developing countries. It should be noted that the time spent on gathering fuel wood can differ among countries.
[27] World Bank 1996
[28] FAO/WEC 1999, p. 59
[29] FAO 1999
[30] World Bank 2000a, p. 97

Case Study 6 Cook stoves in Kenya

The stove programme in Kenya was successful for a number of reasons: the central production of key components, the use of small enterprises to produce and market stoves in areas where users could afford to pay, the use of women's groups for stove dissemination in rural areas, and the tailoring of designs to meet local conditions. Some 16% of households are presumed to currently use the new 'jiko stove', which led to a price decrease from US$15 initially, to US$1-US$3 today. This is a good example of the downward effect of the 'experience curve' on costs, discussed in Chapter 1

Nevertheless, switching to more efficient cooking stoves is challenging, and faces financial and cultural barriers. The stove programme in Kenya (see Case Study 6) is a good example of how these barriers were overcome. It demonstrates that large-scale introduction of a simple but- effective technology goes hand in hand with the creation of a local industry (Small and Medium Scale Enterprises): a step forward towards sustainable development. However, in many areas, an efficient use of biomass is not sufficient to alleviate deforestation problems. Sustainable forest management and development of industrial and/or community silviculture are often needed.

2.2 Off-Grid Renewable Electricity in Developing Countries

2.2.1 The challenge of providing electricity in off-grid (rural) areas

In order to be able to listen to the radio a few hours per day, read at night, consume a minimal amount of clean water, people need a modest level of electricity. These services seem very basic, but greatly affect people's quality of life. It is estimated that to provide such basic electric services for household, community (hospitals and schools) and commercial activity, people need about 50 kWh per person per year (see Table 1 for a list of electricity demand per month per household, assuming on average 5 persons per household). The annual costs of extending electricity services to the rural population are not clearly known, but investments overall in the electricity systems of developing countries is about US$40-60 billion annually. [31] Despite these investments, approximately 1.7 billion people remain without electricity[32].

Table 1 Typical Energy Service Requirements in the Form of Electricity for Off-Grid Populations in Developing Countries

Development NEED		TYPICAL ENERGY SERVICES FOR OFF-GRID HOUSEHOLDS	Electricity Demand. kWh /month, per household
House-hold energy need	Lighting	5 hours / day at 20W for a household	2-6
	Radio/Music	5 hours per day at 5W per household	
	Communication	2 hours per day at 10W per household	
	Potable water	Electric pump providing the community with 5 litres per day per capita	
Medical services		2.5 kWh / day for basic services in a rural clinic for 100 households	0.5-1
Education		2.5 kWh /day for lighting, water pumping, copying, computer, copier, TV, Video, radio etc in a school for 100 households	0.5-1
Productive (income generating uses)		5 kWh / day for equipment used by workers from 10 households	0-20
TOTAL			3-30

The actual electricity needs of off-grid households depend on the culture and normal activities of the communities concerned, geographical variations, and the extent to which it is feasible and appropriate to provide services on a community basis and to individual households.

The fact that poor people attach great value to energy services is revealed by the relatively large share of their income that they are willing to pay to acquire reliable energy services (see Case Study 7). Most developing country governments recognise this and see rural electrification as a high priority in their effort to increase the standard of living in rural areas, reduce migration trends, and realise other development objectives. Many governments have formulated plans for rural electrification. The three key challenges for rural electrification are: (a) how to provide sustainable energy (electricity) services to the poorest of the poor, who have no purchasing power to pay for electricity services?; (b) how to offer the most cost-effective, clean and reliable electricity to those who are currently already spending a significant share of their income on energy services?; and (c) how to set up the commercial infrastructure to provide these services?

Case Study 7 People value reliable services in the South Pacific

A mini grid has been installed on one of the outer islands in Tuvalu in the South Pacific, using diesel generators. This mini grid operates for only a few hours per day (mainly in the morning and the evening), due to difficulties in supplying diesel to the remote island and also due to the cost of running the mini grid. Charges for households are as high as 30 Australian Dollars per month even for this limited service. The mini grid provides electricity for a range of services including lighting, television, video, radio, music, electric fan and fridge freezer. In addition to this diesel mini grid, some people are also willing to lease a solar home system for around 9 Australian Dollars per month. The solar home systems installed only provide enough electricity for lighting, and radio/music, but people value the reliability of being able to switch on a light at any time of night, and are willing to pay extra for this facility.[33]

Decentralised energy systems are often more applicable and affordable than grid extension linked to large fossil-fired power generators. Existing mini-

[31] NDC 2000; Feinstein 2001

[32] The fact that 2 billion people—one-third of the world's population—rely almost completely on traditional energy sources was first noted in a World Bank report on rural electrification (World Bank 1996). WEA 2000 estimates that "2 billion people are without clean, safe cooking fuels and rely on traditional biomass sources; 1.7 billion are without electricity' (WEA 2000a, p.44)

[33] AEAT 1999

grids are primarily fossil-fuel based, and diesel generation sets are widely applied either directly, or to charge batteries. Even though in many countries a commercial infrastructure to provide such electricity services is in place, it is questionable whether this is the most sustainable, cost-effective, and reliable way to provide electricity services.

2.2.2 The role of renewables in off-grid areas and barriers to further deployment

Although a share of the 18,000 MW of small hydro installed in developing countries also powers mini-grids, the use of renewable energy for off-grid stand-alone productive uses like small industry or agriculture has so far been very limited, except in telecommunication stations. Where renewable energy is abundant, expandable and decentralised renewable energy systems, such as solar photovoltaics (PV), small hydropower and wind systems, can be the most affordable and accessible option to provide off-grid electricity services. Many renewable energy technologies, because they are small in scale and modular, are well suited to the energy needs in off-grid areas (providing stand-alone or mini-grid systems) and can be expanded as demand grows.[34] They also have a good potential for continued reduction in cost as a result of field experience and larger volumes of manufacture. As such renewables ought to be seriously considered as a response to the key challenges in rural electrification. Why then, are they not more widely applied and considered in rural electrification plans?

One of the principal barriers to increased deployment of renewables, and PV in particular, is access to appropriate finance, at all levels: householder/end-user credit or prepayment scenarios; credit for small business providers and installers; working capital for distributors and new small businesses; etc. The World Bank Group's PV Market Transformation Initiative is a programme that successfully addresses the need for financing, distribution and service capabilities (see Case Study 8 for India). Peru's revolving fund is another example of successfully addressing financing barriers (Case Study 9 in Annex 7).

Case Study 8 PV Market Transformation Initiative in India

The PV market in India was approximately 10 MWp/year in 1997. Government PV purchasing and subsidy programmes have played a significant role in supporting the development of an Indian PV industry. However the market is characterised by:

- an unacceptably high incidence of system failure in the field
- Inadequate marketing, distribution, customer support and after-sales service; attributable to private sector markets being suppressed by subsidy programmes.
- general lack of consumer awareness of PV technology and its benefits.
- dependence on end-user subsidy.
- underdeveloped availability of consumer finance which is crucial to make solar home systems affordable.

The PVMTI programme aims to build up financing, distribution and service capability. This will be achieved through the provision of finance for sustainable and replicable commercial PV business models, the financing of business plans with commercial loans at below-market terms or with partial guarantees or equity instruments, and the provision of technical assistance to PV businesses on planning, financing operations and technology.

Even where there is a demand for the product (electricity), the question arises as to whether people in rural areas of developing countries should pay up-front for their electrification hardware. Those people connected to the grid do not: they merely pay a fee. Well-designed subsidy programmes, particularly so-called "smart subsidies" which are temporary, competitively administered and performance-based, can be appropriate in developing country markets. It is important to periodically review subsidy and incentive programmes to identify those that are working effectively and to recommend curtailment of those that are not working or are producing harmful market effects.

Even though renewables are often more economic than current conventional alternatives on a life-cycle basis, they are perceived as more costly because they require that the bulk of the life-cycle costs be paid up-front. There is a need to spread payments out over time, as is routinely done with large purchases in developed countries. There is also a need for "patient seed capital" for renewable energy firms, and financing to help clear project development expenses for private developers/sponsors of renewable energy projects. An example of this is provided in Case Study 10 (Bangladesh). In general, innovative financing schemes should make their way into local and international financing and development institutes, which is critical to ensuring widespread use of renewable energy technology.

[34] Renewable energy should not be considered as the only energy resource possibility, but as a sub-set of all appropriate energy options (including energy efficiency) that support sustainable development.

However, widespread diffusion of renewables in off-grid areas requires more than (innovative) financing. It requires also strengthened capacity for local manufacturing/ assembly of renewable energy technology and a commercial infrastructure for the delivery and maintenance energy services from renewables. An example of a successful programme to build such capacity is provided by the Solar Development Group in Case Study 11. The African Rural Energy Enterprise Development (AREED) Initiative also seeks to develop sustainable energy enterprises (see Case Study 12 in Annex 7).

Case Study 10 Bangladesh - seed funding for solar home systems

In 1998 the Global Environment Facility (GEF) provided funding to an organisation in Bangladesh, Grameen Shakti, which enabled them to offer improved credit terms, increasing the payment period for solar home systems from one to three years. This had a significant effect on demand. Between 1997 and 1999, Grameen Shakti sold 1500 systems Solar Home Systems and installed 2000 to 2500 systems in the year 2000. Grameen Shakti found that after a "critical mass" of installations, for example 100 systems, the process of building customer confidence and demand became less time consuming, as people bought systems on the recommendations of other customers. Grameen Shakti believes that after three to four years of this profitable growth they will be able to obtain financing from commercial banks. This project has shown that the use of GEF financing to support a "high risk" project, unable to obtain commercial financing on its own, can result in significant growth and provide the means by which an organisation can obtain commercial financing.

