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New and emerging technologies

New and emerging technologies: renewable energy for development

Report of the Secretary-General

Executive summary

This report seeks to identify ways to overcome the challenges associated with the deployment and scaling-up of new and emerging renewable energy technologies in developing countries. Improved access to energy services is widely accepted as being of crucial importance to achieving the Millennium Development Goals. Added to this priority is the need to enhance energy security through diversification of energy supply, taking into account concerns about climate change. Renewable energy technologies provide a viable way of achieving these objectives.

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Introduction

1. Energy underpins all sectors of the economy, and improved access to modern energy services is central to development. The 2002 Johannesburg Plan of Action[1] stressed that achievement of the Millennium Development Goals depended on improved access to modern energy; this was then further reiterated in the 2005 World Summit Outcome Document.[2] Both documents call for efforts to increase access to clean and renewable energy, and urged the international community to help facilitate access to – and development, transfer and diffusion of – renewable energy technologies.

2. Added to the imperative of energy for the achievement of the Millennium Development Goals is the need to pursue low-carbon development in order to avoid catastrophic climate change. Given that over 60 per cent of global greenhouse gas (GHG) emissions come from the energy sector,[3] increased access to energy must be coupled with a transition from carbon-intensive to low-carbon energy systems. Renewable energy technologies (RETs) are central to this system-wide transition, which must also include the deployment of low-carbon technologies that promote efficiency and conservation.

3. In 2007, the Commission on Science and Technology for Development (CSTD) selected "New and emerging technologies for development" as its priority theme for the 2009–2011 biennium. In line with the World Summit Outcome, the Commission decided to examine the role of renewable energy technologies and how they could contribute to the Millennium Development Goals and other internationally agreed goals. In order to contribute to further understanding of the issues and to assist CSTD with the deliberations at its thirteenth session, the UNCTAD secretariat convened an intersessional panel meeting for 28 to 30 November 2009 in Geneva. The present report is based on the findings of that panel, on national reports contributed by members of CSTD and on other relevant literature.

I. Energy: challenges and development

4. Energy is central to sustainable development. Although it is not explicitly a Millennium Development Goal (MDG) in itself, access to modern forms of energy and to the services that they provide – such as electricity and mechanical power – is a prerequisite that underpins all the Millennium Development Goals. Access to modern energy services can contribute, among other things, to higher living standards, greater access to information, improved provision of water and health services, and increased productivity, such as higher yields in agricultural production. It also contributes significantly to gender equality and education.[4] Table 1 provides an overview of the important linkages between modern energy services and the Millennium Development Goals.

[1] Agreed at the United Nations World Summit on Sustainable Development in Johannesburg in 2002.

[2] Agreed at the United Nations World Summit in New York in 2005.

[3] United Nations Environment Programme (2008). *Kick the Habit: A UN Guide to Climate Neutrality.* Malta: UNEP/GRID-Arendal.

[4] GTZ (2009). Energising Development: Report on Impacts. GTZ and SenterNovem. Eschborn. Modi V et al. (2005).
Energy Services for the Millennium Development Goals. World Bank and United Nations Development Programme. Washington D.C. and New York. DFID (2002).
Energy for the Poor: Underpinning the Millennium Development Goals. London.

Table 1
Important linkages between modern energy services and the MDGs

Goal	*Linkage*
Goal 1: Eradicate extreme poverty and hunger	Access to energy services facilitates economic development – microenterprises, livelihood activities, locally owned businesses – which will create employment and assist in bridging the "digital divide". Energy services can improve access to pumped drinking water and to cooking.
Goal 2: Achieve universal primary education Goal 3: Promote gender equality and empower women	Energy services reduce the time spent by women and children (especially girls) on basic survival activities (such as gathering firewood, fetching water, cooking etc.); lighting permits home study, increases security, and enables the use of educational media and communications in schools, including information and communication technologies (ICTs).
Goal 4: Reduce child mortality Goal 5: Improve maternal health Goal 6: Combat HIV/AIDS, malaria, and other major diseases	Energy is a key component of a functioning health system; it is used, for example, to light operating theatres, to refrigerate vaccines and other medicines, to sterilize equipment, and for transport to health clinics.
Goal 7: Ensure environmental sustainability	Improved energy efficiency and use of cleaner alternatives can help to achieve sustainable use of natural resources, as well as reducing emissions, which protects the local and global environment.

