FACT SHEET

Renewable energy

Key points

- ***Promoting renewable energies is integral to low carbon green growth.***
- ***Policymakers should work towards boosting the competitiveness of renewable energy.***
- ***There is no blueprint for the right combination of renewable energy policies. Good practice measures should be watched closely and applied to national strategies when feasible.***

Renewable energy explained

Renewable energy derives from natural resources that have the capacity to replenish themselves over a relatively short period of time and can be regarded as infinite. Conventional energy sources, on the other hand, such as coal, natural gas or oil, restore themselves so slowly that their quantity and availability is limited for anthropogenic use. Examples of renewable energy sources include the sun, wind, moving water, biomass (including organic waste) and heat contained in the Earth's crust.

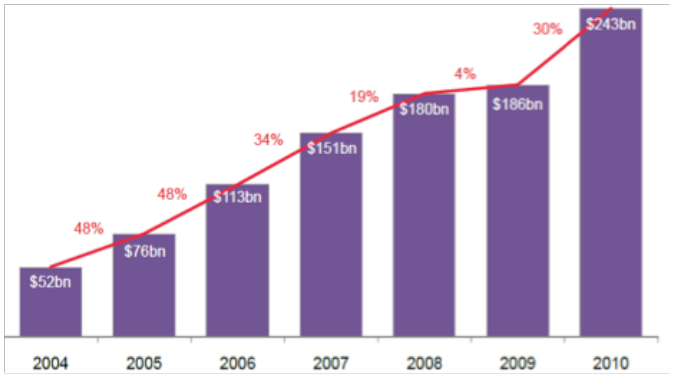
Renewable energy is also known as green energy because it does not produce toxins or pollutants that are harmful to the environment in the same quantity or quality in which non-renewable energy does. And it can counterbalance the carbon emissions created during energy production, transformation and distribution processes.

How it works

Renewable energy market share

Renewable sources supplied an estimated 16 per cent of global final energy consumption in 2009 and close to 20 per cent of the world's power supply by end 2010.[1] Despite the recession, total global investment in renewable energy reached a record high in 2010, amounting to US$243 billion (figure 1).[2] The scale of the renewable energy market has expanded over the past decade, thanks to its considerable potential (table 1).

Figure 1: Global total new investment in clean energy



Source: Bloomberg New Energy Finance, *Bloomberg New Energy Finance Summit: Results Book 2011* (London, 2011).

[1] Renewable Energy Policy Network for the 21st Century (REN21), *Renewable energy 2011: Global Status Report* (Paris, REN21, 2011).Available from www.ren21.net/Portals/97/documents/GSR/REN21_GSR2011.pdf (accessed 10 February 2012).

[2] Bloomberg New Energy Finance, *Bloomberg New Energy Finance Summit: Results Book 2011* (London, 2011). Available from www.bnefsummit.com/images/file-upload/Reports2011/Summit_2011_Results_Book.pdf (accessed 10 February 2012).

Table 1: Existing global capacity of solar PV and wind power, 1996–2010

Existing global capacity of solar PV				Existing global capacity of wind power			
Year	**GW**	**Year**	**GW**	**Year**	**GW**	**Year**	**GW**
1996	0.7	2004	3.9	1996	6.1	2004	47.6
1997	0.8	2005	5.4	1997	7.6	2005	59.3
1998	0.9	2006	7.0	1998	10.0	2006	74.6
1999	1.2	2007	9.5	1999	13.5	2007	94.0
2000	1.4	2008	16.0	2000	17.4	2008	121.0
2001	1.8	2009	23.0	2001	24.2	2009	159.0
2002	2.2	2010	40.0	2002	31.3	2010	198.0
2003	2.8			2003	39.4		

Source: Renewable Energy Policy Network for the 21st Century (REN21), *Renewable energy 2011: Global Status Report* (Paris, REN21, 2011).

The potential of renewable energy sources in meeting energy demands varies, depending on local and regional conditions, such as source endowments, climatic conditions and the price of energy. Site-specific analysis is always required to determine the technical and economic feasibility of renewable energy generation. The following table provides a general overview of selected renewable sources.