Data on international financing flows for off-grid renewable energy are limited. To date, about 700,000 solar home systems have been installed in developing countries, reflecting a cumulative capital investment on the order of US$300-500 million. One of the largest existing sources of finance for off-grid renewable energy is the Global Environment Facility, which has allocated more than US$200 million in grants and attracted more than US$1 billion in additional co-financing from multilateral agencies, governments, and private companies for off-grid renewable energy[35].

Case Study 11 Solar Development Group: SME and capacity building

The World Bank/GEF has recognised that greater support should go directly to entrepreneurs and other potential private sector developers of the rural PV market (including NGOs and financial intermediaries). If these actors do not participate in programmes designed to reach rural areas, the funds intended for the rural PV sector may not reach the rural population without electricity. In order to address this barrier, the World Bank and IFC along with a number of charitable foundations, have developed the **Solar Development Group** (SDG). The mission of SDG is to accelerate the development of viable, private sector business activity in the distribution, retail sales and financing of off-grid rural electrification applications in developing countries. A total of 10 local PV companies have already received financial support through the SDG and another 12 are expected to be funded during 2001. A pipeline of over 200 companies in 57 countries have been identified and are under evaluation for possible support.

2.2.3 Sustainable development dimensions of off-grid electricity

Serving people in off-grid areas with renewables enhances their quality of life, benefits the economy, and reduces stress on the environment. The case of Madagascar (Case Study 13) is an example of how those living in remote parts of the world can benefit from renewable energy services for health centres and households.

Providing rural people with lighting, power equipment and telecommunications powered by electricity can dramatically improve productivity and enable the creation of cottage industries, service businesses, and more efficient farming and animal husbandry practices. With easy access to electricity, children and adults can study at night, and schools can access educational media, bringing prospects for a better future. Electricity can provide improved healthcare facilities via lighting, vaccine refrigeration, and monitoring and communication equipment. Improving the quality of life in remote rural areas and facilitating communication with family and friends in urban areas reduces the pressure to migrate from rural to urban areas.

Key Facts: Energy and the poor

- 2.8 billion people live on less than US$2/day and 1.2 billion on less than 1US$/day (World Bank 2000b)
- 2 billion people lack modern energy sources and depend on biomass for their cooking, lighting and space heating needs (WEA 2000a, p.44)
- People in developing countries without access to modern fuels actually spend a higher fraction of their income on energy than those who have access (World Bank 2000a, p.3)

[35] Martinot/Ramankutty/Rittner 2000

Case Study 13 Madagascar PV for health centres and households

A rural electrification project has been launched in Madagascar based on three components: a social component for the electrification of rural health centres, a domestic component for the electrification of households using micro-credit, and an economic component where electrification is intended for productive applications.

Solar PV electrification of health centres to provide better healthcare through the installation of lighting and refrigeration, also serves to increase the awareness of the rural population of the use of renewables for electricity provision. For the financing of household systems a micro-credit financing scheme has been set up through a local bank and a local retailer. In the first phase of the project, 50 health centres and approximately 500 consumers are expected to obtain access to electricity. A key element of the work is the involvement of the various local stakeholders (institutional, banks, retailers and suppliers, users).

Electricity produced from renewable energy resources has negligible local and global environmental impacts and safety problems compared with conventional energy systems. However, it should be recognised that conventional options often require less up front capital and may therefore be the more feasible option, even though they require higher operating and life-cycle costs.

Key Facts: What are people willing to pay for a reliable energy services? – Uganda

Rural people are willing to pay high prices to make up for their lack of access to grid electricity. Because the alternatives are limited and inefficient, energy represents a major item of rural household expenditure.

- 4% of average household expenditure is for dry cell batteries, which are 15-30 times as expensive per kWh as grid electricity (equivalent to a "tariff" of US$400 per kWh).
- About 9% of the non-grid connected households use car batteries to power their televisions and lights, at an annual cost of about US$120 (7% of income), at an average of US$3 per kWh.
- So many Ugandan firms have their own generating sets, they have installed the equivalent of a third of the capacity of the national utility, but pay from two to seven times as much for electricity as their counterparts fortunate enough to be connected to the grid

A similar ESMAP survey in Malawi (1998) found that rural people in the lowest income bracket (less than US$25 equivalent per month) spent up to a third of this on energy (candles, kerosene, charcoal) and would be willing to pay even more for electricity.

Sources: Uganda Rural Electrification Strategy study, final report January 1999; Malawi Rural Energy and Institutional Development, draft July 1998, World Bank, ESMAP

2.3 Grid-based markets in developing and transition countries

"The current energy system is not sufficiently reliable or affordable to support widespread economic growth. The productivity of one-third of the world's people is compromised by lack of access to commercial energy, and perhaps another third suffer economic hardship and insecurity due to unreliable energy supplies[36]."

2.3.1 The challenge of providing quality electricity services

In the past 30 years, developing countries' electricity use has increased at a rate three and a half times that of OECD countries. This has resulted from lifestyle changes made possible by rising incomes, higher population growth rates, and a shift from traditional to commercial energy. Currently, about 1.3 million megawatts of electric power capacity exists in developing countries, representing about 40% of total global capacity[37]. Global generating capacity outside OECD and the transition economies is projected to increase by nearly 1.6 million megawatts over the next 20 years. This will require investments of around US$1.7 trillion[38] or US$3.8 trillion for total energy investments in 30 years[39].

Available data suggest that typical per-capita electricity consumption today in developing countries for urban residential needs is about 200-500 kWh/year, although this number varies widely from country to country and across different economic classes of urban and peri-urban households. Traditionally used initially for lighting, electricity consumption grows rapidly with rising living standards as home appliances like refrigerators, air conditioners, washers, televisions, and computers multiply in

[36] WEA 2000b
[37] IEA 1998
[38] WEO 2000 p.38
[39] WEC 1995

developing country households. The per capita demand for electricity is expected to increase considerably in the future. With a conservatively estimated growth-rate of 8%, electricity needs would double in the next decade, reaching about 500-700kWh per person per year.

2.3.2 The role of renewables in grid areas and barriers to further deployment

Of the 1.3 million megawatts of grid-based electric power capacity installed in developing countries, about 70,000 MW, or 5%, is based on renewable energy (large hydropower excluded). Most of this capacity is small hydro and biomass power generation, with some wind power and geothermal.[40] This represents a cumulative investment in grid-based renewable energy of US$70-90 billion.

Servicing the growing electricity needs described above would require approximately 730 GW in the period 1997-2010[41]. The key barrier to accelerated deployment of renewables in grid areas is financing. National plans and proposals for renewable energy in developing countries might reach or exceed 50-70 GW in the coming decade, representing capital investments on the order of US$40-60 billion. The bulk of these investments would be expected to come from the private sector. The concessional (or "soft") financing that would accompany such capital investment is uncertain, but for a non-concessional- to-concessional finance ratio of 5:1, the concessional finance required would be on the order of US$8-12 billion (or US$0.8-1.2 billion per year over ten years).[42] Thus, given the existing flows of total power sector investment in developing countries of roughly US$40 billion per year, capital investments for renewable energy would need to represent about 10-15% of total annual investments over a period of ten years (US$4-6 billion/year). In comparison, an estimated US$0.5-1.5 billion annually, or 1-3% of power sector investment, have been invested in renewable energy in developing countries in recent years. These renewable energy investments are expected to increase to the US$2-3 billion/year range once some countries, such as India and China, enact further policies favourable to renewable energy development.[43] The capital investments in renewable energy in India and China alone could amount to US$1-2 billion/year in coming years, given further policy developments and cost reductions.

In many developing countries consumers pay well below the market price for electricity. The WEO finds that, due to entrenched government support, in eight of the largest countries outside the OECD end-use prices are, on average, approximately 20% below market-based levels. This despite substantial progress in recent years to move towards more rational pricing and market based policies, which would enhance the competitiveness of renewables. The report concludes that these price subsidies result in substantial economic losses and impose burdens on the environment. Removal of these subsidies would reduce primary energy consumption by 13%, increase GDP through higher economic efficiency by 1%, and lower CO_2 emissions by 16%[44]. However, it should be noted that removing these subsidies may have social consequences.

2.3.3 Sustainable development dimensions

Current grid supply of energy services is often not sustainable. Current available energy services need to be improved to enhance people's quality of life, facilitate commercial activities, enhance economic growth and stability on a national level, as well as address adverse environmental effects. Providing people with affordable and reliable energy services would greatly improve their quality of life. People in developing countries who have access to electricity spend substantial portions of their income on energy. However, electricity supplies are often plagued by frequent interruptions, which have serious disruptive impacts on people's ability to do business, and causes hardship to individuals. In some developing countries half of the electricity systems are episodically inoperable. The costs of investing in back-up facilities are considerable (typically a third of the system costs)[45].

[40] Martinot 2001
[41] WEO 2000, p. 106
[42] For comparison, the renewable energy portfolio of the Global Environment Facility has resulted in a non-concessional-to-concessional financing ratio of 5:1 (US$580 million in GEF grants and US$2.5 billion in co-financing).
[43] World Bank, personal communication.
[44] WEO 1999, p.9
[45] WEA 2000a, p. 114

Improving economic conditions
Including renewables in the energy portfolio can improve energy security and enhance price stability, to the benefit of any country's economy. Energy security means the availability of energy at all times in various forms, in sufficient quantities and at affordable prices. Another common definition is not being dependent on other countries for one's energy supply. Most developing countries are net energy importers, which makes them vulnerable to disruptions in supply and even potentially to sabotage, disruption of trade and conflict. Renewable energy included in the energy portfolio implies energy diversification and reliance on indigenous energy resources. Developing countries are particularly vulnerable to fossil fuel cost increases and supply shortages. When oil and gas prices escalate, most developing countries are hit much harder than the industrialised countries. Increasing fuel prices coupled with a decline in a major export, such as cocoa, can send a country's economy reeling. Including renewables in the energy portfolio can strengthen a country's ability to withstand fluctuations in the terms of trade. Reducing dependence on fuel imports can also reduce effects of currency exchange rate fluctuations, which impact on the price of oil in local currency.