Source: Department for International Development, United Kingdom (2002).[5]

5. Low levels of access to modern energy services – in particular, access to electricity – are common in many developing countries, particularly in sub-Saharan Africa and parts of Asia (see figure 1). Today, around 2.5 billion people, especially in rural areas of sub-Saharan Africa and South Asia, still lack access to modern energy services, and an estimated 1.6 billion people do not have access to electricity.[6] These people rely on biomass fuels such as firewood, charcoal, manure, and crop residues[7] for cooking and heating –

[5] DFID (2002).

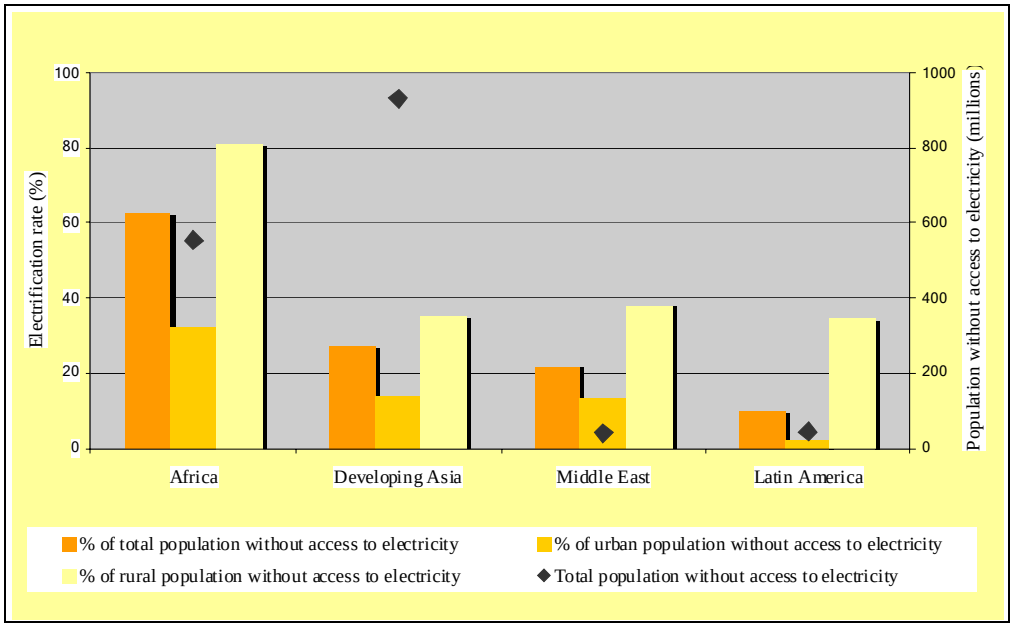
[6] World Bank (1996). *Meeting the Challenge for Rural Energy and Development.* Washington D.C. ESMAP (2007). *Technical and Economic Assessment of Off-grid, Mini-grid and Grid Electrification Technologies.* World Bank. Washington D.C.: xxv.

[7] United Nations General Assembly (2008). Sustainable development: Promotion of new and renewable sources of energy. Sixty-fourth session. 10 August 2009. IEA (2009). Energy Balances of Non-OECD Countries. OECD/IEA. Paris.

practices that have severe adverse effects on health,[8] the environment, and social and economic conditions, and which particularly disadvantage women and girls.[9]

6. Even in developing countries with relatively high rates of electrification, the urban and rural poor often lack access to energy services, largely due to the high costs associated with connection and distribution and with infrastructure extension.[10] In some cases, heavy reliance on imports of fossil fuels, which are subject to price volatility and price increases, has resulted in higher energy costs for many households.[11] If the Millennium Development Goals are to be achieved in developing countries, then significant efforts are needed to increase access to modern energy services.[12]

Figure 1
Access to electricity by geographical region



Source: International Energy Agency (2006).[13]

7. The energy sector as a whole is responsible for approximately 61.5 per cent of total global GHG emissions, a major cause of anthropogenic climate change.[14] As a result, there has been increasing recognition and consensus over the past two decades that a systemic transformation within national energy sectors is required, if the disastrous impact of climate change is to be reversed.