Table 2: Overview of the renewable energy sources

Renewable energy resource	Market readiness	Strengths	Weaknesses	Areas for R&D	Challenges
Solar	High cost of power from photovoltaic cells and concentrated solar power is a challenge, but significant cost reductions are possible Low-temperature solar thermal technology (such as solar water heaters) is market ready	Scalable and modular, highly compatible with distributed generation Wide geographic range, including in urban settings Large potential	Intermittent power generation and seasonal fluctuations	Efficiency increases and cost reductions to make photovoltaic cells generation cost-competitive Storage	High capital requirements Land-use issues for large solar power plants
Wind	Large-scale onshore development at prime wind sites can compete with conventional power	Scalable Highly compatible with distributed generation	Intermittent power generation and seasonal fluctuations	Improvements to reliability and storage as well as cost reduction through innovation Offshore turbine technology, especially for deep water applications	High capital requirements Site-specific modelling and assessments needed

Bioenergy	First-generation biofuels characterized by mature markets, technology Upgrades to existing conventional thermal power plants can allow for co-firing with solid biomass or liquid biofuel	Large amount of biomass resources from agricultural, forestry and municipal wastes Possible waste management co-benefit Compatible with distributed generation	Burning of biomass still generates greenhouse gas and local air pollution, some types more than others Limited distance from biomass resources required for economic viability	More efficient densification processes Efficient production and use of second- and third-generation biofuels	Land-use issues for energy crops Need targeted policies to support only "beneficial biomass" use
Geothermal	Conventional systems are commercially ready	Large potential in Ring of Fire countries Steady supply	Highly limited geographical availability of sites for conventional geothermal	Enhanced geothermal systems Better materials to deal with high acidity and other extreme	High capital requirements Site exploration required
Hydropower	Conventional systems are market ready and provide low-cost power Micro and small-scale hydro systems are the cheapest renewable energy	Storage possibilities Steady supply Scalable and compatible with distributed generation	Sites limited to where there is adequate water flow	Efficiency, lower requirements for flow speeds of run-of-river systems	Large-scale land- and water-use issues, high capital requirements and community dissent for large hydro
Ocean	Tidal dams are commercially ready; other technologies still in research and demonstration phases	Relatively steady supply (though with some peak times, such as with tides) Low operation costs	Sites limited by a number of geographic factors; may interfere with other economic uses of ocean, sea life and sediment flows	Much R&D is still needed for most ocean power technologies	High capital requirements Immature technologies Lack of specific resource data Insufficient transmission capacity from coastal areas to load centres

Renewable energies in developing countries

In 2011, developing countries represented more than half of the 118 countries that had established renewable energy targets and support policies.[3] Investments of developing countries in renewable energy companies, utility-scale renewable energy generation and biofuel projects exceeded those of industrialized countries for the first time in 2010.[4] Because most of the future growth in energy demand is expected to occur in developing

[3] Renewable Energy Policy Network for the 21st Century (REN21), *Renewable energy 2011: Global Status Report* (Paris, REN21, 2011). Available from www.ren21.net/Portals/97/documents/GSR/REN21_GSR2011.pdf (accessed 10 February 2012).

[4] ibid.

countries, this trend helps to reduce the negative environmental impact of those countries' present and projected rapid economic growth.

Policy goals

Policies for promoting renewable energy exist in different shapes and combinations, depending on the national energy market conditions. Essentially, governments try to achieve the following goals:

- Reduce market barriers for the relatively new renewable energy technologies
- Create energy market and infrastructure conditions in which renewable energy products can compete with the currently dominating fossil fuels
- Price the resource scarcity of conventional energy sources and thereby prepare for the time when their stocks are running low
- Reduce the vulnerability to energy price volatility
- Decrease impacts on environmental and human health
- Explore the industrial renewable energy market that features huge future growth prospects and employment capacities
- Balance the social, environmental and economic costs of conventional energies with renewable energy.