Improving the environment
Conventional energy production and consumption often leads to environmental degradation. In developing countries the local environmental problems associated with energy use remain matters of concern that are at least as pressing as they were in industrialised countries 50 and 100 years ago. Looking into the future, developing countries also have high stakes in addressing global environmental issues. Although developing countries are suffering disproportionately from the adverse effects from climate change, it is in the interest of all to tackle this problem.

2.4 Grid-based markets in developed countries

2.4.1 The challenge of providing quality and sustainable electricity services

Average per-capita electricity consumption in OECD countries for residential needs is about 2700 kWh/year[46]. Nearly all (1 billion) people living in the developed world have access to grid electricity, using a range of home appliances and other electrical equipment[47]. However, the electricity generated is most often not from energy sources sustainable on a long-term basis.

Energy demand in OECD countries is expected to increase by 16% between 1997 and 2010, a result of growth in population and economic activity. From Figure 1 can be inferred, that energy use per person in OECD countries by far exceeds per capita energy use in developing countries. Nevertheless, technology advances and resulting efficiency improvements have decreased energy use per person/ and per unit of GDP.

2.4.2 The role of renewables and barriers to further deployment

Total installed electric power capacity in developed countries now exceeds 1.8 million MW, of which about 40,000 MW is renewable energy[48]. In terms of electricity production, 98% of electricity is generated by conventional technologies (fossil fuel, nuclear and large hydro), while the share of renewables in the technology portfolio is currently approximately 2%. The alternative scenario of the World Energy Outlook 2000 projects that if OECD countries were to adopt new policies to encourage further use of renewables, their share in the electricity mix could increase from 2% in 1997, to 8.6% of electricity output in 2010 (590 TWh). This corresponds to providing an additional 150 million people with renewable electricity in 10 years, assuming approximately 3000 kWh per person per year for residential electricity needs in 2012. This would require an additional 160,000 to 180,000 MW of renewable energy capacity, representing additional capital investments of US$90- 120 billion. Assuming a non-concessional-to-concessional finance ratio of 5:1, the concessional finance required would be on the order of US$15-20 billion.

People in OECD countries spend approximately 2% of their income on electricity. In many countries electricity is directly or indirectly subsidised. Subsidies are typically introduced for social reasons, or to help an industry/technology develop, and to protect domestic industries against the loss of

[46] This includes transmission and distribution losses. Following WEO 2000, recent OECD members are not included.
[47] Schipper 1997
[48] IEA 1998; Martinot 2001

international competitiveness. Most of these subsidies are invested in conventional and nuclear energy. Removal of these subsidies would reduce electricity use, encourage equal treatment of renewables vis-à-vis conventional energies, and increase their deployment.

Many people in the developed world do not think about where their energy comes from. They just flick a switch or start their car. Nevertheless, there is increasing awareness of the adverse environmental impacts of today's energy systems. Due to the deregulation of energy markets, a growing number of people have a choice in what kind of energy they wish to purchase. Demand for clean ("green") electricity is growing. Because 'internalising external costs' (taking the environmental or other societal damage into account in pricing) may be controversial for some time, 'green' pricing of electricity and heat (which lets consumers pay more for environmentally benign energy supplies if they choose) can be an appropriate option in industrialised countries. In the US, more than one third of all consumers now have an option to purchase green power[49]. Some countries and states have made great progress in designing policies that stimulate renewables, such as the Texas Renewables Portfolio Standard (Case Study 4), the German Renewable Energy Law (Case Study 14) and the Netherlands tax incentives for green funds (Case Study 15). The latter provides tax exemptions to consumers investing in green funds, which are used to finance not only 'green projects' in the Netherlands, but also in developing countries.

Case Study 14 German Renewable Energy Law

The German Renewable Energy Law was passed in 2000, in order to establish a framework for doubling the market share of renewable energy sources by 2010. The law sets specific maximum pay-back prices for each individual renewable energy technology, based on their annually decreasing real cost. The aim of the tariffs is to initiate a self-sustaining market for renewables and create a critical mass through a large-scale market introduction programme, whilst not imposing any additional burden on the taxpayer. A key lesson learned is that a law which takes into account learning curves for renewable energy technologies through decreasing feed-in tariffs is appropriate, particularly in a deregulated market. It has led to the largest installed wind energy capacity in the world.

Case Study 15 The Netherlands tax incentives for green investments

The Green Fund System (GFS) was introduced in the Netherlands in 1992, as a co-operative activity between the government and the financial sector. It combines a tax incentive, a framework for designation of green projects and the active involvement of the financial sector. The basic principle behind the system is that the general public receives tax advantages for investments in 'Green Funds'. The Green Funds provide soft loans with low interest rates to green projects. Initially, only projects in the Netherlands were eligible for funding, but in 1995 the scope was extended to projects in developing countries and economies in transition.

The enthusiasm of the public has contributed to the success of the Green Funds system. The Green Fund System has successfully set up a self supporting market development programme for green projects, which is based on existing financing infrastructures and encourages the active support of the financial sector and general public.

2.4.3 Sustainable development dimensions

Impact on the economy

Significant amounts of primary energy resources, particularly oil and gas, are located in politically charged regions. The oil crises in the early and late seventies and recent price spikes have demonstrated the dramatic implications of energy price changes on OECD economies. The risk of supply interruptions, and the costs of managing those risks, has increased dramatically. The cost of insecurity of the electricity system for non-deferrable economic activities is considerable. In the United Sates it is estimated that these costs might exceed US$5 billion a year[50]. The costs of the recent disruptions in electricity provision in California are substantial and still being calculated (Case Study 16). Some renewables embedded in the grid can be targeted to distribution system locations to alleviate load stresses at lower costs than installing new generation and distribution assets.

Case Study 16 California: the costs of disruptions in electricity

The California crisis provided a close view into the imperfect behaviour of the energy marketplace. The costs seem to be tremendous.

The utilities say they are near bankruptcy because wholesale prices have risen sharply with the shortage and they have lost more than US$11-billion. A recent one-day power outage in the San Francisco Bay Area is reported to have cost manufacturers in Silicon Valley over US$75-million in lost production. During the last heat wave, the California Independent System Operator spent over US$200-million to obtain emergency power to stabilise the system.

Current energy portfolios depend mostly on fossil and nuclear technology. Like financial investments, each energy technology is characterised by different risk profiles. Diversification is the new buzzword, acknowledging that too much concentration on one type of technology or investment is risky. This is

[49] Swezey/Bird 2000

[50] Newton_Evans Research Company, 1998, adapted from WEA 2000a, p. 115

particularly true if a technology or investment is associated with fuel cost or environmental issues. Diversification of a portfolio involving a range of fossil-fuel based alternatives is risky, as the prices of these different alternatives are highly correlated, making hedging against price risks impossible. Including renewables in the energy mix means decreased dependence on imported resources and fuel supply insecurities.

Social impact
The social dimension of renewable energy use in industrialised countries is also important. Unlike conventional power plants that are built in fenced security compounds, renewables can more readily be part of the community fabric. Renewables often engage the community in energy decision making and encourage individual responsibility.[51]

Impact on the environment
Energy use per unit of GDP has declined in OECD countries in recent decades, as has pollution per unit of fossil fuel used. But overall energy usage has increased, leading to overall increases in emissions of carbon, particulates and other by-products of fossil use, raising the spectre of climate change and other environmental impacts. Renewables do not produce carbon, or generate other significant pollutants. Cost-effective strategies to tackle global warming, including offshore investments in Joint Implementation or the Clean Development Mechanism, can promote renewables.

G8 nations renew pledge to tackle global warming

After two days of closed-door talks, the G8 Environment Ministers say they would aim to finalise the Kyoto agreement. "We commit to take the lead by strengthening and implementing national programmes and actions to reduce greenhouse gas emissions," said the G8 countries, which together produce more than half of the world's population.

Source: Planet Ark, 6.3.01

[51] The US Church building project is a good example

3 CONDITIONS FOR MARKET EXPANSION

3.1 Market forces to expand the market for renewables

In order to expand the markets for renewables, it is important to understand the market forces that encourage renewables' market deployment, as well as those restraining their entry.

Table 2: Market Forces

Forces stimulating RE	G8 vehicles to influence forces		Forces restraining RE
→			←
Aspirations to eradicate poverty	National RE plans	Co-operation with DC's through ODA/IFIs	Lack of awareness of RE options/ benefits in DC's, IFI's & lack of co-ordination
Aspirations to improve local/global environment		Climate change & other environment policies: taxation, incentives and fiscal measures, carbon trading CDM,	Vested interests and subsidies for conventional energy, ignorance
Aspirations to diversify for energy security		RE portfolio	Vested interests in conventional energy, ignorance
Energy market liberalisation		Green certificates; Distributed generation policy; Renewable portfolio standards	Decrease ODA/IFI support for energy projects
Cost reductions for RE technology	R&D policies, public-private-partnership		Lack of awareness / trust / familiarity with RE technology, other barriers to RE project development; apparent cost competition
Increased FDI / trade promotion Increased role of private sector	ECA, public-private-partnership, tax and other incentives, risk mitigation, global corporate initiative		Vested interests in conventional energy and export credit support Decreased role of government
Global integration of markets	Coherent action, policy co-ordination, information exchange, ECA reform		Market immaturity

The following sections highlight how the G8 can manage these market forces through national plans, policy reform, financing tools and strategies, and through interaction with the private sector, NGO's, and other stakeholders. An effective mix of incentives and mandates can push those forces stimulating renewables, while overcoming those restraining the renewables market.