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[8] Recognized as the second most adverse cause of deaths (after malnutrition) in poor developing countries. The World Health Organisation (WHO) estimates that 1.5 million people die annually (i.e. 4,000 deaths per day) due to indoor air pollution. WHO (2006). *Fuel for Life: Household Energy and Health.* Also: Conference report. International Energy Conference. Vienna, Austria. 22–24 June 2009.

[9] The use of biomass accelerates deforestation and requires much time and effort for collection. Women and children are usually responsible for this activity. If they were freed from this responsibility, they could be pursuing other productive activities, such as education and employment activities.

[10] Modi et al. (2005).

[11] United Nations General Assembly (2009). Sustainable development: Promotion of new and renewable sources of energy. Sixty-fourth session. 10 August 2009.

[12] Modi et al. (2005): 7–8.

[13] IEA (2006). *World Energy Outlook 2006.* OECD/IEA. Paris.

[14] UNEP (2008).

8. In developed countries and those developing countries with well-established energy systems, this transition means that concrete steps must be taken to decarbonize the current systems. In the case of developing countries with very limited energy sectors, expansion of those sectors to provide the energy needed to achieve the MDGs must involve efforts to "leapfrog" the carbon-intensive development trajectory of developed countries and to embrace low-carbon pathways.[15] Such efforts should be supported by the international community through technology transfer and other means. This will avoid a dangerous lock-in to a fossil fuel trajectory, which is likely to significantly disadvantage developing countries in the long term. The lock-in arises when the development of infrastructures, organizations, institutions and cultural practices to support one particular energy system perpetuates that system.

9. Decarbonizing, or building low-carbon energy systems, requires, among other things, rapid diffusion and development of low-carbon energy technologies throughout the system, e.g. the use of RETs in electricity generation, smarter and more efficient transmission and storage of energy (such as modern cabling or improved transformers in national grids), and more efficient and adaptable end-use of energy (such as LED lighting or electric vehicles). The promotion of energy conservation is important too.[16]

II. New and emerging renewable energy technologies

10. Renewable energy technologies (RETs) are technologies that provide modern energy services – such as electricity, clean cooking fuels, and mechanical power – by harnessing the power of renewable energy. The International Energy Agency defines renewable energy as follows:

> "Renewable Energy is derived from natural processes that are replenished constantly. In its various forms, it derives directly or indirectly from the sun, or from heat generated deep within the earth. Included in the definition is energy generated from solar, wind, biomass, geothermal, hydropower and ocean resources, and biofuels and hydrogen derived from renewable resources."[17]

Table 2 lists renewable energy sources and some associated renewable energy technologies.

Table 2
Renewable energy sources

Elemental renewables	
Solar energy	Solar radiation exploited for hot water production (solar thermal) and electricity generation (solar photovoltaic (PV)). Does not account for passive solar energy for direct heating, cooling and lighting of dwellings etc.
Hydropower	Potential and kinetic energy of water converted into electricity in hydroelectric plants.
Wind energy	Kinetic energy of wind exploited for electricity generation in wind turbines.

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[15] Sauter R and Watson J (2008). Technology Leapfrogging: A Review of the Evidence. DFID. London.
[16] Ockwell D et al. (2009). *Low-carbon development: the role of local innovative capabilities.* STEPS working paper 31. STEPS Centre and Sussex Energy Group. SPRU. University of Sussex. Brighton.
[17] IEA (2009). *Renewables Information 2009.* OECD/IEA. Paris.

Elemental renewables	
Wave/tidal/ocean energy	Mechanical energy derived from tidal movement, wave motion or ocean current, and exploited for electricity generation.
Geothermal energy	Energy available as heat emitted from within the earth's crust, usually in the form of hot water or steam. It is exploited at suitable sites for electricity generation after transformation, or directly as heat for district heating, agriculture etc.
Combustible renewables and waste (CRW)	
Solid biomass	Covers organic, non-fossil material of biological origin which may be used as fuel for heat production or electricity generation. Wood, Wood Waste, Other Solid Waste: Covers purpose-grown energy crops (poplar, willow etc.), a multitude of woody materials generated by an industrial process (wood/paper industry in particular) or provided directly by forestry and agriculture (firewood, wood chips, bark, sawdust, shavings, chips, black liquor etc.), as well as wastes such as straw, rice husks, nut shells, poultry litter, crushed grape dregs etc.
Charcoal	Covers the solid residue of the destructive distillation and pyrolysis of wood and other vegetal material.
Biogas	Gases composed principally of methane and carbon dioxide produced by anaerobic digestion of biomass and combusted to produce heat and/or power.
Renewable municipal waste	Municipal waste energy comprises wastes produced by the residential, commercial and public services sectors, and is incinerated in specific installations to produce heat and/or power. The renewable energy portion is defined by the energy value of the combusted biodegradable material.