Strengths in using renewable energy

- **Supporting domestic energy security:** Because the energy demand from the Asia-Pacific region is strong, renewable energy is a cost-effective way to increase the domestic green energy supply and to reduce the dependence on fossil fuel imports and thus the exposure to energy price volatility.
- **Mitigating climate change:** Renewable energy can help countries reduce their carbon emissions. Renewable energy facilities support climate change mitigation and combat climate-induced consequences on agriculture, erosion and extreme hydrological events.[5]
- **Promoting regional development and industries in rural areas:** The renewable energy industry creates significant regional benefits through economic development that is based on the creation of employment using local resources in a new green industry with enormous export potential. The development of a domestic market and industries can attract numerous green financial investments, which benefit adjacent businesses and thus raise the living standard in a region.[6] Considering that natural resources and the space needed for renewable energy generation are often abundant in rural areas, it offers one of the rare opportunities for economic development there.
- **Improving economic competitiveness:** In addition to creating jobs, renewable energy can improve the economic competitiveness of a region by providing the chance to become part of the green industry sector, whose popularity and demand is rising steadily, and by stabilizing long-term energy prices.
- **Preserving air quality:** The avoidance or reduction of sulphur and nitrogen oxide emissions, released during the combustion process in conventional energy generation, enhances the quality of air.[7]
- **Opportunity for developing countries:** Renewable energy can directly contribute to poverty alleviation by providing the energy needed for creating businesses and employment in areas not connected to the grid. Producing renewable energy locally can offer a viable alternative for the 1.3 billion people around the world who don't have access to grid electricity.[8] Even though they are typically very poor, these people have to pay far more for lighting than people in industrialized countries because they use inefficient kerosene lamps. Solar power, for example, costs half as much as lighting with kerosene.[9] Renewable energy impacts poverty by supplying energy for cooking, space heating, lighting and even the operation of schools in remote areas. In developing countries that do not have extensive electricity grids, pipelines or other energy infrastructure, renewable energy technologies can be the most cost-effective option for electrifying remote villages.

[5] William Moomaw and Francis Yamba, *Renewable Energy and Climate Change* (Cambridge, 2011). Available from http://srren.ipcc-wg3.de/report/IPCC_SRREN_Ch01.pdf (accessed 9 February 2012).

[6] Union of Concerned Scientists, *Benefits of Renewable Energy Use* (Cambridge, 2005). Available from www.ucsusa.org/clean_energy/technology_and_impacts/impacts/public-benefits-of-renewable.html (accessed 9 February 2012).

[7] United States Environmental Protection Agency, Office of Air and Radiation, *The Benefits and Costs of the Clean Air Act from 1990 to 2020: Final Report* (Washington, 2011). Available from www.epa.gov/air/sect812/feb11/fullreport.pdf (accessed 9 February 2012).

[8] Kevin Bullis, "In the Developing World, Solar Is Cheaper than Fossil Fuels", in *Technology Review* (27 January 2012). Available from www.technologyreview.com/energy/39544/?p1=MstCom (accessed on 14 February 2012).

[9] ibid.

Challenges to using renewable energy

- **Costs and pricing:** Both implicit and explicit subsidies for fossil fuels distort the market conditions and investment decisions, thereby handicapping their renewable energy competitors. The prevailing blindness of conventional markets to environmental costs encourages the subsidies. And yet, because renewable energy accounts for the environmental impacts that conventional energy sources usually externalize, they have a hard time competing with the low market price of fossil resource-based power. Additionally, renewable energy investments require larger amounts of financing than conventional energy sources due to the high initial capital costs. Thus the hurdle rate for renewable energy projects is higher, and capital markets can demand a premium lending rate for financing these projects because more capital is being risked upfront than in conventional energy projects. Periodic fluctuations of oil and gas prices change the opportunity costs for renewable energy projects and directly influence investment motivation.
- **Legislation:** Generally, renewable energy producers encounter a variety of legal hurdles, owing to the fact that the policy field is relatively new and often works on a trial-and-error basis. Because of the newness, renewable energy policies are subject to constant changes, and investments are often held back because governments don't provide the necessary policy stability that can guarantee long-term profit. Although independent renewable energy producers suffer from a lack of legal frameworks, other renewable energy entities are impaired by planning restrictions that are too stringent to foster innovative technologies or business strategies.
- **Infrastructure:** Renewable energy producers must compete against technologies that rest on well-established infrastructure, designed to suit their special characteristics. The difficulties in predicting the exact production quantities from renewable energy sources makes it hard to weave these technologies into a grid that is designed to calculate and deliver the exact amount of electricity that is consumed at any given point in time. Natural processes bring about these fluctuations in production capacities for renewable energy; further research and technological advancement are needed to match conventional grid characteristics and novel renewable energy generation.
- **Information:** The information infrastructure of renewable energy is also lagging. The lack of technical skills, commercial skills and sufficient information about the benefits, risks and implementation of renewable energy projects hinders the uptake of this relatively new technology.
- **Market performance:** Power project developers have difficulties obtaining sufficient bank financing due to the prevailing uncertainties of long-term power purchase agreements of energy utilities. Because the innovation adoption lifecycle of renewable energy technologies has not reached the early majority stage yet, the lack of perceived technology performance raises the required rate of return and restrains access to capital.
- **Suitability of technologies:** Although renewable energy offers considerable improvement in environmental integrity compared with conventional energy sources, it also impacts the environment. Hydroelectric power generation, for example, often entails flooding of huge terrestrial ecosystems while the electricity production from biomass entails sulphur dioxide emissions.[10] The applicability of renewable energy technologies depends on the availability of capital, equipment and know-how as well as resource and space accessibility. The most suitable renewable energy mix, incurring the least costs on society and the environment, differs from country to country, and national strategies are limited in their transferability.