3.2. Managing market forces through national plans

A growing number of developing countries now recognise that their energy and development agendas are intricately linked. For example, governments may wish to reduce local air pollution as part of environmental policy, or promote domestic renewable-energy-based businesses and industries as part of industrial or technology policy. They may wish to accelerate rural electrification with renewables through the private sector in the absence of sufficient public resources to do so. Or they may wish to attract grant financing for certain technologies from bilateral and multilateral donor agencies.

Case Study 17 National plan in China

China Renewable Energy Plan
The Government of China has developed 5 year plans to accelerate renewable energy development through market based policy instruments. In addition the Government will introduce a range of fiscal measures, such as VAT and income tax reduction, interest rate subsidies and government subsidies, to pay for part of the additional financial costs of new renewable energy capacity.

Currently the government is considering:

- To create a Mandated Market Share for renewable energy in the form of a legal requirement that a specified share of electricity comes from renewable energy.
- To introduce an instrument, such as trading, to share the incremental cost and benefits among the regions in China.

In response, a surprisingly large number of developing countries, including China (see Case Study 17) and India, are beginning to embrace ambitious renewable energy development plans that define strategies and measures for accelerating renewable energy deployment to serve energy and development agendas[52]. Annex 4 provides an overview of developing country plans for renewables. While these plans may vary in quality and effectiveness, they can provide a coherent focus for collaboration between national and local government agencies, domestic and international businesses and investors, the donor community, community groups, and other key stakeholders in advancing renewable energy deployment. They also provide an important signal to market players and enable the private sector to make long-term investment decisions. The development of such plans takes time and resources. It is important to implement these plans now in anticipation of a future where less expensive and more reliable renewable energy technologies are available**.** The donor community must use these plans to focus and co-ordinate their activities (see Case Study 18). The World Bank/GEF Strategic Partnership is an example of an effective program that provides assistance in the development of such national plans (Case Study 19).

Case Study 18 Guidelines for national renewable energy plans in developing countries (NREL/TCAPP, 2001).

Developed countries should facilitate preparation and implementation of renewable energy development plans, especially where such plans and planning activities:

- Drive the budgeting and policy decisions in developing countries so that the plan recommendations translate into real commitments for action at national and local levels.
- Integrate renewable energy strategies and initiatives with national and local economic, poverty alleviation, health, environmental, and other development programs
- Engage the business and finance community in structuring and implementing initiatives to ensure that they build sustainable markets and accelerate renewable energy investment
- Provide a vehicle for co-ordinating and focusing bilateral and multilateral donor support for renewable energy programs in developing countries
- Engage and build support from all key stakeholders in the country, including national and local government agencies, community groups, technical institutions, businesses and finance organisations, and other key stakeholders.

Case Study 19 The World Bank/GEF Strategic Partnership for Renewable Energy

Uganda: Energy for Rural Transformation is the first project submitted under the World Bank/Global Environment Facility Strategic Partnership for Renewable Energy. The principles of the Strategic Partnership include:

1. Targeted increases in GEF resources, with a proposed interim target of US$150 million annually
2. Long term country based business planning approach, i.e. five to ten year development plans
3. Simplified approval process

The Strategic Partnership was set up to expand and increase the effectiveness of the renewable energy activities of the World Bank and GEF and shift efforts from an individual project approach to long term, programmatic pathways. The aim is to provide developing countries with the time and resources required to develop renewable energy markets and technologies in a comprehensive and sustainable way.

Nearly all OECD countries have either announced or adopted national plans for renewables, including in many cases a portfolio target. Analysis in section 5 indicates that the implementation of these existing plans and targets in the OECD will create the conditions to underpin significantly expanded renewables markets in developing countries. See Annex 5 for a compilation of many of these policies and measures. Case Study 20 (Annex 7) describes the national plan of France as an example.

[52] Gupta 2000, SETC 2000

3.3 Need for policy reform

3.3.1 Energy market reform

Several forces stemming from the structure of the energy sector are driving the current of change that is sweeping through the energy industry, opening the window of opportunity for renewables:

- The traditional monopoly utility model, where all electric power is generated in large power plants on the scale hundreds thousands of megawatts, used to be considered the most technically efficient and financially stable. This situation has been changing with the introduction of more efficient distributed technologies on the scale of 0.1-100 megawatts, along with deregulation and competition.[53] Distributed generation is gaining importance in the energy market as its flexibility to install enhances efficiency of infrastructure investments.
- In most cases, the traditional model puts generation assets "behind the fence", and far removed from most local community involvement. This tends to limit public involvement in energy choices, previously the exclusive domain of energy companies and their regulators. Restructuring and liberalisation have raised the importance of customer value and choice as a factor in new energy supply systems
- Energy companies previously operated in an ever-expanding market. However, the need to improve efficiency so as to be more competitive, and to reduce pollution, will make renewables more attractive. Moreover, in many countries, the energy sector as a whole is growing less fast than GDP. To enhance profits, energy companies are seeking new opportunities in both regionally and technologically.

One result of this transformation of the energy sector is that policymakers have less direct control over the composition of the energy portfolio. Competition drives the utilities to strategies that focus on cutting costs. Market forces alone cannot guarantee price stability, nor energy security. Moreover, the market left to itself will not deliver energy services without harm to the environment. In restructured energy markets, cross-subsidies will not be available to increase access in areas that are not attractive to investors, unless restructuring is accompanied by policy measures that specifically address such concerns.

Case Study 21 Sri Lanka: the importance of IPP regulation

In Sri Lanka, the World Bank/GEF Energy Services Delivery project was started in 1997 with the aim of promoting the provision of grid electricity by private-sector power developers. The project had the effect of opening up the market to third-party mini-hydro developers. More than 21 MW of small hydro has been financed by independent-power-producers (IPPs) as a result of the project. Also regulatory frameworks for IPPs were developed, including standardised "non-negotiable" power-purchase tariffs and contracts (Power Purchase Agreements -PPAs). This project provided sufficient incentive for the national utility to adopt IPP frameworks and agree to PPAs, which together with demonstration of the technology through previous mini-hydro installations and new incentives for developers (such as import duty waivers and income tax concessions), succeeded in stimulating the market.

Where markets fail to secure energy services, protect the environment and secure wide access and other important public benefits, it is appropriate for governments to guide and complement energy sector reform with cost-effective incentives and guarantees to encourage inclusion of renewables in the energy portfolio. For example, governments could set goals that define the performance characteristics of qualifying sustainable energy technologies. Alternatively, governments could provide fiscal and/or financial incentives to stimulate renewables, as well a supporting R&D. Other regulatory approaches to recognise the value of renewables include: mandating that a certain percentage of energy comes from renewable sources (portfolio quotas); requiring that energy grids be open to independent power producers; feed-in laws; and distributed generation policy (ensuring wide access to energy services). Such regulations are based on the recognition that energy market restructuring in itself may not help achieve sustainable development and adequately account for the social and environmental costs of energy provision and use. This is demonstrated in Case Study 21 (Sri Lanka).

[53] Dunn 2000

The public's appreciation of renewables' environmental performance is now becoming a revenue-enhancer for renewables. "Green electricity" becomes a real energy product when consumers have the right to choose their energy supply and utilities, and service providers respond with new products (see Case Study 22). To give greater confidence to this emerging market, "tradable renewable certificate systems" are being developed to confirm the renewables source, and to avoid double counting. Annex 6 contains a report on tradable renewable certificates that was submitted as a result of an expert meeting sponsored by the Italian Ministry of Environment.

Case Study 22 Green electricity in Italy
In 1999 Italy introduced a quota system that obliges each power supplier from 2002 on, to feed electricity from renewable energy sources (2% of the non renewable electricity generated or imported in the previous year) into the Electrical National System. Suppliers can meet this obligation by building their own RE-plants or by buying certificates. This 'Compulsory Renewable System' (CRS) follows defined rules regarding certificate issuing and trading.

The Italian government considers separate trading of green certificates and electricity to be one of the best options to promote renewable sources inside the European common market. The Italian government strongly advocates a common market, where all participants share similar rules and where green certificates are not merely a proof of origin, but a title per se, which can be sold separately.

3.3.2 Align subsidies with general policy objectives

Policies that promote an equal treatment of all energy options, in other words, that 'level the playing field' would improve the market position of renewables. A glance at the right column in table 2 reveals factors restraining renewables market development and provide insight in opportunities to achieve a more balanced support for alternative energy options through revision of subsidies, tax policies, etc.

The value of subsidies depends on public policy goals. These goals are subject to change, and the question is whether current subsidies match these changed policy goals. While many governments take on ambitious goals to address environmental challenges or diversity their energy portfolio by for example adopting portfolio targets, these policy goals will be difficult to realise without equal treatment of all energy options, including support to renewables. The challenge is to align government, bilateral or multilateral- support with general policy objectives.

Market distortions can be reduced by evaluating the appropriateness of subsidies to conventional energy (estimated at US$250–300 billion a year in the mid-1990s[54]) and eliminating those that no longer serve the public interest. Subsidies for conventional energy resources should be seen in the context of overall taxation of conventional resources which significantly exceeds the subsidies. Re-addressing them, and making even a minor re-direction of these considerable financial flows toward renewables, provides an opportunity to bring consistency to new public goals and to include social and environmental costs in prices. Where energy markets cannot function effectively because of absolute poverty, "smart" (targeted, time-limited and close-to-the-market) subsidies can be appropriate, as demonstrated in the case of Argentina (Case Study 23). A part of the current subsidies to conventional energy could be shifted to renewables.