Source: IEA (2007).[18]

11. RETs have been in existence for decades. Often, these technologies have been subject to continuous improvement or have been adapted to specific conditions, and as a result, they might be considered to be "new and emerging". In many countries – and even, to varying degrees, in particular areas within those countries – technologies that are not new to the world are often still new to the local market and/or local firm.

12. For developing countries, the most feasible RETs include, but are not limited to, solar PV, hydro (mini, micro and pico – in descending size), wind turbines and biofuels.[19]

13. RETs have been recognized as appropriate for both developed and developing countries. They provide an environmentally sound way of supplying energy for domestic and productive uses. They allow traditional fuels to be utilized in cleaner, more efficient

[18] IEA (2007). *Renewables in Global Energy Supply: An IEA Factsheet.* OECD/IEA. Paris. Available at http://www.iea.org/papers/2006/renewable_factsheet.pdf (accessed on 31 Dec 2009). See also: REN21 (2007). *Renewables 2007: Global Status Report.* Available at http://www.ren21.net/pdf/RE2007_Global_Status_Report.pdf (accessed on 31 Dec 2009).

[19] In this discussion, we do not include fuels for transport.

ways, reducing health risks and minimizing time spent gathering fuel, and they can produce electricity using clean, locally appropriate sources of energy.

14. Although affected by technical challenges such as intermittency (which may require expensive energy storage), RETs can particularly benefit developing countries and contribute to improvements in power supply, energy security, and energy-related economic development. In rural areas that have problems of insufficient transmission and distribution infrastructure, producing renewable energy locally is particularly advantageous. Moreover, broadening the energy mix through varied indigenous fuel sources can improve some aspects of energy security, such as exposure to volatile fossil fuel prices. Expansion of the national renewable energy sector can create local employment opportunities and provide economic opportunities for developing countries to commercialize, produce and export these technologies.[20]

15. Increased recognition of the benefits of RETs has been matched by a relatively high growth rate in the renewable energy sector. In 2006, global new investment in renewable energy sources amounted to about $71 billion – an increase of 43 per cent over 2005. Although $15 billion of this amount was invested in developing and emerging countries,[21] the majority of it went to large developing countries such as Brazil, China and India. These countries have managed to catch up fairly rapidly with technological leaders in certain renewable energy sectors such as wind and solar. In other developing countries, however, the development of manufacturing and of research, development and deployment (RD&D) capabilities has been very limited.

16. In general, most countries look to imported technologies. But the widespread deployment of RETs via technology transfer involves major challenges. In some cases, RETs are introduced into existing systems that are inefficient (financially, technically and institutionally) and which might entrench high-carbon infrastructure and/or systems. In particular, if the capacity to install, manage, repair and adapt these imported technologies does not exist, their deployment risks being economically, socially and environmentally unsustainable.

III. Overcoming the challenges of deploying RETs in developing countries

17. The issue of transfer of technology is at the heart of the global renewable energy and low-carbon economy debate. The economic reality is that many developing nations are unlikely to “leapfrog” the pollution-intensive stages of industrial development without a commitment by developed nations to assist in providing access to the technologies needed.[22] Fortunately, many of these technologies already exist in the public domain and can be made available where they are needed. New and emerging RETs (in particular, their key components) are mostly developed and produced in industrialized or middle-income countries. The increase in the overall use of renewable energy in developing countries means an increased need for international transfer of technologies to developing countries.

[20] World Bank (2009a). Technology transfer in the climate context: who is responsible? Available at http://blogs.worldbank.org/climatechange/technology-transfer-climate-context-who-responsible (accessed on 6 February 2010).

