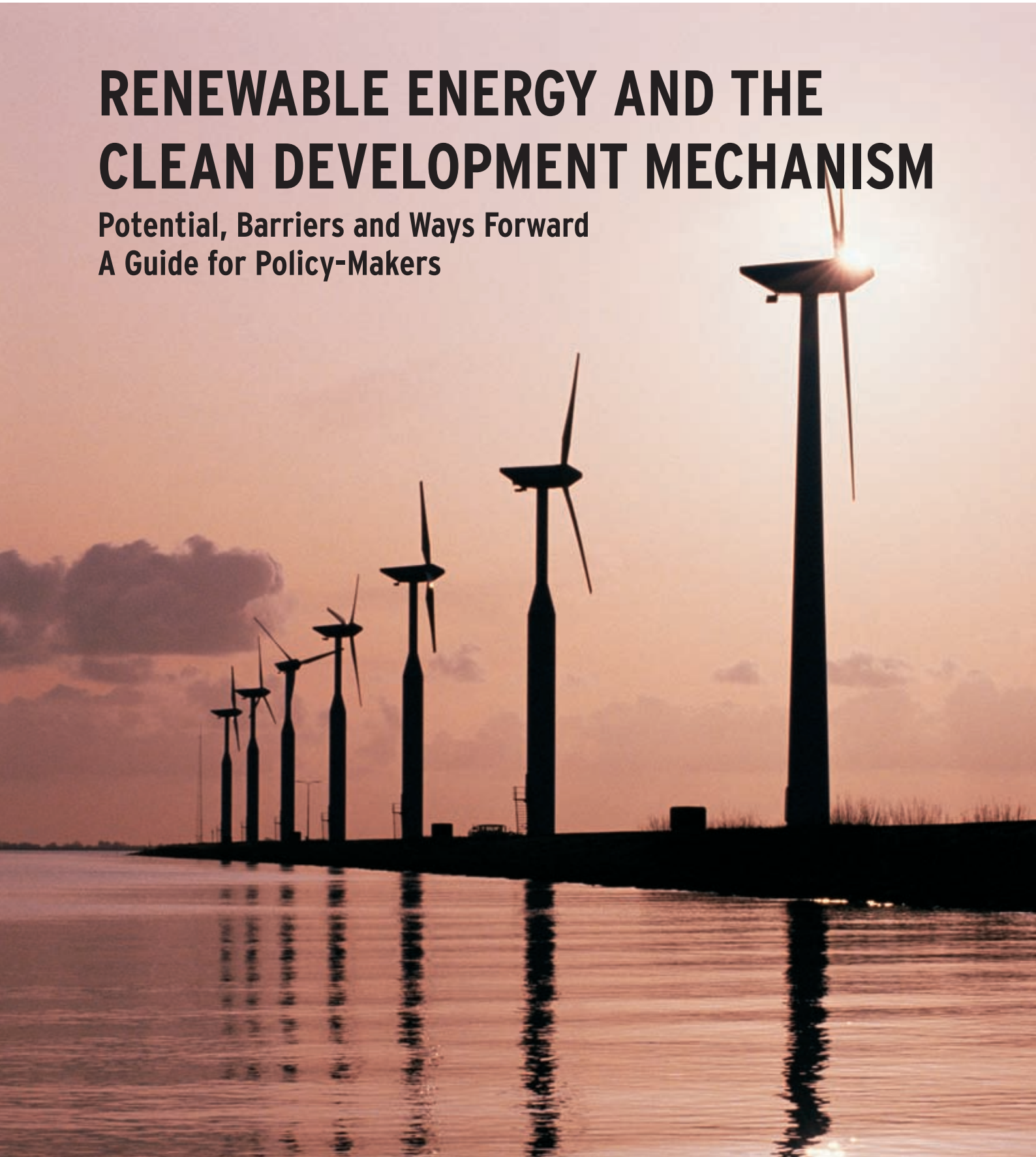
Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

Umwelt Bundes Amt
for Humanity and Environment

RENEWABLE ENERGY AND THE CLEAN DEVELOPMENT MECHANISM

Potential, Barriers and Ways Forward
A Guide for Policy-Makers



IMPRINT

Publisher:	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) Public Relations Division • 11055 Berlin E-Mail: service@bmu.bund.de • internet: www.bmu.de, www.erneuerbare-energien.de
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English editing:	Words-Worth Stocks & Stocks, Bonn
Design:	VisLab, Wuppertal Institute
Print:	Offset Company Wuppertal 100% Recycling paper ''Öko-Art matt''
Photos:	PhotoDisc, Winrock (p. 17), GTZ (p. 3, p. 15, p. 19)
Date:	April 2007
First Edition:	2,000 copies

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EXECUTIVE SUMMARY

Widespread use of renewable energy technologies (RET) is vital in securing a sustainable global energy system. Advantages of RET include:

- In contrast to conventional energy sources, the potential supply from renewables is essentially infinite and largely free of external costs.
- While RET currently still have relatively high installation costs, operating costs are low.
- In many countries, some RET are already competitive with conventional energy sources, for example biomass or biogas applications in Thailand. For most RET, costs will fall significantly below those of conventional energy sources within the next two decades.
- Increased use of RET is an insurance against rising import prices of fossil fuels.
- RET equipment can be produced domestically. For example, China has become one of the leading manufacturers of low-temperature solar thermal applications.

The number of countries where RET have seen significant market growth is steadily increasing. However, in most countries of the world, dissemination of new renewable energy technologies is still very limited. A range of barriers – financial, economic, institutional, political and technical – impede implementation. Key barriers include energy markets that are either monopolistic or oligopolistic and distorted by subsidies, lack of awareness of RET potential and benefits, and a lack of technical and institutional capacity and financing means. So far only a few countries have implemented clear policies promoting RET.

Under the Kyoto Protocol's Clean Development Mechanism (CDM), public and private project developers can generate and sell certified emission reductions (CERs) from projects, including renewable energy projects, that reduce greenhouse gas emissions in developing countries. The CDM thus provides financial incentives for shifting to a less emissions-intensive economy.

But while the CDM is able to lower some of the key barriers to renewable energy development, especially with regard to the financial and economic aspects, it is not designed to nullify all existing obstacles. Host country conditions are the decisive factor. Adjusting these conditions will attract more CDM activities and assist the host country in reaping the benefits of RET.

Addressing the manifold barriers that discriminate against RET in energy markets usually requires a mix of well-designed and mutually supportive policy instruments. Probably the most important issue is the economic performance of RET compared to the energy sources that presently dominate the energy markets. In principle, there are two approaches to addressing this problem, both of which are indispensable in developing promising strategies:

1. Bringing down the cost of renewable energy technologies and their related energy services
2. Abolishing market distortions that discriminate against the technologies