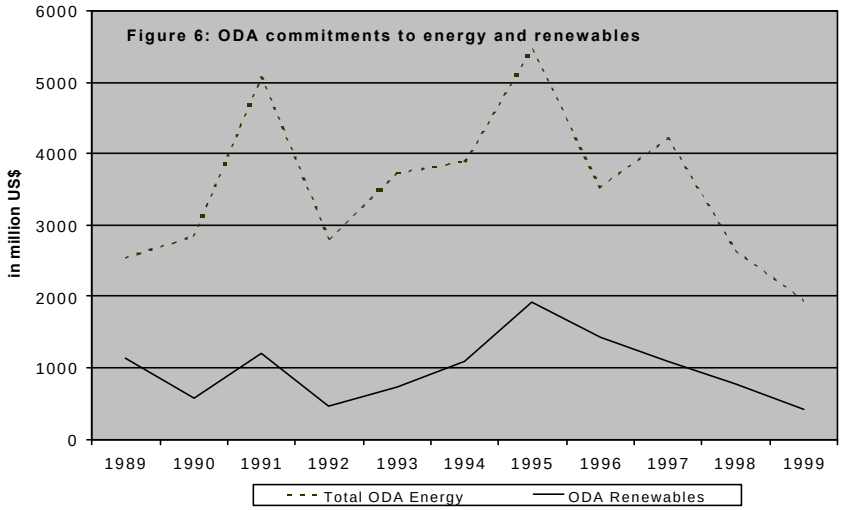
Case Study 23 Argentina: concession approach and smart subsidies (adapted from the Report of the regional consultation in Latin America to the Task Force)

In conjunction with the World Bank, Argentina is implementing Renewable Energy in Rural Markets (PERMER), a rural electrification programme with a strong focus on renewable energy technologies. The PERMER project recognises that the private- sector participants in the conventional grid-tied electricity market have little incentive to extend services into remote, dispersed communities. Therefore, PERMER offers unique concessions in rural areas. The concessionaires are provided the rights and responsibilities for electrification of the communities within the defined area. Funding for the electricity supply (primarily solar photovoltaics, but also wind, hybrids, and other technologies) comes from the end users and the government. A unique feature of PERMER is its provision for subsidy minimisation, whereby potential concessionaires bid on the basis of lowest required subsidy. The government remains a critical participant however, providing resources and institutional support for long-term sustainability.

[54] WEA 2000b

3.3.3 Reform of development assistance

Energy production and delivery is moving from the public sector to private firms. Many governments are getting out of the energy business, focusing instead on regulating the private operators.



Along with this transition of the energy sector, where investments are now mostly private sector driven, ODA agencies have decreased their support for energy projects. As a result, knowledge about renewables in development and other agencies has waned. Although these developments in the energy sector justify a reduced 'project support' through ODA, there is an even more pressing need for 'programmatic support' to help governments shape the 'enabling environment' in which the private sector can operate. ODA support for renewables is still a small fraction of overall spending in the energy sector (Figure 6), though both have reached historically low levels.

Renewables are sometimes not integrated into other development or energy programmes. There is a need to establish the links between renewable energy and sustainable development, and indicate where renewable energy technologies offer the most economically attractive energy option for delivering the development targets. There is also a need to explore options for up-dating the development funding instruments used by donors, and make them fit better with the activities needed to increase the deployment of renewable energies.

3.4 Financing for renewables

The lions share of the financing flows for renewable energy comes from the private sector, stimulated by- or combined with- multilateral assistance and investments (World Bank Group, Global Environment Facility, Regional Development Banks) and Export Credit Agencies.

Key Facts: Trends in financing for renewables

- Financial support for energy sector projects from IFI/ODA is declining.
- The share of renewables investments in the energy portfolio of IFI's is increasing but still small compared to total investments in the energy sector.
- Energy capacity in development and other assistance has waned.
- Overall FDI flows are increasing to (a small number of) developing countries
- Companies commitments for renewables are on the rise

Current approaches to financing renewable energy in the developing world are inadequate to realise the promise of these technologies to meet expanding energy needs while producing environmental benefits. Multiple approaches are needed to stimulate greater financing of renewable energy, particularly in developing countries.

There is also a substantial need for removal of barriers that impede further orderly development of these markets. Developing countries are likely to attract more domestic and foreign investment funds to renewable energy projects if appropriate financial incentives are provided to the private sector to counter market barriers, afford adequate financial returns and offset higher risk perceptions.

It is only when the role of the private sector and private capital flows in this sector both expand significantly that substantial results on the ground are likely to be achieved.

Particularly, there is a need to make greater strategic use of multilateral financing sources to leverage and mobilise private financing flows for developing country renewable energy investments (i.e. align IFI's with renewables goals). There is also a need to re-channel available bilateral and trade support for conventional energy development, especially those placed with Export Credit Agencies (ECAs) in developing countries towards renewables projects. Furthermore, developing countries' awareness to renewables needs to be enhanced through such ways as policy dialogue.

3.4.1 Increasing private sector investments

The 1990s were a decade of expanded private financing of the power sector in developing countries. Driven by energy sector market reform, growth in energy demand in the developing world, and policies to attract private sector investors, the volume of private sector financing of the power sector grew dramatically.

It is estimated that between US$500 million and US$1.5 billion is being used to finance renewable energy projects in developing countries each year. This market is conservatively estimated to be growing at between 5% and 10% per annum (although individual market segments for specific technologies may be growing at higher rates). One recent estimate suggests that of the 110,000 MW of total world-wide installed capacity of renewable energy, some 70,000 MW is located in either the developing world or economies in transition.[55]

Commitments by major firms to invest in renewable energy over the next 2-5 years are difficult to quantify, but a quick review of published announcements indicates that these commitments may already amount to more than US$10-15 billion. The main drivers of financial flows - technology, financial innovation, economic progress, and a supportive political environment - are expected to stay strong over the next decade.[56] The challenges are to direct these flows into expanded development of renewable energy projects and to encourage firms to fulfil and increase their investment commitments for renewable energy.

3.4.2 Increasing investments and programmes from International Finance Institutions (IFIs)

Despite the trend of decreasing support for energy-related projects, the World Bank Group, including the International Finance Corporation (IFC), financed a growing number of renewable energy projects during the 1990s with important assistance from the Global Environment Facility (GEF). The Renewable Energy Efficiency Fund (REEF) is a tool to mobilise financing for renewables (Case Study 24 in Annex 7).
However, the absolute size of renewables investments remains small compared to investments in conventional energy projects and programmes, which is more fully described in Section 1.3.

Case Study 25 Energy Sector Management Assistance Programme (ESMAP): a tool to increase financing for renewables in IFI's

The overall goal of the ESMAP programme is to increase the availability of energy services for poverty alleviation and economic and social development. A key function of the ESMAP programme is dissemination of the knowledge generated through projects. ESMAP's principal objective under the renewable energy theme is the mainstreaming of the technologies, including solar, wind, small hydropower, and large biomass, into the agendas of local governments and development institutions in order to contribute to international efforts to provide clean energy use. ESMAP's approach includes regional or country pre-investment work, country-specific project identification and technical assistance, and the pilot demonstration of non-conventional energy sources with potential for promising application in rural or peri-urban poor areas.

As of December 2000, the World Bank Group's portfolio of renewable energy projects totalled US$636 million with GEF co-financing of US$230 million and mobilisation of US$1.4 billion on other financing. The total financing potential of these projects (which are generally multi-year in nature) is approximately US$2.3 billion.[57] The GEF's financing of renewable energy projects has been approximately US$580 million from its inception in 1991 through 2000. Of this total, the World Bank Group's share is US$490

[55] Martinot 2001
[56] World Bank 2000d
[57] World Bank 2000c

million and that of other agencies is US$90 million.[58] ESMAP is a tool to co-ordinate support and increase financing for renewables (Case Study 25).

3.4.3 Align International Finance Institutions (IFI's) with renewables goals

Reform in the energy sector and the increased role of the private sector in financing energy projects has had a similar impact on the agenda of International Finance Institutions (IFI's) such as the World Bank Group and regional development banks. Overall lending for energy, however, is on the decline. The World Bank Group lending for renewable energy projects in developing countries accelerated during the 1990s as a confluence of development, environment and social factors began to convince the Bank and its client countries that renewable energy projects were viable investments.[59]

Key Facts: Mainstreaming renewables in the World Banks portfolio

The key factors pushing along the mainstreaming of the renewable energy agenda are:

- The availability of GEF financing, particularly to address barrier removal needs for what are perceived to be win-win opportunities; and
- The perception that off-grid renewables in the rural areas are responsive to the growing poverty-alleviation mandate to provide basic modern energy services to the poor.

The greatest obstacles within the Bank at this point are

- Uncertainties about the level and reliability of future GEF financing; and
- A general shortage of internal resources to support strategy/policy development, project identification and project preparation work, which is where programmes like ESMAP and ASTAE can help.

Key Facts: Supply and demand agenda

Supply-side/ energy agenda
"how to most cheaply provide electricity to rural households?"

Demand-side/ development agenda
"how do renewables offer advantages to people in developing countries in meeting their most basic everyday needs?"

The role of renewables within the Bank has started to be driven less by an energy-sector (supply) agenda and more by a rural-development (demand) agenda. Still, there are obstacles to pursue to marry both agendas. Bank managers often claim that their client countries must be willing to borrow for renewables before the Bank can lend—the "demand side" of the equation. "Borrower commitment" is constrained by lack of familiarity with renewable energy technologies, lack of understanding of the costs and benefits and international experience, perceptions of increased risk, and entrenched political interests which bias policy-makers towards conventional energy supply.[60] This indicates that there is a lot Bank managers can do to educate client countries on the benefits of renewables to achieve sustainable development goals. The ASTAE programme is an excellent example of how these problems can be addressed in an effort to mainstream renewables in the Bank's lending portfolio (Case Study 26).