[21] GTZ (2007). *Energy Policy Framework Conditions for Electricity Markets and Renewable Energies: 23 Country Analyses.* Eschborn.

[22] Sauter R and Watson J (2008).

18. Techniques for the production, generation, transmission and distribution of energy supplied by renewable sources may require significant investments in appropriate infrastructure and research and development, as well as an integrated policy approach. This presents a significant challenge to the effective transfer of RETs.

19. Initiatives to overcome this challenge will play a very significant role for the successful and effective adoption, transfer, and local development of such technologies. These initiatives will have to take into account cross-cutting factors, such as legal, regulatory, institutional, financial, infrastructure, market, political, social and cultural issues. Furthermore, measures to increase information flow and transparency are necessary, in order to raise consumer awareness of alternative energy sources and their uses.

20. The effective diffusion and development of renewable energy technologies requires strong policy initiatives; large investments in infrastructure; long-term commitments to R&D activities; and innovations tailored to local opportunities, capabilities and needs.[23] Identified below are three particularly important requirements that should be in place in order to facilitate the deployment of RETs in developing countries, namely (a) indigenous local capabilities; (b) appropriate financial mechanisms; and (c) an integrated, systemic approach.

A. Building local capabilities

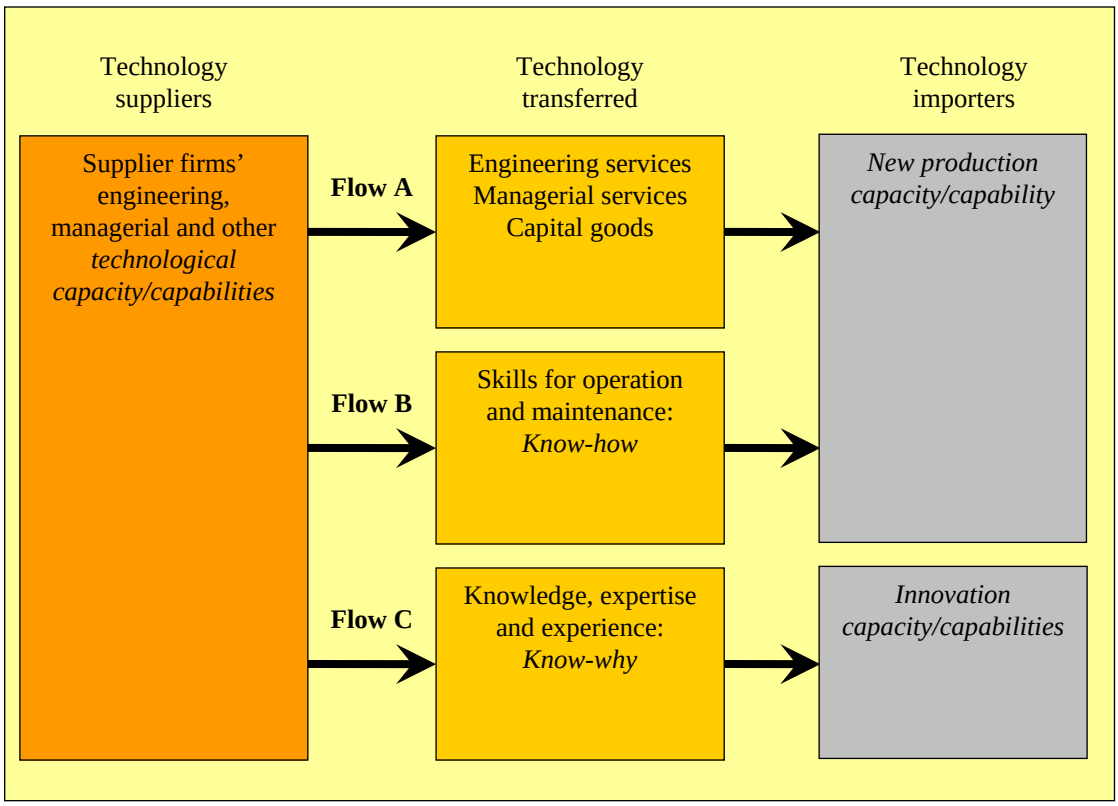
21. The deployment of RETs in developing countries is often seen as simply a case of technology transfer from developed countries. This has resulted in insufficient focus on local innovation and on building local capacities to innovate (i.e. to modify and adapt etc.) – the so-called "innovative capabilities". North–South and South–South transfer of technology, and corresponding knowledge about how to use the technology – in other words, "know-how" – play an important role in the development and deployment of RETs. However, efforts at building local innovative capabilities – "know-why" – are essential too, if technology is to be modified and adapted to local needs.[24] The transfer of technology should not replace but rather complement domestic capacity-building efforts, which should be supported by domestic policies that foster learning.[25]