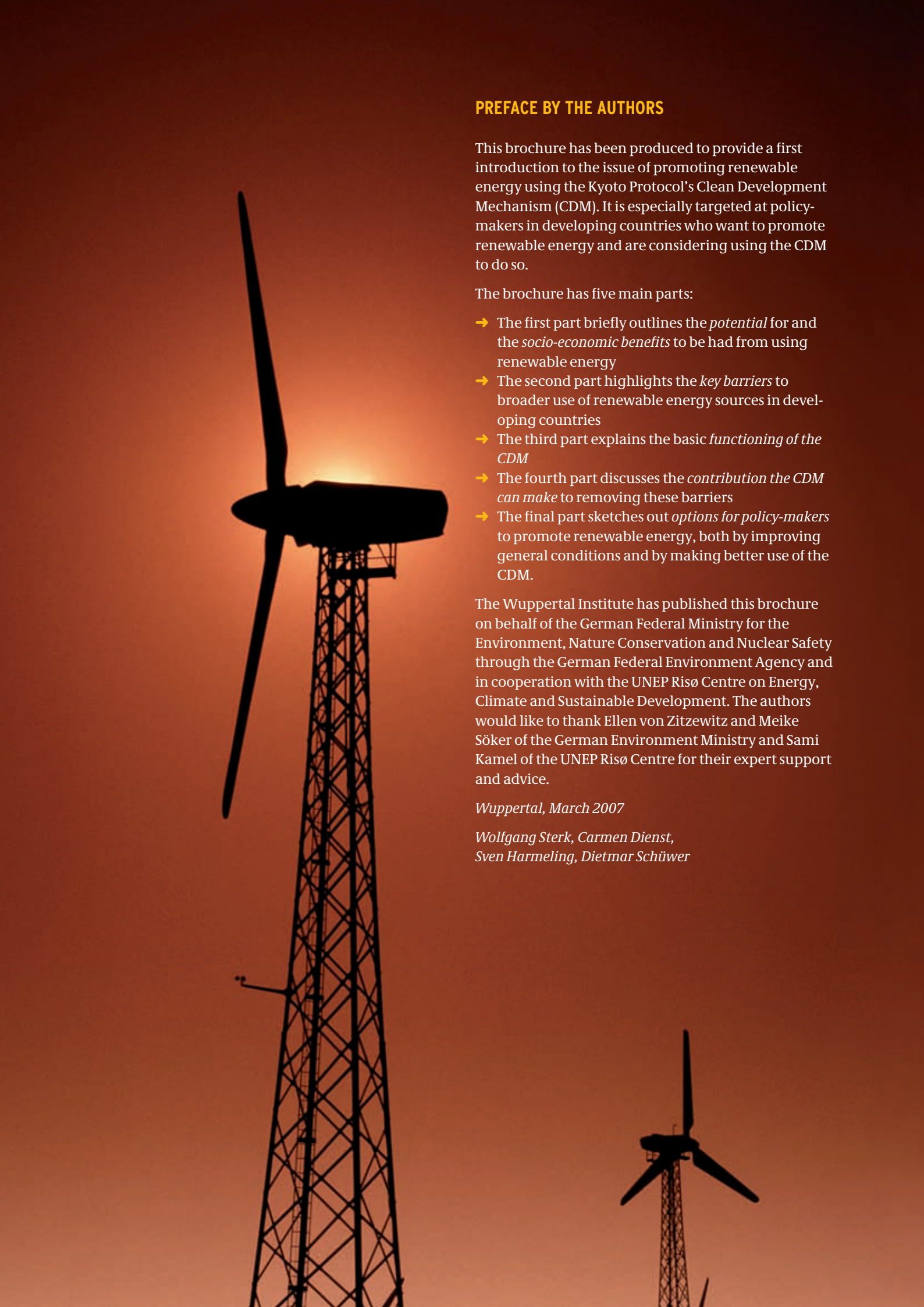
Measures to address CDM-specific barriers include priority setting at project level by host countries, development of a suitable legal CDM framework, capacity building, CDM promotion and pursuing the new concept of CDM Programmes of Activities. This is not to say that the host country has the sole responsibility for promoting CDM. Industrialised countries and the private sector can also provide assistance such as capacity building and up-front financing. But host countries do not have to wait for international assistance, to a large extent they have it in their own hands to attract CDM investment in RET.

The following table provides an overview of key measures that can be taken to promote renewable energy, both by improving general conditions and by making better use of the CDM.

Table 1: Options for Overcoming Barriers to RE CDM Projects

Measure	Actor(s) Responsible / Involved	Barrier(s) Addressed
Reduce subsidies for fossil fuels and for electricity tariffs	Host country government, researchers, utilities	Lack of level playing field and willingness to finance 'expensive' investments in RET
Ambitious targets for renewables expansion	Host country government	Lack of policy clarity
Open access to grids and other distribution networks, facilitating market entry	Host country government	Lack of guaranteed grid access for independent producers
RE feed-in tariffs, tax credits, investment subsidies, green certificates	Host country government	High specific up-front investment costs for RET
Dedicated loan facilities	Host country government, banks, business associations	High specific up-front investment costs Insufficient purchasing power among potential users
Lower taxes and customs duties	Host country government, researchers, manufacturers, industry associations	Taxes and customs duties on RET equipment
Establish and enforce manufacturing standards	Host country government, manufacturers, industry associations, researchers	Inadequate appliance quality
Practical support for RET users Capacity building	Host country government, regional or municipal governments, consumer associations	Lack of technical capacity and knowledge
RET promotion	Host country government, media, celebrities, educational bodies, project developers, industrialised country governments	Lack of awareness and capacity Lack of RET success stories which create positive image Perception of RET as old-fashioned Inadequate, insufficient education of consumers/RET system users Lack of social acceptance
Speedy and transparent CDM approval process	Host country government	Transaction costs
CDM capacity building and promotion	Host country government, media, celebrities, educational bodies, project developers, industrialised country governments	Lack of awareness and capacity
Integrate CDM into national energy and economic development planning	Host country government	Lack of clear signal to government officials to support CDM
Preference to RET CDM Projects	Host country government, industrialised country governments	Competition from low-cost high-yield projects
Using CDM Gold Standard	Host country government, industrialised country governments	High specific investment costs Competition from low-cost high-yield projects
Higher prices and up-front financing for RET CDM projects	Industrialised country governments	High specific up-front investment costs Competition from low-cost high-yield projects
Pursue CDM Programmes of Activities	Host country government, regional or municipal governments, project developers, industrialised country governments	High specific up-front investment costs Lack of incentive system for certain technologies

Source: Wuppertal Institute



PREFACE BY THE AUTHORS

This brochure has been produced to provide a first introduction to the issue of promoting renewable energy using the Kyoto Protocol's Clean Development Mechanism (CDM). It is especially targeted at policy-makers in developing countries who want to promote renewable energy and are considering using the CDM to do so.

The brochure has five main parts:

- The first part briefly outlines the *potential* for and the *socio-economic benefits* to be had from using renewable energy
- The second part highlights the *key barriers* to broader use of renewable energy sources in developing countries
- The third part explains the basic *functioning of the CDM*
- The fourth part discusses the *contribution the CDM can make* to removing these barriers
- The final part sketches out *options for policy-makers* to promote renewable energy, both by improving general conditions and by making better use of the CDM.

The Wuppertal Institute has published this brochure on behalf of the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety through the German Federal Environment Agency and in cooperation with the UNEP Risø Centre on Energy, Climate and Sustainable Development. The authors would like to thank Ellen von Zitzewitz and Meike Söker of the German Environment Ministry and Sami Kamel of the UNEP Risø Centre for their expert support and advice.

Wuppertal, March 2007

Wolfgang Sterk, Carmen Dienst,
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1 RENEWABLE ENERGY TECHNOLOGIES: BENEFITS AND POTENTIAL

Widespread use of renewable energy technologies (RET) is vital in securing a sustainable global energy system.

At present, one fourth of the world's population (1.6 billion people) have no access to electricity in their homes.

For the most part, these people are located in developing and emerging countries. Often they have only low-income opportunities and limited access to education. This leaves them little chance of improving their standard of living. Some 2.4 billion people live without clean, safe cooking fuels and must therefore depend on traditional biomass use – an inefficient, labour-intensive and time-consuming practice which has negative impacts on human health. New studies conducted by the World Health Organisation show that indoor burning of solid fuels is responsible for the deaths of around 1.5 million people each year, making it the fourth most important health risk in developing countries.

Access to modern energy services is a prerequisite for economic and human development.

➜ *Economic development.* Energy can provide:
- Power for enterprises – providing power for machines, access to communication services and creating jobs
- Light for education – empowering people and raising workforce qualifications and skills
- Improvements in agricultural processes – allowing for better irrigation, preservation of agricultural goods and wider market access.