Implementing strategies

Setting a national target for renewable energy

Almost half of the countries in the world have proposed a renewable energy target to meet the green energy demand and mitigate climate change (table 3). The targets are typically guided by obligations to international agreements, vulnerability to the negative effects of climate change and the national capacities for the promotion and deployment of renewable energy. Quantitative goals are most commonly set for the share of renewable energy in electricity production, primary consumption or final consumption. Other aims may target the

[10] Bent Sorensen, *Renewable Energy: Its Physics, Engineering, Environmental Impacts, Economics & Planning* (Oxford, Academic Press, 2011).

share of renewable energy in the energy supply for different industrial sectors or define ratios for specific renewable technologies (table 4).

Table 3: Existing national shares of and targets for primary and final energy from renewable sources

Country/region	Existing share (2008/2009)	Future target	Existing share (2009)	Future target
	Primary energy		Final energy	
EU-27	8.2%		11.6%	20% by 2020
Germany	8.9%		9.7%	18% by 2020 30% by 2030 45% by 2040 60% by 2050
France	7.5%		12%	23% by 2020
UK	3.1%		2.9%	15% by 2020
Sweden	32%		50%	50% by 2020
China[11]			9.1%	15% by 2020
Fiji				100% by 2013
Indonesia	5%	17% by 2025		
Japan	6%	10% by 2020		
Republic of Korea	2.5%	4.3% by 2015 6.1% by 2020 11% by 2030		
Thailand	6.4%	20% by 2022		
Tonga				100% by 2013
Viet Nam		5% by 2020 8% by 2025 11% by 2050		

Source: Renewable Energy Policy Network for the 21st Century (REN21), *Renewable energy 2011: Global Status Report* (Paris, REN21, 2011).

Table 4: Other national renewable energy targets

Country/region	Target sector	Targets
EU-27	Transport	All 27 EU countries are required to meet 10% of final energy consumption in the transport sector with renewable energy by 2020
Australia	Renewable generation	Additional 45 TWh per year from large-scale renewable sources Power sources by 2020 (equal to 20% of generating capacity)
Bangladesh	Rural off grid solar	2.5 million units by 2015
Cambodia	Renewable generation	15% of rural electricity supply from solar and small hydro by 2015
India	Renewable capacity Wind Small hydro (< 25 MW) Biomass cogeneration Waste-to-energy Solar hot water Solar PV Rural lighting systems	78.7 GW added in 2007–2012 10.5 GW added in 2007–2012 1,400 MW added in 2007–2012 1,700 MW added in 2007–2012 0.4 GW added in 2007–2012 10.5 GWth by 2017; 14 GWth by 2022 12 GW by 2022 20 million by 2020
Malaysia	Renewable capacity	3,000 MW of new renewable energy by 2020, including 1,250 MW of solar PV and 1,065 MW from biomass
Nepal	Solar Wind Rural	3 MW by 2012/2013 1 MW by 2012/2013 7% from renewable energy
Pakistan	Renewable capacity	5% by 2030

[11] China's target changed in 2007 from a 15 per cent share of primary energy from renewable energy to a 15 per cent share of final energy from renewable energy and nuclear power combined.

Philippines	Renewable capacity Transport biodiesel Biomass power	10.6 GW by 2030; 4.5 GW added in 2003–2013 1,885 million litres annually by 2030 76 MW by 2010; 94 MW by 2015; 267 MW by 2030
Singapore	Solar hot water	0.035 GWth by 2012
Sri Lanka	Rural off-grid households served by renewable energy	6% by 2010; 10% by 2016

Source: Renewable Energy Policy Network for the 21st Century (REN21), *Renewable energy 2011: Global Status Report* (Paris, REN21, 2011).