[23] Foray D (2009). Technology transfer in the TRIPS age: the need for new types of partnerships between the least developed and most advanced economies. ICTSD Programme on IPRs and Sustainable Development.

[24] Ockwell D et al. (2009).

[25] See: UNCTAD (2003). *Investment and Technology Policies for Competitiveness: Review of Successful Country Experiences.* United Nations publication. UNCTAD/ITE/IPC/2003/2. New York and Geneva.

Figure 2
Building innovative capabilities through technology transfer



Source: Bell (1989)[26] and Bell (2009).[27]

22. Figure 2 provides a graphical representation of the technology transfer process. Flow A depicts the process of hardware – capital-embodied technology – being created and brought into use during investment projects. Discussions about international technology transfer usually include these capital goods as part of the overall flow that may be involved. Flow B depicts the human capital associated with the operation and maintenance of the physical capital. This is the know-how, and it includes information on operating, maintenance and repair procedures and routines, usually codified in the form of instruction manuals. It also includes people-embodied knowledge and expertise, usually transferred through training, which helps develop capacity to deal with unforeseen circumstances not set out in manuals and standard routines. Flow C is also a flow of people-embodied knowledge and expertise, but rather than providing a basis for operating existing technology such as that in Flow B, it provides a basis for managing technical change: the know-why. In this sense, Flow C allows for existing technology to be adapted and modified to suit local conditions and local needs.[28]

23. Technology transfer may take place in various different modes. Most commonly, it occurs through the consumption of products or services that incorporate the technology,

[26] Bell M (1989): 208.
[27] Bell M (2009). Innovation capabilities and directions of development. STEPS working paper 33. STEPS Centre. Brighton: 11.
[28] Bell M (1989). International technology transfer, industrial energy efficiency and energy policy in industrialising countries. CIFOPE/AIT/CEC International Energy Policy Seminar on "Energy development in South-East Asia and cooperation with the European Communities": 208.

through licensing the production, or by a joint venture arrangement or foreign direct investment. Technology transfer also may result from technical assistance programmes from either multilateral or bilateral donors. These might include training and capacity-building in technical skills, policy formulation, project management, development and monitoring, and application and commercialization. Whichever mode is used, the transfer of hardware and of knowledge and expertise to operate that hardware must be complemented by the development of local knowledge and expertise to modify and adapt that hardware as necessary.

24. One option for developing this local knowledge and expertise is the concept of low-carbon innovation centres in developing countries, as proposed by the United Kingdom's Carbon Trust. These centres would be institutions designed to foster and accelerate innovation in low-carbon technologies such as RETs.[29] Specific centres dedicated to designing local technology solutions are already in existence – box 1 presents the case of Eritrea, where a local training centre was set up to undertake RD&D of locally adapted or designed RETs.

Box 1. Local capabilities to modify cookstove technology in Eritrea

In 1995, the Energy Research and Training Centre (ERTC) was set up under the auspices of the Eritrean Ministry of Energy and Mines. The ERTC's main objective was to research and develop different RETs, with cookstove improvement and dissemination identified as a key project.

Learning from early donor-funded stove programmes in China and India, the localization of stove manufacture at affordable prices was a key goal. Successful research, development and testing of stove design were undertaken by the ERTC with assistance from the University of Asmara and the Ministry of Construction. The materials required to construct the final product are all produced in Eritrea, with the possibility of manufacturing most components in rural areas where the stoves were to be disseminated. The improved stove can burn a wider variety of fuels, such as twigs, leaves and animal dung, relieving pressure on fuelwood resources. As the fireholder is raised off the floor, it reduces the risk to children.