➜ *Poverty reduction.* Poor people can gain from modern energy services by:
- Having to spend less time collecting firewood – time they can invest in earning money, education or other productive activities
- Obtaining light to allow education and income generation in the evenings
- Reducing expenditure on petroleum-based fuels or batteries, allowing households to spend money on education or other productive activities

Table 2: Energy Services and Income Generation

Energy Services	Income-Generating Value to Rural Households and Enterprises	Renewable Energy Options
Irrigation	Better yields; higher value crops; greater reliability; growing during periods when market prices are higher	Wind, solar photovoltaic (PV), biomass
Illumination	Increased working hours	Wind, solar PV, biomass, micro-hydro, geothermal
Grinding, milling, husking	Creation of value-added products from raw agricultural commodities	Wind, solar PV, biomass, micro-hydro
Drying, smoking (Preserving with process heat)	Creation of value-added products enabling sale to higher-value markets	Biomass, solar thermal, geothermal
Refrigeration, ice making	Preservation of produce enabling sale to higher-value markets	Wind, solar PV, biomass, micro-hydro, geothermal
Extraction	Production of refined oils from seed biomass	Solar thermal
Transport	Access to markets, public transport	Biomass (biofuels)
Communication (Computer, Internet, Telephone)	Access to market news; entertainment; co-ordination with suppliers and distributors; weather information	Wind, solar PV, biomass, micro-hydro, geothermal
Battery charging	Wide range of services for end user	Wind, solar PV, biomass, micro-hydro, geothermal

Source: REN21 2005

→ *Reducing health risks.* Access to modern energy services helps:
- Improve medical facilities – equipment sterilisation, surgery lighting, etc.
- Reduce exposure to indoor air pollution
- Facilitate the manufacture and distribution of medicines
- Thereby improving human health and reducing child mortality and maternal deaths

Current Energy Systems are not Sustainable

Since the beginning of industrialisation, energy needs have increased by no less than a factor of 60. GDP growth has so far generally coincided with a corresponding increase in energy demand.

Fossil fuels are currently the dominant source of energy worldwide. Their extraction, transportation and combustion has caused greenhouse gas (GHG) emissions to increase in line with growth in energy demand.

Rising GHG emissions are the prime cause of global climate change, which will severely affect development efforts in developing countries.

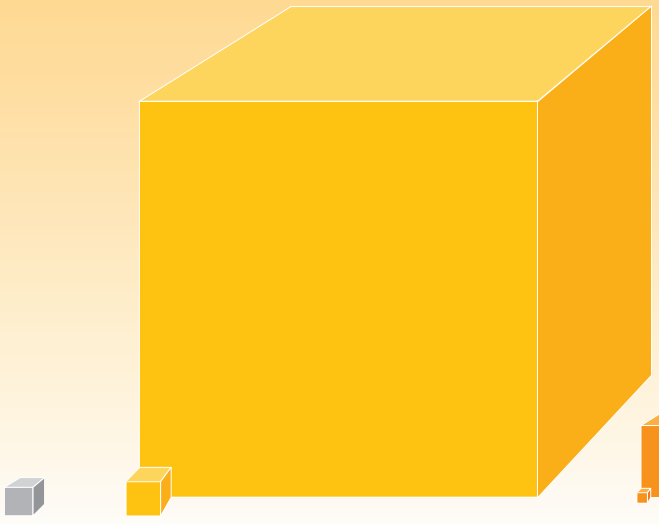
The anticipated and in some cases already observed impacts of climate change include rising sea levels, increased occurrence and intensity of extreme weather events like droughts and floods, lower agricultural yields and the spread of tropical diseases like malaria.

Also, dwindling reserves of the finite fossil fuels gas and oil are set to increase dependence on fuel-exporting countries and lead to price increases in the coming decades.

In the case of Kenya, for example, it has been estimated that the rise in the price of oil from US$ 30 to 50 a barrel led to additional costs of US$ 400 million. This is equivalent to the total official development assistance the country received in 2004. For poor countries in particular, this will lead to a huge outflow of monetary resources and so further hamper their social and economic development.

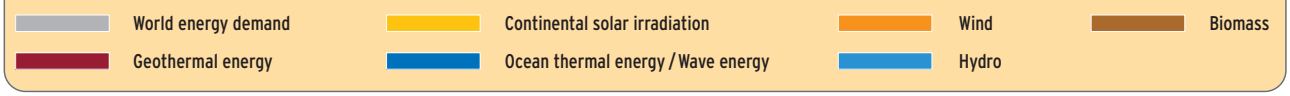
If this trend continues and the course is not set soon for more efficient and sustainable energy use, global energy demand and related CO_2 emissions will increase dramatically in the coming decades. A two-fold increase in CO_2 emissions is projected by 2050 (compared to 2000), resulting in ever more human-induced global warming.

Figure 1: Availability of Renewable Energy Compared to Current Energy Demand



Energy Form	Natural Availability	Technical Availability	Presently Used
Cont. Solar Irrad.	2,850	3.80	0.001
Wind	200	0.50	0.001
Biomass	20	0.40	0.145
Geotherm. Energy	5	1.00	0.006
Ocean Thermal/ Wave Energy	2	0.050	0
Hydro	1	0.15	0.035
Total	**3,078**	**5.90**	**0.188**

Source: DLR



Rear cubes: The natural availability of renewable energy is extraordinarily large. **Front cubes:** The technically available energy in the form of electricity, heat and chemical energy carriers exceeds the present-day energy demand (grey cube, left) by a factor of six.

Developing countries play a key role in this issue as they will require most of the additional projected future energy demand. The question as to which energy sources they choose will therefore heavily influence the world's policies, environment and long-term future.

Increased use of modern renewable energy sources can play a key role in overcoming these challenges.

➜ Renewable energy can contribute to *slowing climate change* by providing heat, cooling, power generation and fuel for transportation with no or only marginal direct and indirect CO_2 and other GHG emissions.

➜ Renewable energy improves supply security:
- Renewable energy sources are inexhaustible and their natural availability is 3,000 times higher than current global annual energy consumption. Even the current technical potential for renewables use is six times higher (see Figure 1)
- Renewable energy sources are available in most regions of the world, not just in specific geographical areas as is the case with fossil and nuclear resources
- This leads to less import dependency, more stable energy prices, stronger market competitiveness and improved long-term prospects

➜ Renewable energy provides greater flexibility:
- Offering a broad portfolio of applications, sources and technology solutions for different climate and societal conditions
- Satisfying the need for small and large-scale energy services in urban and rural regions
- Offering technologies not only for power generation, but for heat generation, cooling and fuels for transportation

➜ Renewable energy addresses environmental concerns by:
- Reducing the environmental damage resulting from fossil fuel use, thereby cutting the associated external costs
- Reducing the unsustainable use of firewood and thus deforestation, a major concern in many developing countries
- Reducing the unforeseeable environmental and proliferation risks of cost-intensive nuclear energy generation with its unresolved problems of nuclear waste disposal

Box 1: RET Potential and Costs

Potential The share of RE worldwide is around 17 percent of global primary energy supply, including traditional use of biomass (9 percent) and large-scale hydro power (5.7 percent). This share does not reflect overall potential, however. Even the potential that is accessible today using proven technologies is around six times higher than current worldwide energy demand (Figure 1).

Costs Modern renewable energy technologies harbour great potential for further improvements in productivity, efficiency and cost. The capital cost per kWh is projected to drop dramatically (see Figure 2). Despite current costs, several technologies are already well tested and ready for large-scale introduction.

Renewable Energy Technologies: Future Outlook

In many developing and emerging countries, currently meagre access to energy services offers a chance to shift directly to the use of new renewable energy sources and leapfrog the need for investment in huge fossil fuel power plants.

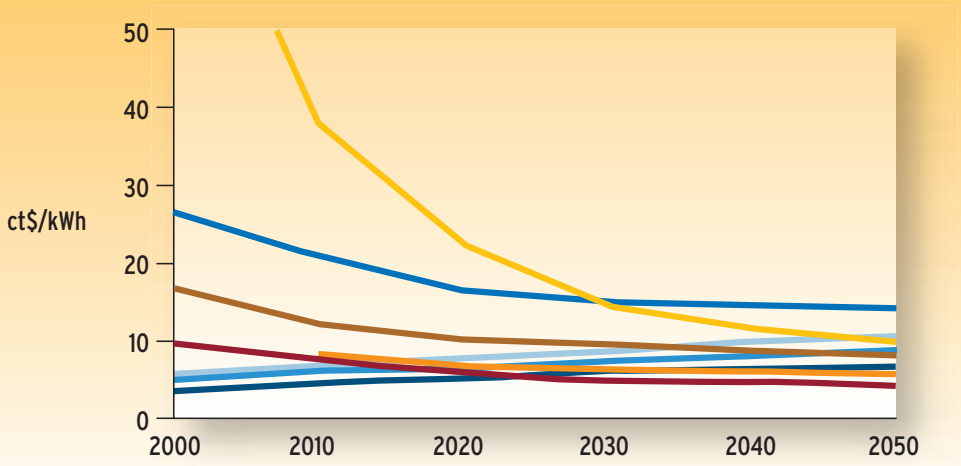
To conclude, introducing modern technologies for renewable energy production and use can mitigate environmental damage, support the meeting of basic energy needs and foster productive activities. While energy is only one determinant of poverty and development, it is a vital one. In particular, the dissemination of renewable energy technologies in developing countries (alongside improvement of energy efficiency) is crucial in preventing climate change, reducing geopolitical risks and securing stable energy prices and long-term availability of energy services.