Establishing a policy framework

To achieve national targets, to promote an increased share of power generation from renewable energies and to develop a sustainable renewable energy industry, there are primarily three policy options to rely on:

Regulatory policies
Regulatory policies ensure that renewable energy is treated with the significance in the energy and transport markets that it deserves, corresponding to its importance in achieving low carbon green growth. The policies should open the grid to renewable energy, guarantee a competitive price or ensure a specific market share of renewable energy. This can be managed with a variety of instruments:

- **Feed-in tariff:** Also known as a fixed-price policy because a government defines a fixed tariff for renewable energy electricity. Grid companies are required to purchase all renewable energy power generated by the power companies. The feed-in tariff can promote specific technologies, project locations or project sizes. Businesses appear to prefer the feed-in tariff and its derivatives because they are more effective than other policy options.[12]
- **Renewable portfolio standards:** Quota obligation policies, also known as renewable portfolio standards,[13] establish a target on the share of electricity from renewable energy sources by a certain date.
- **Renewable energy certificates:**[14] Renewable energy certificates are granted for the production of green energy and can be traded on the market and are commonly used with a renewable energy quota. They establish economic efficiency by enabling those businesses that can produce renewable energy with the least cost to sell a "certificate" to businesses that would have to pay high up-front infrastructure investments to achieve their quota.
- **Net metering:** Net metering describes a system in which solar panels and other small-scale renewable energy generators are connected to a public utility power grid. Only the net difference between electricity consumption and production by the client is accredited or bought by the grid at a price that depends on the retail electricity price.

BOX 1: Comparing feed-in tariffs and renewable portfolio standards, renewable energy certificates and net metering

Although the regulatory policies are not mutually exclusive, there are considerable differences in their impact on technology development, small-scale producers, renewable energy price levels and implementing costs. There are several reasons that make feed-in tariffs more attractive than the portfolio standards:[15]

1. Uncertainties originating from electricity and certificate price fluctuations discourage investment because they increase the cost of capital together with the investment risk.

[12] Mary Jean Bürer and Rolf Wüstenhagen, "Which renewable energy policy is a venture capitalist's best friend? Empirical evidence from a survey of international clean tech investors", in *Energy Policy* (2009), Vol.37, No. 12, pp. 4997-5006.

[13] For instance, quota obligation policies are called Renewable Electricity Standard in India, Renewable Obligations in the United Kingdom and Renewable Energy Targets in Australia.

[14] Ed Holt and Lori Bird, Emerging Markets for Renewable Energy Certificates: Opportunities and Challenges (Golden, National Renewable Energy Laboratory, 2005). Available from http://apps3.eere.energy.gov/greenpower/resources/pdfs/37388.pdf (accessed on 10 February).

[15] Intergovernmental Panel on Climate Change, Special Report on *Renewable Energy Sources and Climate Change Mitigation* (Cambridge, 2011). Available from http://srren.ipcc-wg3.de/report/IPCC_SRREN_Full_Report.pdf (accessed 09 February 2012).

2. Renewable portfolio standards are weak mechanisms to encourage technological and geographic diversity. A feed-in tariff offers a more suitable mechanism to promote specific technologies, locations or project sizes because they can adjust to those factors more flexibly and project conductors are incentivized to go beyond end-of pipe solutions to maximize their revenue.
3. The transaction cost of the portfolio standards could discriminate small-scale renewable energy producers while the feed-in tariff can even benefit those businesses and thereby help to diversify the renewable energy market and drive competitiveness.

Another common policy for renewable energy deployment is net metering. Similar to the feed-in tariff, it enables small-scale renewable energy generators to sell the produced electricity to the grid. However, it differs in several ways:

1. In the net metering system the power producer receives revenue, depending on the retail electricity price, without any long-term guarantee. It does not provide any certainty regarding that rate and thus there is little investment security.
2. Net metering does not give any incentives to enhance the capacity of a renewable energy project. A feed-in tariff is seen as an investment, and the system is sized to maximize the return.
3. The net metering system suffers from a lack of transparency because producers are not able to determine either the total generation of renewable energy from their system or their total consumption.

Source: National Renewable Energy Laboratory, *Feed-in Tariff Policy: Design, Implementation and RPS Policy Interactions* (Golden, CO, 2009).

Fiscal incentives

Fiscal incentives look to reduce the costs of renewable energy projects or at improving the relative competitiveness of renewable energy technologies.