Case Study 26 Greening the Energy Sector Portfolio of Multilateral Banks: the case of ASTAE

The Asia Alternative Energy Programme (ASTAE) was established by the World Bank in 1992. The goal of ASTAE was to mainstream sustainable energy in Asia by 'greening' World Bank lending to the power sector in this region. The programme has been so successful that the target of increasing the share of alternative energy in its Asian power sector loan portfolio to 10 percent has now been met and exceeded. In the financial year of 1999 the share was as high as 46.3%. As of June 2000, 38 projects were either in the pipeline, approved or completed and it is projected that the implementation of these projects will avoid around 1GW of conventional capacity.

3.4.4 Align Export Credit Agencies with renewables goals

ECAs play a key role in shaping international investment. These institutions have been created or supported by governments to facilitate the entry of their domestic industries' exports and investments into riskier overseas markets, mainly those in developing countries. During the 1990s, ECA provided an average of US$100 billion per annum in loans and guarantees. This amount represents roughly twice the level of official development assistance during the same period (US$50 billion), and over 30% of all long-term finance received by developing countries.[61] In addition, defaults on ECA-financed projects account for approximately half of all developing country official debt.[62] WRI calculates that in

[58] Martinot /McDoom 2000
[59] The term "Bank" refers to the World Bank Group throughout the paper.
[60] Martinot 2000
[61] WWF 2001
[62] Eurodad 1999

the period 1994 to 1999, ECAs provided US$44 billion in support for energy-intensive investments (which leveraged US$60 billion more in private capital), the bulk of which went to carbon-based electric power projects, and oil and gas development. By contrast, the volume of ECA financing for renewable energy projects in the same period was US$2 billion. This reflects the fact that conventional energy receives preferential treatment. Guidelines to assess the environmental impacts of ECA financed projects are currently under discussion.

3.5 Roles for the private sector.

The development of renewable energy markets has been constrained due to barriers at the market level, and at the project development level. Key to realising the potential of renewables in the market is to engage and support the private sector. It is, after all, the private sector that will finance and deliver energy services. Moreover, the private sector is, collectively, one of the largest and most concentrated consumer of energy in the world. As such, the private sector has great influence on energy patterns, both current and in the future.

3.5.1 Engaging the global business community in renewables

Business leaders are increasingly torn between competing demands. Due to competition, businesses seek low energy costs to keep their own costs down. But, increasingly, business leaders are acting on their sense of greater responsibility to the local and the global community. Business associations and non-profit organisations have undertaken bold programmes on the themes of social responsibility and sustainable development. Such organisations as World Business Council for Sustainable Development and the Pew Charitable Trust have started projects to invest in the alleviation of climate change. The World Resources Institute has begun a partnership with ten leading US corporations to install 1,000 MW of renewables electricity over the next ten years as a "market pull" for clean energy systems. There is also a trend among individual companies to set targets for renewables or environmental targets.

These private initiatives provide good evidence that the broader business community can be engaged in accelerating renewables markets. Both from narrow self-interest in securing renewables supplies for their own operations, and from the longer term societal interest of increasing renewables in the energy portfolio, business leaders and associations can play a critical role.

3.5.2 Addressing barriers to expand renewables business

There is a substantial need for removal of barriers that impede further orderly development of renewable projects. Developing countries are likely to attract more domestic and foreign investment funds to renewable energy projects if appropriate financial incentives are provided to the private sector to counter market barriers, afford adequate financial returns and offset higher risk perceptions. It is only when the role of the private sector and private capital flows in this sector both expand significantly that substantial results on the ground are likely to be achieved.

Key Facts: Key barriers to the introduction of renewables (projects)

Despite some significant gains in recent years, renewable energy sources still make only a modest contribution to the provision of modern energy services world-wide.

Key barriers:

1. Lack of business and technical infrastructure
2. Financial and economic constraints
3. Policy and institutional barriers
4. Lack of consultation, co-ordination and co-operation
5. Vested interests and inertia
6. Human resource limitations
7. Lack of information exchange and awareness

Some of the barriers to accelerated deployment of renewables in developed and developing country markets have been addressed in chapter 2. The key barriers to renewable energy project development can be grouped under seven headings. The barriers and their solutions vary according to the political, socio-economic and environmental context and the technology type. For example, barriers impeding renewables in off-grid systems are not necessarily the same as those related to grid-connected projects. Solutions that have worked in developed countries may not be applicable in developing countries. However, there are some general observations and lessons that can be drawn from experience world-wide. It is important to share these lessons. New strategies must be attempted to provide incentives to the private sector to overcome risk and to increase financial gain to the host country and the companies.

3.6 Concerted action leads to market coherence

Despite existing effort in the public and private sectors and ambitious plans, the market for renewables remains limited. Efforts in both public and private sector are largely fragmented and dispersed and could be improved with greater co-ordination. In other words, market coherence is required to achieve a commercial market for renewables. The development of cellular phones provides an example from another dynamic industry: without governments taking the lead in creating the market rules (system connection and management, tariffs etc.), the private sector could not have provided millions of people with cellular phones around the world.

Case Study 27 RETScreen: a tool for market coherence

RETScreen is a global decision support and capacity building tool for assessing potential renewable energy projects developed by the Energy Diversification Research Laboratory of Canada. The tool evaluates the energy production, life cycle costs and greenhouse gas emission reductions for renewable energy projects at any geographic location around the world

The tool enables planners and decision makers to routinely consider renewable energy technology projects at the critically important initial planning stage. The tool has been used widely to date for example for: preliminary feasibility studies, project lender due-diligence, market studies, policy analysis, information dissemination, training, sales of products and/or services, project development and management, product development and research and development

The previous chapters have shown that there is sufficient interest among developed and developing country public and private sector for more co-ordination and stronger links through common codes, rules, and procedures, to build global market conditions. RETScreen is a tool to enhance such market coherence (Case Study 27). The case of PRESSEA (Case Study 28 in Annex 7) demonstrates how a database with information and experiences contributes to market coherence.

The challenge is to work with donors in a collaborative manner, in order to leverage activities better and to ensure that their activities are conducive to private sector interests. Now is the time to bring all these dispersed efforts together and reap the benefits of co-ordination and collaboration.

4 Recommendations and suggested actions to address key barriers to accelerated deployment of renewable energy technologies

4.1 Barriers

To secure sustainable commercial success, renewables must overcome a number of key barriers, including:

- cost; although the cost of renewable energy is falling as volumes increase, in most cases it is not yet directly competitive with conventional alternatives;
- insufficient human and institutional infrastructure; limited capacity to support projects and markets, owing to a lack of experience and investment;
- high up front costs of renewables and other impediments to capital mobilisation; leading to inadequacies and shortfalls in financing programmes;
- weak incentives and inconsistent policies; the characteristics and benefits of renewables are not always adequately and fairly addressed in energy policy frameworks.

4.2 Recommendations and suggested actions

The Task Force believes that the accelerated deployment of renewable energy systems is important for both developed and developing countries, and that the G8 should act now to prioritise efforts to remove barriers to this deployment. It is also true that the G8 cannot act alone. Concerted action is needed to benefit the more than 2 billion people in developing countries who do not have reliable access to modern forms of energy. Some actions needed will be short term and some will be long term, requiring 10 years or more for implementation. G8 commitment is needed throughout. We have indicated below the relevant actors needed to help G8 achieve this important goal, and a time-scale for those actions, recognising that in many instances the timings indicate the start of processes.

In order to create a step change in renewables use the G8 must act to shape an enhanced environment for the private sector to offer renewable energy services. We believe that if G8 takes the outlined actions they will act as a spur to sustainable development and in particular lead to greatly reduced greenhouse gas emissions. Actions to address the barriers are clearly interlinked.

Recommendation 1: Reduce technology costs by expanding markets

Technology costs will be reduced as markets expand. In order to create the right climate for market expansion renewables' cost-competitiveness must be assured. Costs-competitiveness can be enhanced directly by investments in R&D, creating confidence in the current and future performance of renewable energy technology. Driving down the costs in developed country markets will underpin the expansion of many markets in developing countries. Risk sharing to reduce transaction costs of launching small renewables projects in developing countries also reduces costs and builds experience, leading to expanded markets.

Recommended actions	**Partners** **Starting date**
A.1. G8 and other developed countries should implement existing and proposed national plans to expand domestic renewable energy markets in order to drive down costs and underpin the development of markets in developing countries. Governments should align policies with consumers' willingness to pay, using such nationally-chosen market mechanisms as portfolio quotas and incentive tariffs.	Other developed countries With urgent effect
A.2. The G8 countries should continue and expand support for R&D of renewable energy technologies that address all sectors of the energy economy—buildings, industry, transport, and utility energy services. Co-operation with developing countries on R&D will assist in technology transfer towards systems tailored for developing country use.	Private sector, IFIs, developing countries October
A.3. Working with both public and private sector participants, G8 countries should help develop and demonstrate renewable energy projects where: (i) renewables are a least cost option on a life cycle basis and/or (ii) renewables achieve protection of local and/or global environment at a reasonable cost. To that end, G8 and International Finance Institutions (IFIs) should help formulate well-defined subsidy programmes – particularly 'smart subsidies', which are temporary, competitively administered and performance-based.	Private sector, IFIs, developing countries October
A.4. G8 should place more trust fund resources with IFIs that can be accessed by private sector project developers on a cost-shared basis to assist with the development costs of renewable energy projects.	IFIs August
A.5. Global corporations are large consumers of energy, and are well-equipped to investigate renewables and strategies for cost-effective uses. G8 should encourage industry to make voluntary global commitments to procure and use renewables-based energy, recognising that policy frameworks encouraging renewables will strengthen such commitments.	Industry; civil society

Recommendation 2: Build a strong market environment

There is a need to build a strong market environment. Building a strong market environment, including a healthy entrepreneurial environment, requires investments in human capital or strengthening of skill mixes in micro- financing institutions, commercial banks, multilateral institutions, development agencies and export credit guarantee agencies. A strong market environment also requires a supportive renewables policy/ legislative framework, in the context of comprehensive national plans.