Widespread use of RET is therefore vital in securing a sustainable global energy system. In the following, some RET are highlighted in spotlights.

Biogas for cooking: Small household-scale biogas digesters offer an option which allows rural areas to obtain energy for cooking, heating water or lighting with biogas lamps. To run a digester, the livestock or domestic waste of one farmer's family with one head of cattle is sufficient. In China, more than 1 million households use household digesters.

Biogas for electricity: Another option for using biogas is its conversion to electricity

Expected Development of Electricity Generation Costs from Fossil and Renewable Options



Source: EREC / Greenpeace 2007

PV
Wind
Hydro
Concentrated solar thermal power plant without storage
Natural gas CC
Geothermal CHP
Biomass CHP
Coal

Reference: Figures for OECD Europe, concentrated solar thermal power plant without storage for Middle East. (Generation costs depend partly on site specific fuel costs and heat credits.)

2 BARRIERS TO DISSEMINATION OF RENEWABLE ENERGY TECHNOLOGIES

The number of countries where RET have seen significant market growth is steadily increasing. Nevertheless, dissemination is still very limited in most countries of the world.

Implementation is impeded by various kinds of barriers – financial/economic, institutional/political and technical.

Identifying barriers is a prerequisite in designing appropriate measures to overcome them at the various levels (local, national and regional). Table 3 lists the key barriers.

Probably the most important issue is the economic performance of renewable energy technologies compared to the energy sources that presently dominate the energy markets.

RET are characterised by high specific investment costs and low (for biomass) or zero fuel costs. This leads to two main problems:

- First, the willingness and/or the ability to finance 'expensive' investment in RET is often relatively low
- Second, in many countries subsidised fuel and electricity prices nullify the RET advantage of low operating costs. Global subsidies for conventional energy are estimated to exceed US$ 200 billion annually.

Dynamic market growth is unlikely to be achieved if the relative economic performance of RET is not improved.

The dissemination of renewable energy technologies is also often hampered by institutional and political barriers.

Energy policy in most developing countries (and also most industrialised countries) has historically been fixated on large-scale, predominantly fossil energy technologies.

This fixation is often accompanied by hierarchical intra-institutional structures. RET, which are of a different nature, require different political strategies that foster market processes on a more decentralised level. Combined, these factors impede bottom-up diffusion of new knowledge and ideas. Also, the lines of responsibility for energy planning and market development are in many cases unclear and not yet sufficiently streamlined. Dispersed responsibilities increase transaction costs for project developers and may also pose risks due to uncertainties concerning the outcomes of approval and planning processes.

Table 3: Barriers and Effects that Hinder RET Implementation

Barrier Group	Barrier	Effect / Impact
Financial & Economic	High specific up-front costs of RET versus low fuel prices and electricity tariffs (as a result of subsidised fossil fuels and electricity)	No level playing field; lacking willingness and/or ability to finance 'expensive' investments in RET; higher risk premiums
	Comparison of installation costs in €/kW instead of specific electricity generation costs in €/kWh	RET investments not implemented even if a project would be profitable over its lifetime
	Taxes and customs on imported equipment	RET installations become even more expensive
	High transaction costs due to small-scale and decentralised nature of RET applications	Potential RET applications not implemented
Institutional & Political	Conflicting objectives and interests among policy-makers	Shifts power to powerful lobbyists, hinders objective policy formulation, lack of policy coherence
	Institutions for RET promotion relatively powerless compared to institutions favouring use of fossil fuels	Government concentrates on fossil energy; RET potential not realised
	Unclear ministerial responsibilities and insufficient coordination between government agencies responsible for RET	Weak promotion of RET both generally and in specific sectors (e.g. biomass)
	Strong hierarchical structure of public institutions	Impedes bottom-up diffusion of new knowledge and ideas (especially serious barrier for small and medium enterprises)
	Monopolistic energy market	No guaranteed grid access and no fair feed-in tariffs for independent RE power producers; decentralised, small-scale RE potential in particular will not be realised and will be kept out of the market
Technical	Inadequate appliance quality; lack of technical standards and inappropriate technical designs	Gives RET a bad reputation, impeding their further dissemination
	Some RE technologies / components (e.g. solar thermal power plants, large-scale thermal storage) not yet commercially tested	Increased investment cost; financial risk for plant operators
	Negative externalities (e.g. air pollution from biomass projects)	Lack of social acceptance may hinder project implementation
Awareness / Information / Capacity	Lack of awareness of potential and the multiple benefits of RET utilisation among decision-makers at different political and administrative levels	Potential and positive side benefits of some RET still underestimated
	Lack of qualified personnel	Problems in technical implementation, maintenance and financial arrangements hinder RET market development in general
	Inefficient resources for data collection and information transfer	Insufficient information basis may lead to no, or wrong, decisions by project developers, investors etc.
	Inadequate, insufficient education of consumers/RE system users	Technological mistrust in case of system breakdown; overblown expectations followed by discontent; monetary losses to consumers

Source: Wuppertal Institute

Concentrated solar power: This technology has recently been refined and implemented in countries like Spain and the USA and is planned for Morrocco and Egypt. Direct solar radiation is concentrated and converted to thermal energy. The heat can then be converted into electrical energy in conventional power plants (steam generation) or be used in heating or cooling processes and for water desalination. Sun-belt regions hold the greatest potential for solar thermal energy as a power generation technology.

When it comes to electricity generation, a key barrier is the *lack of guaranteed grid access* for independent power producers in monopolistic (or oligopolistic) national energy markets.

A further important barrier has been the lack of technical standards or their enforcement, which has led to poor-quality products and given renewable energy applications a bad reputation.

Other important technical barriers are the need for more research and development for the improvement or adaptation of RET to meet national and local conditions (e.g. wind turbines designed for heavy sand storms) and to refine technologies that are particularly well suited to large-scale use of RET (e.g. energy storage technologies) until they reach a marketable stage.

Finally, there is a severe lack of awareness in many countries as to the potential for using RET and the associated benefits. There is also a lack of qualified technical personnel.

Solar Thermal Power Plant

3 THE CLEAN DEVELOPMENT MECHANISM: HOW IT WORKS AND THE CDM MARKET TODAY

Background: The Kyoto Protocol and its Flexible Mechanisms

In 1997, the Parties to the United Nations Framework Convention on Climate Change agreed on the Kyoto Protocol as a first binding step towards reducing GHG emissions.

Under the Kyoto Protocol, industrialised countries committed to reducing their GHG emissions in the period 2008-2012 by an average 5.2% below 1990 levels. To help them reduce the costs of meeting their targets, the Kyoto Protocol established three 'flexible mechanisms' allowing them to count emission reductions achieved in other countries.