- **Subsidies:** Governments can subsidize different economic variables via investment subsidies or capital subsidies, output subsidies or consumer (user) subsidies.[16]
- **Tax incentives:** To enable businesses to bridge the time and price gap of relatively expensive renewable energy investments, governments can grant tax reductions, such as annual income or fixed-assets tax decreases for investors or producers of renewable energy, or tax exemptions for the purchase of renewable energy technologies.
- **Energy production payment:** Governments pay per unit of produced renewable energy.

Public financing

Public financing is used to muster up the necessary capital for the renewable energy sector, either by providing funding for renewable energy projects or by awarding contracts:

- **Public competitive bidding:** Renewable energy projects are tendered by a government and a bidding process is used to choose investors. Power companies sign a power purchase agreement with the successful bidder within a specified period and all electricity is purchased at the bidding price. The competitive tender process can either commit successful bidders to deliver power at the price offered in their proposal or set the price for all successful bidders according to the highest accepted bid.[17]
- **Public renewable energy fund, loans or grants:** Due to the limited access to finance, especially for small and medium-sized enterprises, public funds, loans with favourable interest rates, grants and other financing options can be a viable mean to bridge this deficiency.
- **Public procurement:** Governments can step in and set a good example by installing renewable energy facilities in and around government buildings and public places or by covering their energy demand with renewable energy.

[16] International Energy Agency, Organization of the Petroleum Exporting Countries, Organisation for Economic Co-Operation and Development and World Bank, Analysis of the Scope of Energy Subsidies and Suggestions for the G-20 Initiative (Toronto, 2010). Available from www.oecd.org/dataoecd/55/5/45575666.pdf (accessed 10 February 2012).

[17] Renewable Energy Task Team, *Renewable Portfolio Standard Implementation: Working Group Report* (Ontario, 2003). Available from www.owa.ca/assets/files/publications/rett.pdf (accessed 10 February 2012).

Varying national strategies for renewable energy promotion

Most policymakers will adopt at least one of the policy options outlined here or rely on a few of them. The decision of which policy mix should be applied depends heavily on national conditions and varies from country to country (table 5). Countries with a similar energy market and infrastructure conditions can benefit from each other's experience, failures and successes.

Table 5: Renewable energy support policies of countries in Asia and the Pacific

	Regulatory policies						**Fiscal incentives**				**Public financing**	
	Feed-in tariff (incl. premium payment)	Electric utility quota obligation/ RPS	Net metering	Biofuels obligation/mandate	Heat obligation/ mandate	Tradable renewable energy certificates	Capital subsidy, grant or rebate	Investment or production tax credits	Reductions in sales, energy, CO_2, VAT or other taxes	Energy production payment	Public investment, loans or grants	Public competitive bidding
HIGH-INCOME COUNTRIES												
Australia	▲			▲		●	●				●	
Japan	●	●	●			●	●				●	
Singapore											●	
Republic of Korea[18]		●		●		●	●	●	●		●	
UPPER-MIDDLE INCOME COUNTRIES												
Iran								●		●		
Kazakhstan	●					●						
Malaysia	●										●	
LOWER-MIDDLE INCOME COUNTRIES												
China	●	●		●	●		●			●	●	●
India	●	●		●		●	●	●	●		●	●
Indonesia	●						●	●	●		●	●
Marshall Islands									●			
Mongolia	●											●
Pakistan			●				▲				●	
Philippines	●	●	●	●			●	●	●	●	●	●
Sri Lanka	●											
Thailand	●			●							●	
Viet Nam							●	●	●			
LOW-INCOME COUNTRIES												
Bangladesh							●				●	
Kyrgyzstan		●					●		●			
Nepal							●	●	●		●	●

▲ = Some states/provinces within these countries have state/provincial-level policies, but there is no national level policy.

Source: Renewable Energy Policy Network for the 21st Century (REN21), *Renewable energy 2011: Global Status Report* (Paris, REN21, 2011).

[18] In the Republic of Korea, the current feed-in tariff will be replaced by a PS policy in 2012.

Further reading

Energy Outlook for Asia and the Pacific (Manila, Asian Development Bank, 2009).

Energy Technology Perspectives (Paris, International Energy Agency, 2010).

Renewable energy 2011: Global Status Report (Paris, Renewable Energy Policy Network for the 21st Century, 2011). Paris. Available from www.ren21.net/Portals/97/documents/GSR/REN21_GSR2011.pdf

Special Report on Renewable Energy Sources and Climate Change Mitigation: Summary for Policy Makers (Geneva, Intergovernmental Panel on Climate Change, 2011).

World Energy Outlook 2011 (Paris, International Energy Agency, 2011).