A number of developing countries already have ambitious plans for renewables in place. These should be welcomed as a positive example and should be encouraged to grow and spread. In developing countries in particular there is often insufficient human and institutional infrastructure. To address this, expanded assistance should be given to developing countries to establish market plans for renewables, building on south-south co-operation, and utilising existing centres of excellence to enhance capacity.

Many developed countries already have implemented or announced ambitious market plans for renewable energy market expansion. Where not yet implemented, these plans need to be formalised. Further strengthening of G8 national plans can be undertaken only by the nations themselves, on the basis of new information about global conditions and their national interests.

Recommended actions	Partners Starting date
B.1. The G8 should use its influence to ensure that renewables are adequately considered as part of energy policy in assessing development priorities of countries participating in poverty reduction programmes. Institutional capacity should be strengthened in developing countries to support the development of comprehensive renewable energy strategies with complementary private sector investment programmes within national planning processes for sustainable development, such as National Strategies for Sustainable Development, power sector reform, Poverty Reduction Strategy Papers, etc. In this context, technical assistance for capacity building is useful	IFIs, developing countries; private sector October
B.2. Consistent with a greater emphasis on energy and in particular on renewable energy, G8 countries and development institutions should establish a higher level of expertise in their development agencies and/or country offices on the role that energy policy choices can play in development.	ODA offices; IFI offices October
B.3. G8 should, on an expedited basis, provide incentives to their renewable energy industries for the creation of joint ventures and other manufacturing, assembly, and distribution/installation capabilities in developing countries.	Industry October
B.4. G8 should expand the scope, visibility, and funding of innovative approaches that are currently assisting developing countries to develop renewable markets. Many approaches by the Global Environment Facility and associated development agencies, the World Bank/UNDP ESMAP program and many bilateral donors and private firms should be supported. G8 should also encourage aligned and concerted action among these organisations to replicate innovative approaches. G8 should expand support for assistance programmes and networks for capacity building, training, quality control and maintenance to ensure full life cycle benefits are obtained.	IFIs October
B.5. G8 should strengthen programmes that encourage sustainable forest management and an efficient use of fire-wood and other traditional resources.	Private banks, IFIs August

Recommendation 3: Mobilise financing

Multiple approaches to providing greater financing of renewable energy, particularly in developing countries, must be undertaken. Developing countries need to attract more domestic and foreign investment funds for renewable energy projects and are more likely to attract such funds if appropriate incentives are provided to the private sector to counter market barriers, offer adequate financial returns and offset higher risk perceptions. Strategic partnerships should be formed with the Private Sector on financing and investment. Multilateral institutions, bilateral aid agencies, and export credit guarantee agencies must encourage renewables as a high priority towards the achievement of sustainable development, with all energy options considered on an equal basis including consideration of full costs and values.

The success of innovative financing in the developing countries, such as micro lending schemes adopted by the micro-finance institutions should be welcomed and promoted. Some markets for renewables are already commercially viable but project finance is not readily available. In other cases, support is required to motivate the private sector to invest in energy service provision to remote and underdeveloped areas where the poor reside. The private sector will need to see guarantee and risk mitigation mechanisms through attractive financing forms. The need is for "patient" capital (i.e. funds provided by investors willing to wait for a return for a longer period than the commercial norm) that can grow enterprises from initial business model implementation to a stage where they can attract mainstream financing.

Recommended actions	Partners Starting date
C.1. Recognising the importance of energy in sustainable development and poverty eradication, G8 should invite OECD to address energy issues including renewables in the context of the International Development Targets. They should invite annual reports on relative financial flows and donor assistance patterns to support renewable energy. ODA, bilateral and multilateral agencies should explicitly consider renewables for development projects and choose them when they are the least cost option on a life-cycle basis .	OECD/DAC August

C.2. Modern energy access and environmental considerations should be integrated into the IFI's energy sector dialogue and investment programmes. Thus, current instruments and agency programs should be adapted to provide increased support for renewable energy projects which, although economically attractive, may be small and have long pay back periods. Guarantee funds, refinancing schemes for local banks, ad hoc loan facilities to local small private operators, should be considered in this respect.	Developing countries; Private sector, IFIs October
C.3. The G8 should extend so called 'sector arrangements' for other energy lending to renewables and develop and implement common environmental guidelines among the G8 Export Credit Agencies (ECAs). This could include: identifying criteria to assess environmental impacts of ECA-financed projects, and establishing minimum standards of energy-efficiency or carbon-intensity for these projects; developing a common reporting methodology for ECAs to permit assessment of their local and global environmental impacts.	Private sector, OECD/ECA August
C.4. To improve the financial appeal of renewables projects, the G8 should call for proposals to mobilise "patient capital" from industry and private financiers through appropriate tax and other support schemes.	Private sector, civil society December
C.5. G8 countries should support access to renewables by the rural poor such as through strengthening micro finance organisations and competitive rural concessions. Through this, SMEs, NGOs and community assisted energy programs in the developing countries should look to access dedicated funds and adopt renewable energy applications with micro-financing opportunities.	Developing countries, Civil Society, SMEs, Private banks, IFIs. August

Recommendation 4: Encourage market-based mechanisms

Market based mechanisms should be encouraged to enhance renewables competitiveness. Policy options should be evaluated on the basis of economic analysis, ensuring that careful account is taken of full societal costs and the broad range of benefits of alternative energy supply options. This will ensure that market distortions are not created or supported. Market mechanisms that limit the costs of implementing policy options, such as trading, need to be explored. Multilateral institutions and export credit guarantee agencies must also consider all energy options equally on a life-cycle basis. Monitoring of the deployment of renewables and widespread dissemination of the monitoring results will keep the issue on the political agenda and raise public awareness.

Recommended actions	**Partners** **Starting date**
D.1. G8 should ask the IEA to identify and analyse policies and measures related to renewables' competitiveness in the context of economic and societal costs and benefits of all energy options, monitor the deployment of renewables, and make such information widely available.	IEA December
D.2. G8 should invite the IEA to support the evaluation of the benefits of national renewable certificate trading schemes, and evaluate the benefits of enhanced international collaboration.	IEA October
D.3. Renewable energy projects will benefit from any incentives to developing countries which may derive from negotiations on global climate change. G8 should support development of mechanisms such as emissions trading, joint implementation and the CDM, that are conducive to the support of renewable energy projects.	Developing countries August
D.4. G8 countries should take steps to remove incentives and other supports for environmentally harmful energy technologies, and develop and implement market-based mechanisms that address externalities, enabling renewable energy technologies to compete in the market on a more equal and fairer basis.	 August

Implementation

It is for the G8 to decide whether and how to take our recommendations forward, recognising that to address the barriers requires many interlinked actions. To best achieve the intended outcomes we believe that it is essential to bring stakeholders together, track developments, and share experiences. G8 should promote a co-ordination forum and information resource (containing market information, best practice on policies, communications on the status of implementation of national plans, etc.), involving such bodies as the OECD, IEA, World Bank Group, GEF, UNEP, private sector, private finance institutions, and other relevant organisations. The G8 might wish to invite IEA and GEF to

disseminate best practice and information on those policies and measures that can stimulate renewable energy market growth and to track renewable energy market patterns in OECD and key developing countries.

Ultimately, it will take a strong political commitment by the G8 to carry out the recommendations in this chapter, which are ambitious but achievable. Acting upon these recommendations will expedite a more sustainable future, as explained in the next Chapter.

5 LEARNING INVESTMENTS IN RENEWABLE ENERGY TECHNOLOGY PAY OFF

Taking action on the above recommendations will provide enormous benefits but will also require a shift of resources. As noted at the beginning of the Report, continuing cost reductions will occur through increasing scale of manufacturing and deployment. The incremental investments required to bring down costs to the point where renewable energy clearly becomes the most attractive energy option on commercial terms have been called "learning investments." Recent analysis shows that the learning investments necessary to achieve the scale of renewable energy markets discussed in this Report are modest in comparison to existing financing flows for the energy sectors in both developed and developing countries.