The flexible mechanisms are based on the rationale that since greenhouse gases have the same impact on the climate no matter where they are emitted, they should be reduced where it is least costly to do so. The three mechanisms are:

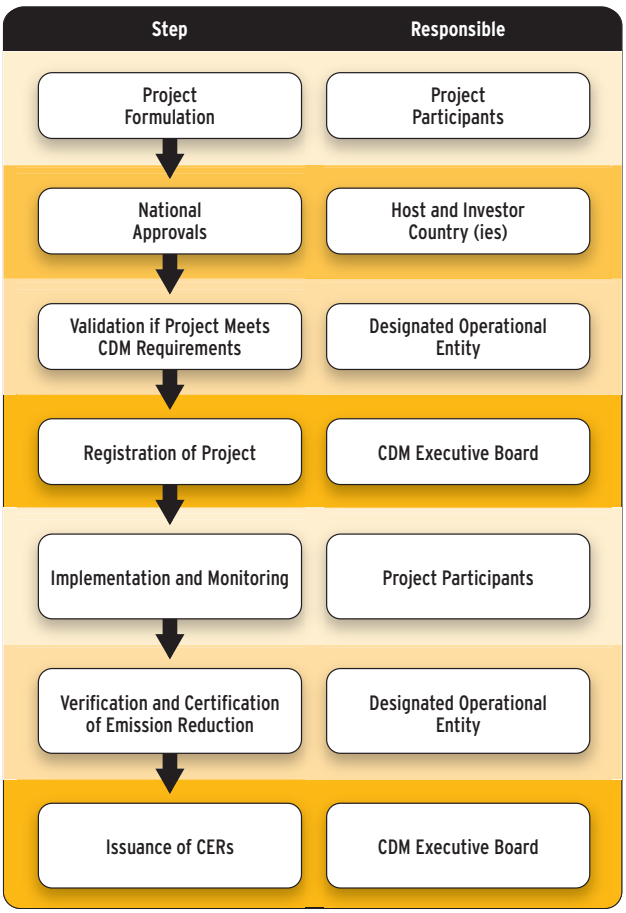
- *International emissions trading,* which allows industrialised countries to buy emission allowances (assigned amount units or AAUs) from other industrialised countries whose emissions are below the limit allowed by the Kyoto Protocol
- Under *Joint Implementation (JI),* public and private project developers can generate emission reduction units (ERUs) from projects that reduce emissions in industrialised countries. Industrialised countries can then buy these ERUs and count them toward their Kyoto targets.
- By the same principle, under *the Clean Development Mechanism (CDM),* public and private project developers can generate and sell certified emission reductions (CERs) from projects that reduce emissions in developing countries.

How the CDM Works

To qualify for CDM approval and issuance of CERs, projects have to successfully complete a predefined project cycle (see Figure 3). The project cycle is designed to safeguard the mechanism's environmental integrity.

Projects need to demonstrate that their envisaged emission reductions are real, measurable and additional to any that would have occurred in the absence of the project.

Figure 3: The CDM Project Cycle



Source: Wuppertal Institute

To demonstrate 'additionality', project developers have to establish a scenario of what would most likely have happened under business-as-usual conditions (the 'baseline') and demonstrate that their project is not the baseline. The baseline needs to be established on a project-specific basis according to approved methodologies. Project-related emission reductions are determined by subtracting the project's emissions from the emissions that would have occurred without implementing it.

The CDM is supervised by a *CDM Executive Board* elected by and responsible to the Meetings of the Parties to the Kyoto Protocol.

Wind power: Germany's recent success in large-scale wind power generation demonstrates that large-scale and intensive use of wind as a reliable energy source for grid-connected electrification is possible in many countries. Despite its low average wind potential, Germany has a total installed capacity of over 20,000 MW. Stand-alone systems made up of small-scale wind energy converters can deliver electricity in dry but windy regions.

The Executive Board accredits private certification companies *(Designated Operational Entities)* to validate that projects meet the CDM requirements and to verify and certify the emission reductions achieved. The CERs are issued by the Executive Board on the basis of the Operational Entity's verification and certification.

Potential Benefits of the CDM and Requirements for Host Country Participation

Apart from helping industrialised countries meet their Kyoto targets, the CDM also has an equally weighted objective of assisting developing countries in achieving sustainable development.

It can do this by:

- *Attracting capital* for projects that assist in shifting to a less carbon-intensive economy by using less carbon-intensive energy sources and improving energy efficiency and conservation
- Alleviating poverty by generating additional *income and employment*
- Providing a tool for *technology transfer*

To be formally able to host CDM projects, a developing country needs to have:

- Ratified the Kyoto Protocol
- Have designated a national authority (DNA) to evaluate and approve CDM projects and serve as point of contact to the government. The DNA needs to be notified to the UNFCCC secretariat.

While the international process has created the general framework for project implementation, each developing country has to establish its own project approval procedures and criteria. The DNA is responsible for evaluating projects based on these criteria and for issuing national letters of approval, which are a prerequisite for a project to become registered and able to generate CERs. The approval has to confirm that the country is participating voluntarily in the CDM project and that the project is assisting the host country in achieving sustainable development.

The CDM Market Today

Having started with many difficulties and delays, the supply side of the CDM is now fully functional and rapidly expanding.

Over 1,500 projects have already been registered or are at the validation stage, with the cumulative number of CERs issued expected to reach 1.7 billion by 2012.

On the demand side, nine EU Member States have so far set aside a combined € 2.7 billion to acquire 365 million emission certificates from all flexible mechanisms through to 2012. Japan has announced that it will acquire another 100 million certificates. Switzerland intends to purchase up to 1.6 million certificates per year over the period 2008–12 from the revenue accrued from its 'climate penny' policy introduced in 2005. There is also an unspecified demand from private companies in the many industrialised countries that allow them to use CERs and ERUs to comply with national climate policy obligations.

In February 2007, prices for CERs ranged from € 5 to € 12 depending on a project's implementation status and various other factors such as project technology and project/country risks.

The more advanced a project is in the CDM project cycle, the more secure its ability to deliver CERs and the higher the price it can charge. To a large extent, the prices offered depend on the demand for CERs in industrialised countries. The more countries commit to reducing their greenhouse gas emissions in future, the better the market outlook for CERs as demand will probably rise accordingly.

4 CDM AND RET PROMOTION

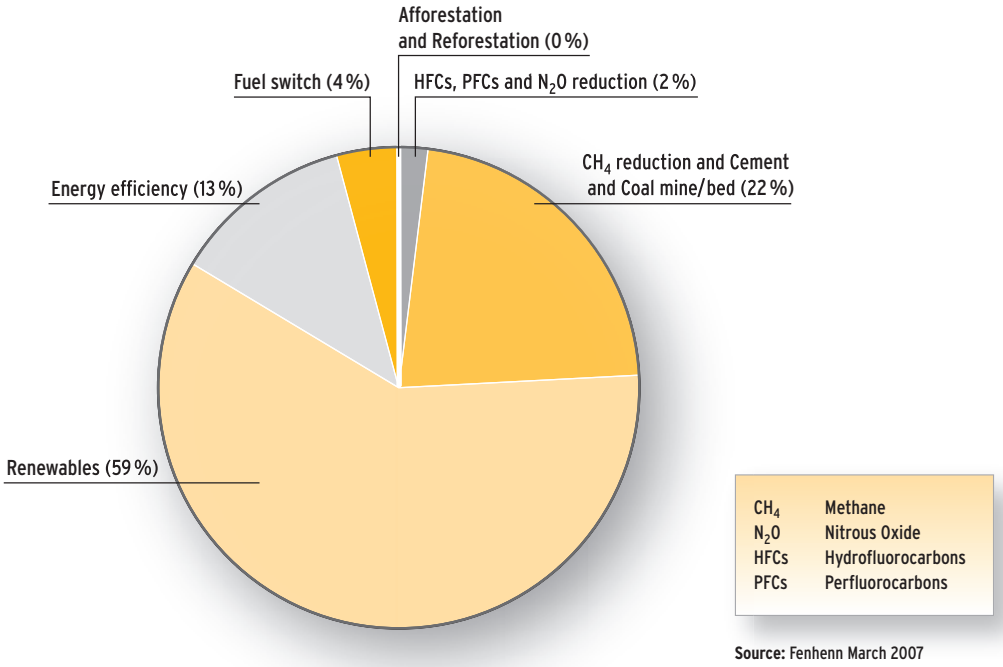
CDM's Potential Contribution to Alleviating Barriers to RET Dissemination

The CDM increases the revenues for renewable energy generation.

Most of the renewable energy projects in the CDM pipeline involve electricity-generating technologies. The basic economic barrier is the *relatively higher electricity generation costs* for RET, although the scale of the difference varies from technology to technology and from country to country. For example, in Thailand costs for electricity from biomass are almost competitive with the average electricity tariff, while wind electricity is about double the average price. The revenues attained from selling CERs from a CDM project can help compensate for this price difference to an extent. Nevertheless, renewable energy projects do not get as much out of the CDM as other project types.

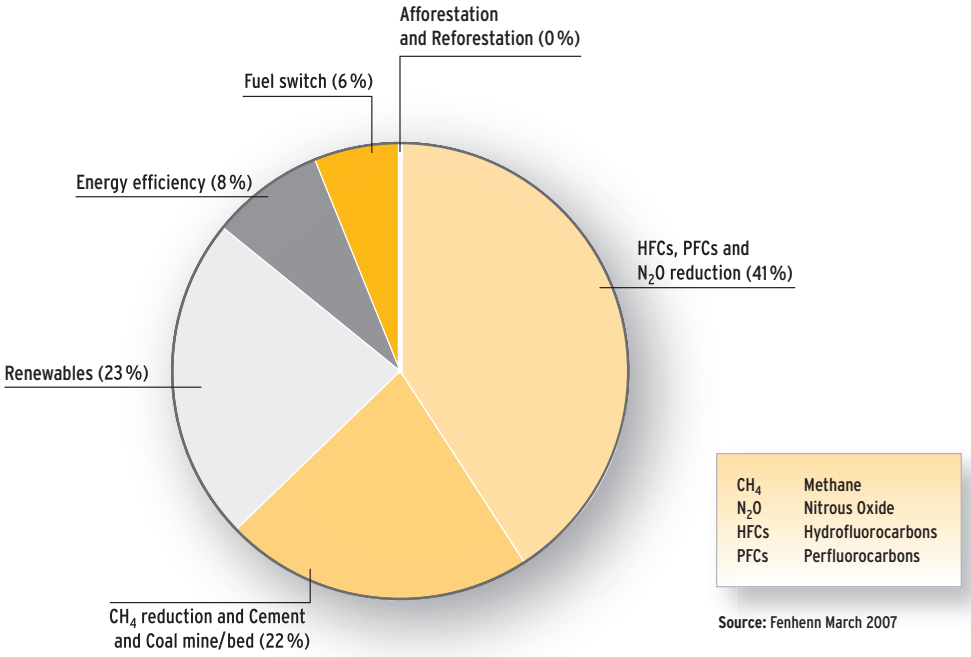
Among the 1,700 projects currently at an advanced stage of the CDM project cycle, biomass projects make up the largest share, accounting for 21%, followed by hydropower projects (including large hydro) at 19% and wind energy at 12%. In total, renewable energy projects constitute 59% of the project portfolio.

Number (%) of Clean Development Mechanism Projects in Each Sector



Source: Fenhenn March 2007

Certified Emission Reductions until 2012 from Clean Development Mechanism Projects in Each Sector



Source: Fenhenn March 2007

The picture changes, however, when the expected CERs are broken down by project type as a measure of how much 'carbon financing' each project type receives. Here, renewable energy projects account for only 24 percent of all expected CERs.

The main reasons for this are:

- Renewable energy projects typically reduce emissions of CO_2, which has a global warming potential of 1
- Many renewable energy projects are relatively small scale

In terms of CERs, the market is dominated by projects to reduce hydrofluorocarbons (HFCs), nitrous oxide (N_2O) and methane (CH_4), which in total account for about two thirds of all expected CERs. This is due to the high global warming potential of these gases, which in the case of HFC-23 is 11,700 times that of CO_2. In fact, a mere 41 HFC, PFC and N_2O reduction projects account for 40 percent of all expected CERs from the more than 1,700 projects in the project cycle.

Renewable energy projects thus receive a disproportionately small financial benefit from the CDM. At current CER prices, the increase in the internal rate of return from the sale of CERs from a CO_2-based renewable energy project is estimated at about 2 percent. This additional CER revenue can be enough to lift projects across the threshold of being economically viable. However, in some countries, energy subsidies tilt the energy market against RET such that CER revenues are not enough for a single one of the RET CDM projects currently in the pipeline to become profitable. Instead, these projects must rely on further support from official development assistance.

The *carbon intensity* of a country's electricity mix is also an important factor. For example, countries like Thailand or Egypt have an average electricity carbon intensity of approximately 500 kg CO_2/MWh. This is much lower than the likes of China (916 kg CO_2/MWh) and India (896 kg CO_2/MWh). The economic outcome under the logic of the CDM is that high-carbon-intensity countries benefit almost double from CERs for each conventional kWh substituted by renewable energy.

By contrast, the CDM strongly promotes renewable energy projects (biogas for example) that avoid methane emissions. Methane has 21 times the global warming impact of CO_2. Projects thus yield high volumes of CERs and this has a very strong impact on profitability.

The other key financial barrier is the *high specific up-front costs of RET*. The CDM could alleviate this problem if buyers were willing to front-load their payments. RET project developers would then receive the CER revenues when they most need them. However, while there are some purchasing programmes where this is possible, buyers have mostly limited their role to purchasing CERs for payment on delivery. As a result, project developers have been forced to finance their projects from other sources.

The CDM could also help to remedy the *insufficient purchasing power* of potential users. The CER revenues could be used to distribute RET applications at subsidised prices.

The CDM incentivises streamlined decision-making and approval procedures.

Although not originally designed for the purpose, the CDM offers limited potential to overcome institutional barriers. To an extent, the opportunity for foreign investment and access to modern technology incentivises relevant government bodies to cooperate better on energy policy issues and to *streamline decision-making and approval procedures*. Energy policy is no longer exclusively designed by energy ministries since most aspects of climate policy – and thus the CDM debate – are the responsibility of environment ministries. Moreover, renewables are gaining ever-greater importance beyond environmental considerations. This is due to their benefits regarding the more 'conventional' purposes of energy policy, especially energy security and reducing dependency on imports.

Since it financially rewards the climate benefit of low-carbon technologies, the CDM offers an important *argument for using RET* in addition to, say, reducing fossil fuel imports. This attracts greater attention from political decision-makers and the private sector.

Being a mechanism established by international policy, the CDM can also give project developers *better access to decision-makers* compared to traditional private investments, especially if they have the official backing of the investor country. This might help to alleviate some of the problems associated with the hierarchical nature of some host country institutions.

In conclusion, the CDM can alleviate barriers against RET dissemination, but it is not a cure-all.

The CDM can make renewable energy projects more profitable and also help to procure up-front financing. It may also contribute to streamlined decision-making, greater awareness of RET options and better access to decision-makers. However, additional revenues are limited and cannot counterbalance fundamental distortions in national energy markets.

The CDM and Host Country Conditions

An analysis of the CDM project pipeline shows that the conditions in host countries are the decisive factor for CDM success.

Being a market-based mechanism designed to mobilise private investment, the CDM is concentrated in rapidly industrialising countries. These offer substantial emission reduction potential and a generally favourable investment environment.

Solar Cooking

Of the 1,700 projects at an advanced stage of implementation, no less than 36 percent are located in India, which, together with Brazil, China and Mexico combined, accounts for about three quarters of all projects. All other countries are way behind. By region, Asia and the Pacific is decisively in the lead with about 66 percent of projects, followed by Latin America with 30 percent. Sub-Saharan Africa, North Africa and the Middle East each account for less than 2 percent.

India, China and Brazil also account for approximately 70 percent of the CERs from renewable energy projects expected by 2012 (see Table 4). Along with

Table 4: Renewable Energy CDM Projects in Selected Countries

	Brazil	China	India
Renewable energy CDM projects already registered	70	27	98
Renewable energy projects in CDM pipeline[1]			
Number of projects	150	185	360
Electric capacity in MW	3,293	7,143	5,897
CERs expected by 2012 in 1000t	56,395	123,206	121,171
CERs as share of global renewable energy CERs	12.7	27.7	27.2

1 Including the projects already registered and the project types agriculture, biogas, biomass energy, geothermal, hydro, solar, tidal and wind.

Source: Own calculations based on Fenhann March 2007

their generally high CDM host country attractiveness – due to good ratings on their mitigation potential, institutional CDM capacity and general investment climate – they also offer a persuasive investment climate specifically for RET.

India and China rank highly in analyses like the global Renewable Energy Country Attractiveness Index (Rank 5 for India and Rank 9 for China). This studies the national renewable energy markets, renewable energy infrastructures and their suitability for individual technologies.

Overall market growth and rising energy consumption in China, India and Brazil attract foreign investors, especially in the energy supply sector. There is also a general need to expand the energy infrastructure. Plus, China and India have a relatively long history of renewable energy support policies and give high priority to renewable energy development:

- China has steadily increased its support for renewables since the 1990s. This has culminated in the Promotion for Renewable Energy Act and targets to promote renewable energy growth.
- India is the only country worldwide to have a separate ministry for new and renewable energy sources, and government incentives have supported the creation of a fairly large and diversified renewable energy manufacturing base and infrastructure. Initiatives at state level often effectively complement federal policies and programmes. A total of fourteen state governments have so far announced promotional policies for power from renewables; these include remunerative feed-in tariffs, renewable energy purchase obligations and tax incentives.