To examine more fully the costs and implications of the recommendations set forward in this Report, a team reviewed two future scenarios, one based on policies and measures in place in mid-2000, and one where additional measures were taken to strengthen renewable energy markets. In large part, these scenarios are based on the IEA's World Energy Outlook 2000 Reference and PowerGen cases, though they differ in several assumptions. Specifics about the analysis are detailed in Annex 1. In contrast to the "Business as Usual" case, based on the WEO 2000 Reference Scenario, shown in Chapter 1, the enhanced renewables scenario is modelled in Figure 7 below. Figure 7 shows the vision for the three markets in "Diversify-Renewables". Realisation of this scenario would move a

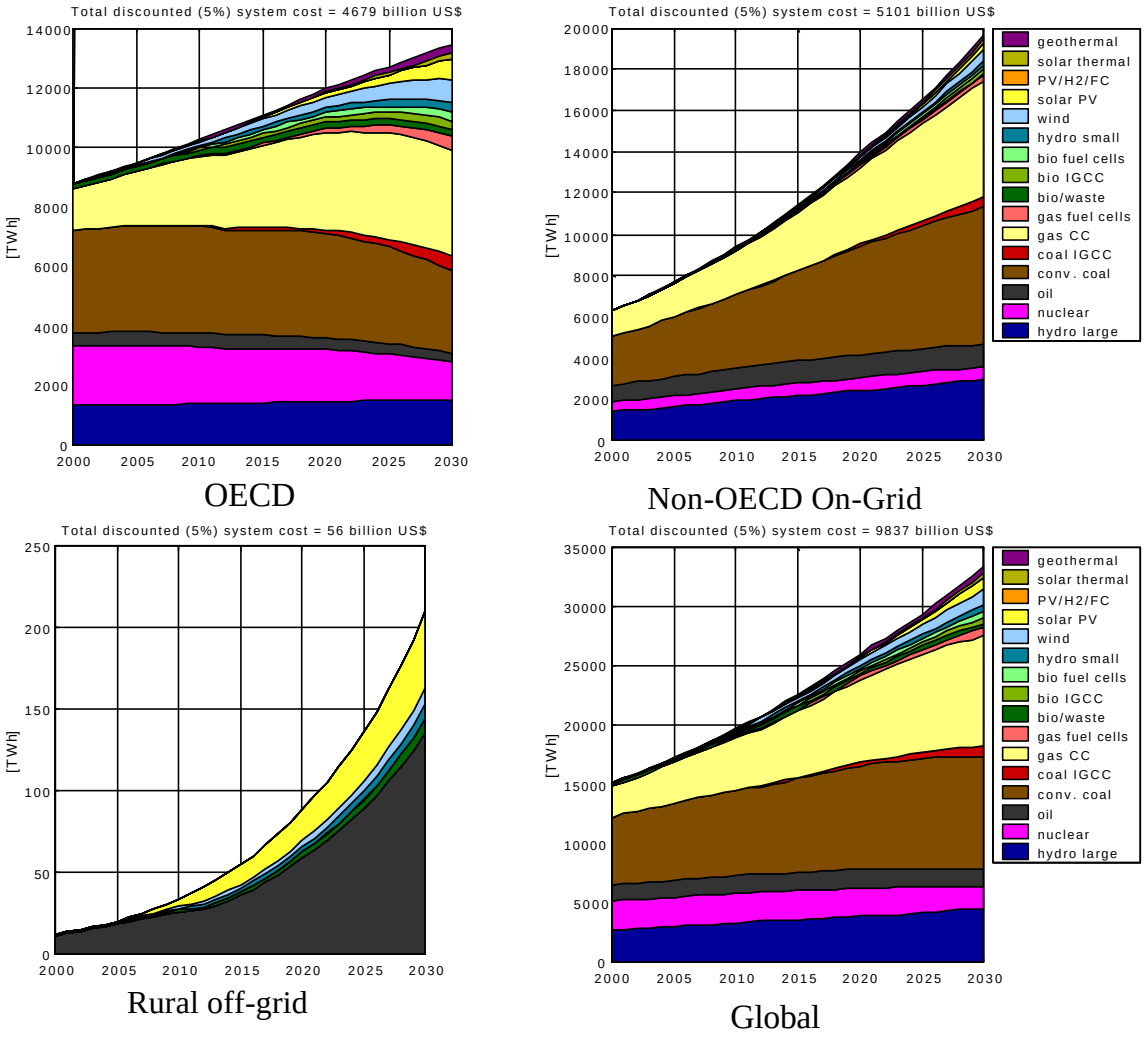


Figure 7: The three markets and the global total in the "Diversify Renewables" Scenario

large step towards achieving the goals of diversification, environmental improvement, and sustainable economic growth. However, considering energy policies already in place or being considered it underestimates the potential for photovoltaic power systems (PVPS). Considering the importance of such systems for rural areas in the developing world, technology learning for such systems is necessary in developed markets in order to provide cheaper and more reliable systems for the developing world. “Diversify-Renewables” thus goes beyond the WEO alternative case on the basis that intended and recommended policies regarding photovoltaics will be put in place.

Figure 8 looks at the balance of total costs for the global electric system, including investments, fuel costs and O&M. “Diversify-Renewables” represents a system that diversifies energy inputs, reduces damage to the environment and supplies less expensive and more reliable renewable energy technologies for off-grid applications in rural areas in the developing world. However, these benefits are not quantified and included in the analysis, except for niche market values associated with PV. The annual costs for this system are compared to corresponding costs for a “Business as usual” system consistent with the Reference Scenario in the World Energy Outlook. The present value of “Diversify-Renewables” is less than the present value of “Business as usual” within any realistic range of real discount rates.

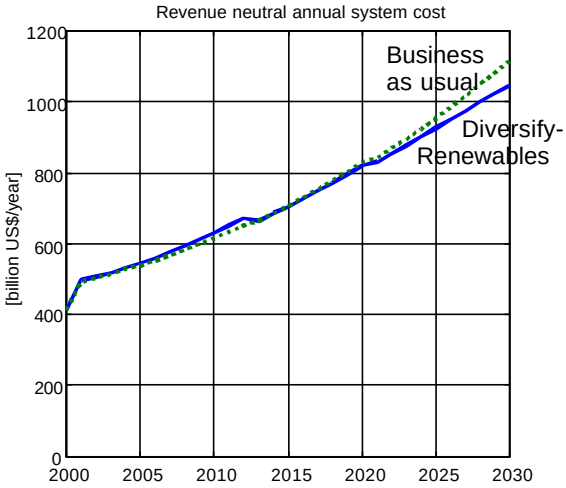


Figure 8 – Comparison of total system costs

“Diversify-Renewables” requires investments in learning for the new renewable energy technologies during the beginning of the period. The effects of these learning investments peak out in 2010-2015 where the additional cost for the alternative reaches a maximum of 3% of total costs. These investments start to pay off after 2015 due to technology learning providing less costly clean technologies and the renewables technologies reducing the reliance on fossil fuels. By the end of the period the bill for fossil fuels is reduced by 1/3. “Diversify-Renewables” provides electricity in rural areas to 40% more families in 2012 than the “Business as usual” system. Such an expansion lead by renewable energy technologies is however only possible with parallel accelerated learning in the grid-based systems; without such support the cost for the expansion in rural areas increase by 5 billion US$ until 2012.
Acting on the recommendations provides the conditions to realise the electric system envisioned in “Diversify-Renewables” and make biomass use for cooking more sustainable. Our analysis shows that serving eight hundred million people with electricity for residential purposes is achievable and supports economic growth and complementary social and environmental benefits.

The supply from renewable energy sources in 2012 would provide an additional 200 million persons in the OECD market and 300 million people in the non-OECD on-grid market with their need for electricity for residential purposes. The installations on the rural markets in developing countries in 2012 would provide 300 million persons with electricity from renewable energy sources.

Additionally, biomass for cooking, using inefficient stoves, puts a heavy burden not only on the environment but also on people’s health in the developing countries. Family members may have to spend up to 2.5 hours per day collecting biomass for cooking purposes. Introducing efficient cooking stoves would reduce the strain on the environment, improve health and free family time for more important tasks. Our analysis shows that it is both culturally feasible and economic efficient to provide better cooking stoves to an additional 200 million people within the next decade.

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Acronyms

AREED	African Rural Energy Enterprise Development
ASTAE	Asia Alternative Energy Programme
BAU	Business As Usual
BOT	Build Operate Transfer
CDM	Clean Development Mechanism
CGAP	Consultative Group to Assist the Poorest
CRS	Creditor Reporting System (OECD)
DAC	Development Assistance Committee (OECD)
DC	Developing Country
DOE	Department of Energy
EC	European Community
ECA	Export Credit Agency
EDF	European Development Fund
ESCO	Energy Service Company
ESMAP	Energy Sector Management Assistance Programme
EU	European Union
FDI	Foreign Direct Investment
FONDEM	Fondation Energies pour le Monde
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse Gas
GNP	Gross National Product
GW	Giga Watt (10^9 W)
IBRD	International Bank for Reconstruction and Development
IDA	International Development Assistance
IDT	International Development Targets
IEA	International Energy Agency
IFC	International Finance Corporation
IFI	International Financial Institution
IPP	Independent Power Producer
JI	Joint Implementation
kW	Kilo Watt (10^3 W)
kWh	Kilo Watt hour (unit of electrical energy)
LPG	Liquefied Petrol Gas
M&A	Mergers and Acquisitions
MIGA	Multilateral Investment Guarantee Agency
Mtoe	Million tons of oil equivalent (energy unit)
MW	Mega Watt
MWp	Mega Watt peak
NGO	Non Governmental Organisation
NREL	National Renewable Energy Laboratory
NSSD	National Strategies for Sustainable Development
O&M	Operation and Maintenance
ODA	Overseas Development Assistance
OECD	Organisation for Economic Co-operation and Development
PCF	Prototype Carbon Fund
PRSP	Poverty Reduction Strategic Paper
PV	Photovoltaic
PVMTI	Photovoltaic Market Transformation Initiative
RD&D	Research, Development and Demonstration
RDB	Regional Development Banks
RE	Renewable Energy
REC	Renewable Energy Certificates
REEF	Renewable Energy Efficiency Fund
REPP	Renewable Energy Policy Project
RESCO	Renewable Energy Service Company
RET	Renewable Energy Technology
RPS	Renewable Portfolio Standard
SDG	Solar Development Group
SHS	Solar Home System (household PV application)
SIMULI	Simulation for Learning Investments
SME	Small and Medium Enterprises
TCAPP	Technology Co-operation Agreement Pilot Project
TWh	Terra Watt hour
UNCTAD	United Nations Conference on Trade and development
UNDESA	United Nations Department of Economic and Social Affairs
UNDP	United Nations Development Programme
UNEP	United Nations Environmental Programme
W	Watt (unit for capacity)
WEA	World Energy Assessment
WEC	World Energy Council
WEO	World Energy Outlook
WRI	World Resources Institute

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