Such policies considerably improve the relative economic performance of renewable energy technologies compared to conventional sources and thus address an important identified barrier.

But this does not mean that only rapidly industrialising countries can play a role in the CDM, even if they benefit most in absolute terms. Guatemala for example has a number of hydro energy projects in the pipeline (297 MW in facility sizes ranging from 3.9 to 94 MW). In Honduras, another least developed country (LDC), 11 biomass CDM projects are in the pipeline, the same number as in Chile.

Policy-makers in many CDM host countries need to make significant efforts to remove barriers to the dissemination of renewable energy technology. Only then can the CDM have stronger impact.

Plans to introduce new policy instruments supporting renewable energy use have often been hampered by concerns that energy policy cutting reliance on fossil fuels and encouraging utilisation of renewable energy

sources may have a negative impact on CDM opportunities, since it may result in many projects no longer being 'additional'. However, at its last meeting of 2005, the CDM Executive Board ruled that baseline setting need not take account of domestic policy efforts put in place after 2001. Instead, the baseline may be calculated on the basis of a hypothetical scenario without the policy.

Contrary to the concerns voiced by some, the CDM does not prevent the introduction of other climate-friendly policy instruments.

5 POLICY OPTIONS FOR PROMOTING RENEWABLE ENERGY

Since there are manifold barriers that discriminate against RET in energy markets, addressing only a single barrier is not enough.

To be effective, strategies must take into account the complex interplay of barriers, which usually requires a mix of well-designed and mutually supportive policy instruments.

When designing the next policy steps to advance renewable energy, it would therefore be useful to discuss the role the CDM could and should play in the overall energy policy setting. This should mean looking for the best ways to combine domestic policy instruments with the CDM in order to maximise CDM benefits and thus the increase in renewable energy use.

Table 1 in the Executive Summary (p. 4) provides an overview of key measures that can be taken to promote renewable energy.

Removing Key Barriers

Probably the most important issue is the economic performance of RET compared to the energy sources that presently dominate the energy markets. In principle, there are two approaches to addressing this problem, both of which are indispensable in developing promising strategies:

- Bringing down the costs of RET and their related energy services
- Abolishing market distortions that discriminate against these technologies, such as direct subsidies for fossil fuels or lacking internalisation of external costs

As to the first approach, there is evidence that policies can effectively induce technological progress and cost savings by creating enabling frameworks. The latter is often described as 'levelling the playing field' in which RET and conventional energy technologies have to compete.

Reforming energy markets by reducing subsidies for fossil fuels

Where they exist, it is absolutely essential to reduce the subsidies for electricity and fossil fuels as a prerequisite for the dissemination of RET. Another reason for redesigning subsidy policies is that prices for fossil fuels (and fossil-fuel products like electricity) will most probably keep rising due to their increasing scarcity and growing world energy demand. Keeping *subsidies* at current levels would therefore *result in an ever-increasing burden on public budgets*.

The challenge is to cut back subsidies in a manner that avoids social unrest. This could possibly be achieved by implementing gradual reductions in subsidies over a period of time rather than making an abrupt cut. Besides, it will be necessary to communicate these changes to the population in a transparent manner and to highlight their long-term necessity and advantages.

Setting ambitious targets for renewables expansion

Setting clear and ambitious targets for the use of renewable energy sources provides planning certainty and helps to create an environment that is favourable to long-term investments. Ideally, there should be an overall target for renewable energy use that is then broken down to sector-specific targets for renewable electricity, heat and liquid fuels.

Cooking with Biogas

For example, Thailand has announced a target of 8% of primary energy to come from renewable sources by 2011, which would mean more than one gigawatt of new capacity. China has set a target of 16% of primary energy to come from renewable sources by 2020, up from 7.5% in 2005. India is aiming for 15% of power capacity, 10% of oil consumption to be substituted and 100% use of solar hot water in all possible applications by 2032. The CDM could be used as a policy instrument to achieve these targets.

Giving independent power producers access to the grid

Due to their decentralised nature, renewables must be implemented by a higher number of operators than those operating large-scale fossil fuel plants. There is thus a need to strengthen the role of independent power producers (IPPs). Giving priority to the interests of renewable energy-based IPPs has been a key driver of RET market growth in the German electricity sector. This principle has also found its way into China's renewable energy law.

Micro-hydro for electrification: In off-grid and non-arid regions with flowing water, small-scale hydropower plants provide good opportunities for the electrification of villages to give them lighting and to supply small rural businesses, mills, farms and food processors. Countries where this technology has been implemented successfully include Nepal and Cameroon.

Implementing supportive policies

Apart from removing policies that negatively impact RET, it is also essential to introduce policies that positively support them in order to push them into the market, achieve economies of scale and quickly 'buy down' technology costs. RET still harbour huge cost saving potential as illustrated in Figure 2. When taking into account the external costs of conventional energy technologies, falling RET prices and the rising prices for conventional energy are set to intersect within the next two decades for many RET. Examples of supportive policies include feed-in laws, market incentive programmes, tax reductions and green certificates.

For example, the US government has enacted 30 percent tax credits for solar photovoltaics (PV) and solar hot water. In 2006, Spain enacted a new building code requiring solar energy in new construction and renovation of certain types of buildings exceeding certain size limits.

Setting fixed feed-in tariffs for RET has been one of the world's most successful policy instruments for disseminating RET and reducing technology costs (see Box 2). Some 41 countries, provinces and states, including China and six Indian states, have adopted feed-in policies.

Other Supportive Measures

Establish and enforce quality standards for renewable energy equipment

Efforts to introduce RET have frequently suffered setbacks due to poor-quality appliances. There is thus a need to establish suitable manufacturing standards and specifications and to strictly enforce them.

Also, policy instruments and incentives could be introduced to encourage local RET manufacturers in developing countries to export some of their production to regional RET markets. By targeting the export market, local manufacturers would have an incentive to improve their production quality and would seek to obtain international RET certification. The local RET market would in turn benefit from better quality products.

Box 2: Feed-in tariff regulation addressing manifold barriers

Germany has often been cited as an example where impressive dissemination and growth of renewable energy technologies has taken place even though the country does not have an outstanding renewable energy resource base. This success is due to a mix of policy instruments, but in particular to the feed-in tariff system in the electricity sector – laid down in the Renewable Energy Sources Act (EEG). This has become a highly powerful and dynamic instrument for bringing renewables into the market and 'buying down' specific costs. The EEG systematically addresses economic and market barriers that impede dissemination in an oligopolistic market based on the following central features:

- Fixed feed-in tariffs over a limited period and on a decreasing scale guarantee *long-term investment security*, but also induce innovation and cost reductions.
- *Tariffs differentiate* between technologies, plant size, technology status and plant location.
- A priority purchase obligation for renewable energy *strengthens the role of independent power producers (IPP)* and standardises and simplifies independent feed-in into the grid.
- Remuneration spread across all energy supply companies and all end consumers *minimises the short-term financial costs* for each consumer.
- Remuneration exemptions for energy intensive industries *address international competitiveness issues*.

In conclusion, the German approach to renewable energy promotion tries to support all renewable energy technologies according to their respective needs. It is not restricted to the most economic or most competitive technologies available. This approach also takes into account that different RET have different strengths (e.g. biomass electricity is suited to base-load power production, solar electricity performs best at noon, a time of peak demand, etc.) and that all sources are needed to establish an energy infrastructure primarily based on renewable energy.

Establish dedicated loan facilities

Even if RET profitability and competitiveness is improved with measures such as the removal of subsidies or the introduction of feed-in tariffs, there is still the problem of high up-front investment costs. One means of addressing this problem is to establish dedicated loan facilities with low interest rates to provide (micro)finance for RET on preferential terms. These should be open both to commercial RET facilities and to private end users wishing to utilise small-scale RET applications such as solar water heaters. Micro-credit linked to micro-enterprise has proven highly successful in promoting renewable energy and reducing poverty.

Lower taxes and customs duties on RET equipment

Apart from high investment costs, the viability of RET is also affected by taxes and customs duties on imported RET equipment. While such duties may be sensible as a means of shielding domestic equipment manufacturers from outside competition, it might be beneficial to lower them for equipment that cannot currently be manufactured locally.

Give practical support to those who implement renewable energy technology

In many cases, RET are complex and difficult to apply, both for project developers and for end users. Many countries do not have the infrastructure to directly support practitioners in RET implementation. It would make sense, therefore, to complement quantifiable 'hard' policy measures like feed-in tariffs with the 'soft' measure of requiring institutions to give free and independent advice on practical implementation of RET and on energy efficiency measures. Germany has such institutions at three levels: The German Energy Agency at federal level, state energy agencies in various states and consumer advice centres at municipal level.

Substantially raise awareness of renewable energy and build technical capacity.

Low awareness and lack of knowledge about how to operate RETs are a major barrier to their dissemination and have in the past contributed to high failure rates in RET application. Hence development of effective public awareness and promotion campaigns which make use of all media but focus primarily on TV and newspapers can be expected to yield a substantial dividend. Such campaigns should provide information on the RET concept, its benefits and its operating requirements. Identification and dissemination of 'success stories' and public-private demonstration projects play a key role in raising awareness and promoting replication.

It is also important to produce a cadre of high-calibre engineering graduates who understand RET. This would require the introduction at domestic higher education institutions of graduate degrees and diplomas which focus on RET. Having locally qualified RET engineers would help reduce the transaction costs associated with RET project identification and design.

Using the CDM to Promote Renewable Energy

Apart from improving general domestic conditions, there are several other ways to improve the use of the CDM to promote renewable energy.

Speedy and transparent CDM approval process

One key prerequisite for attracting CDM projects is to have a DNA with sufficient competent staff to operate a speedy and transparent CDM approval process. An approval process of this kind will decrease legal uncertainty and lower transaction costs for project developers. Countries such as Egypt and Morocco have established a two-step approval process. In the first step, project developers need only present a brief document setting out key aspects of the project. This enables the DNA to give a very early indication of whether or not a project is acceptable and to identify likely major obstacles, thus saving unnecessary paperwork.

CDM promotion and capacity building

In many countries, awareness of the CDM is still relatively low. Given the complexity of the instrument, substantial capacity building will be needed among businesses and stakeholders. Considering the CDM's tendency to concentrate on large, rapidly industrialising nations, an extremely pro-active approach will be needed in many countries. Governments could work to identify potential projects and advertise CDM opportunities to potential business partners and CER buyers. For example, Egypt has developed a project portfolio of 24 projects and has advertised it at international carbon conferences and through other means.

Integrating the CDM into national energy and economic development planning

Apart from improving the regulatory framework for RET in general, the regulatory framework for the CDM

PV Panels

Box 3: The CDM Gold Standard

The CDM Gold Standard is a high quality standard for CDM projects. It was developed by an international panel of stakeholders and experts at the initiative of the World Wide Fund for Nature (WWF). The CDM Gold Standard aims to enhance the environmental and socio-economic integrity of the CDM by defining quality criteria that exceed those established within the Kyoto regime, thus creating a 'premium product' on the emission certificates market. It is based on the expectation that buyers will be willing to pay more for CERs generated by certified high-quality projects. The Gold Standard's criteria include

- A more detailed evaluation of project additionality.
- An assessment of other project-related environmental and social impacts.
- And minimum standards for stakeholder participation.

See the CDM Gold Standard website for more information: www.cdmgoldstandard.org.

itself could be improved by integrating the mechanism into national energy planning and overall economic development. This could serve to mainstream awareness of the CDM and its potential at all levels of government and give government staff a clear signal that they should be promoting CDM projects.

Giving preference to renewable energy CDM projects

The governments of developing and industrialised countries could give clear preference to renewable energy CDM projects. Industrialised countries in particular could significantly help to overcome the barriers of high specific up-front investment costs by paying higher prices and providing up-front financing for renewable energy CDM projects. This could include giving special preference to Gold Standard projects (see Box 3).

Exploring CDM programmes of activities

It has recently been made possible to implement 'programmatic' CDM projects. A programmatic project is defined as coordinated action by a private or public entity which leads to GHG emission reductions via an unlimited number of activities under the programme. This approach will hopefully allow consolidation of dispersed small-scale renewable energy activities to sizes where they become economically viable. Examples include replacing diesel-powered water pumps currently used in agriculture with solar-powered pumps and installing solar water heaters in all houses in a particular city district.

Given the greater complexity of such projects, it might often be necessary for them to be coordinated by public institutions in host countries. Through their investments, industrialised country governments could also make a significant contribution to the implementation of this new project type. A further boost could come from pilot projects conducted by public institutions in CDM host and buyer countries to explore and overcome methodological problems potentially connected to this new approach.

FURTHER INFORMATION

This brochure is based on the results of the research project "Promoting Renewable Energy Technologies in Developing Countries through the Clean Development Mechanism". The project was conducted by the Wuppertal Institute on behalf of the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety through the German Federal Environment Agency. The final report of the project will shorty be available on the website of the Federal Environment Agency.
www.uba.de

The Deutsche Energie-Agentur (dena) – the German Energy Agency – is a competence centre for energy efficiency and renewable energy.
www.dena.de

The Deutsche Gesellschaft für technische Zusammenarbeit (GTZ) works in international cooperation for sustainable development on behalf of the German government.
www.gtz.de

The Deutsche Investitions- und Entwicklungsgesellschaft (DEG) finances and structures investments of private enterprises in developing and transition countries.
www.deginvest.de

The website of the Federal German Ministry for the Environment, Nature Conservation and Nuclear Safety provides a variety of information on renewable energy policy.
www.bmu.de
www.erneuerbare-energien.de

The BMU publication "Renewable Energies – Innovations for the future" provides comprehensive information on renewable energy technologies, their potential, costs, environmental impacts and policy instruments for promoting RET.
www.erneuerbare-energien.de/inhalt/37453/20049

The Federal German Ministry for Economic Cooperation and Development is responsible for German development cooperation activities.
www.bmz.de

The Global Network on Energy for Sustainable Development (GNESD) is a UNEP-facilitated knowledge network of developing country centres of excellence and network partners.
www.gnesd.org

The Intergovernmental Panel on Climate Change (IPCC) is the authoritative international body on climate change. Its reports provide the scientific basis for international climate policy.
www.ipcc.ch

The Johannesburg Renewable Energy Coalition (JREC) is a coalition of governments that are committed to achieving the commitments on renewable energy made at the 2002 World Summit for Sustainable Development (WSSD) in Johannesburg.
http://ec.europa.eu/environment/jrec/index_en.htm

The KfW Carbon Fund of the German KfW Bankengruppe purchases CERs from CDM projects.
www.kfw.de/klimaschutzfonds

REN21 is a global policy network whose goal is to bolster policy development for the rapid expansion of renewable energy in developing and industrialised economies.
www.ren21.net

The Renewable Energy and Energy Efficiency Partnership (REEEP) is a global public-private partnership that structures policy and regulatory initiatives for clean energy. It also facilitates financing for sustainable energy projects.
www.reeep.org

The United Nations Climate Change Secretariat serves the United Nations Framework Convention on Climate Change and the Kyoto Protocol. The Secretariat's website also includes a dedicated CDM website.
www.unfccc.int
http://cdm.unfccc.int

The UNEP Risø Centre is implementing a four-year project on Capacity Development for the CDM (CD4CDM). The project website offers a variety of tools, including material on developing a CDM country strategy and an up-to-date CDM pipeline overview.
www.cd4cdm.org

WISIONS is an initiative that fosters sustainable energy projects by promoting good-practice examples and supporting innovative project ideas.
www.wisions.net

The Wuppertal Institute for Climate, Environment and Energy manages the JIKO project on CDM/JI on behalf of the German Environment Ministry. The project website includes a quarterly JIKO Info newsletter and various policy papers on current CDM issues.
www.wupperinst.org/jiko

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This brochure is part of the public relations work of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety.
It is distributed free of charge and is not intended for sale.
Printed on recycled paper form 100 % waste paper.