In order to encourage local communities to adapt to using the new stove, classes were held to explain its use and to promote the technology. The ERTC is now training women in how to build the stoves themselves, and is also paying them to be trainers to other women.

Source: Ergeneman (2003); Ghebrehiwet (2002); Ashden Awards (2003); Sitzmann (2000).[30]

25. The science and technology policies needed to promote effective technology transfer – including development of local innovative capabilities – include:

(a) Supporting universities and public research centres that are dedicated to renewable energy technologies. These institutes/centres can be funded publicly, or through a mix of donor and/or public–private funding, and can be linked with global learning

[29] Carbon Trust (2009). Blueprint for global collaboration on clean energy. Available at http://www.carbontrust.co.uk/news/news/press-centre/2009/Pages/blueprint-global-collaboration-clean-energy.aspx (accessed on 6 February 2010).

[30] See: Ergeneman A (2003). *Dissemination of Improved Cookstoves in Rural Areas of the Developing World: Recommendations for the Eritrea Dissemination of Improved Stoves Programme.* Energy Research and Training Centre. Eritera.

networks, including the Diaspora. A sound National Systems of Innovation (NSI) is a critical determinant for the success of technology transfer and development;

(b) Supporting community participation in decision-making and ensuring that communities have the requisite capabilities to manage low-carbon technologies deployed in their area. Barefoot College in India has pioneered an approach that ensures that local capacity is developed and retained. Barefoot College's solar engineering programme provides training in the installation and maintenance of PV solar systems in off-grid villages, targeting semi-literate and illiterate women from rural villages. The training programme has led to the installation of 8,700 solar units and the manufacture of 4,100 solar lanterns, without help from urban professionals. More than 574 villages and 870 schools now have access to solar electricity. The approach of Barefoot College has been replicated in 13 states in India, and in many developing countries in Asia and Africa;

(c) Providing incentives for RD&D at the firm level in private companies, and supporting technology deployment in market niches. These include government subsidies, and other support measures such as tax credits for new power plants, targeted cheap credits or financial guarantees;

(d) Government procurement. Government can encourage private firms to adopt renewable energy technologies by committing to an initial investment in the application of the new technology. In fact, prices will fall with growing demand and increasing return to scale so that it becomes economically and commercially viable for private firms to adopt new technologies. This should ease the "carbon lock-in" of the current modes of production and consumption;[31] and

(e) Private sector development, which brings about private sector participation, and scales up development progress. This can include the establishment of business parks and innovation clusters (such as wind farms, or industrial zones for solar cell production) to induce growth and commercialization. The link needs to be made with investment and trade policies to attract foreign direct investment (FDI). As illustrated by the experiences of manufacturing wind turbines in China,[32] licensing arrangements, FDI and joint ventures could be important channels for technology transfer and learning.

B. Financial incentives

26. It has been widely recognized that public intervention is needed in order to stimulate both deployment of RETs and development of the associated local innovative capabilities. Two reasons are commonly cited. Firstly, carbon-intensive technologies benefit from a competitive advantage, since the external costs related to them are usually not reflected in the market price; this price distortion therefore reduces the transfer and the market penetration of renewable energy technologies.[33] Secondly, the larger social benefits of investing in innovation in renewable energy technologies cannot be fully captured by individual firms. Therefore, there is a lack of incentive for the private sector to raise its investment to socially optimal levels. Consequently, the current frontrunners in renewable

[31] Unruh G and Carrillo-Hermosilla J (2006). Globalizing carbon lock-in. In: *Energy Policy*. 34 (14): 1185–1197.

[32] UNCTAD (2010). Powering the green leap forward: China's wind energy sector. In: *Trade and Environment Review 2009/2010: Promoting Poles of Clean Growth to Foster the Transition to a More Sustainable Economy*. United Nations publication. Sales no. E.09.II.D.21. New York and Geneva: 173.

[33] United Nations General Assembly (2009). Promotion of new and renewable sources of energy: Report of the Secretary-General. A/64/277.

energy technologies are those that have benefited from public policy interventions backed by a legal and regulatory framework. For instance, wind power became viable only when the European Union, the United States, and other governments provided active support in the form of RD&D spending and subsidies.[34]

27. Various financial mechanisms have been – and continue to be – developed to reduce some of the disincentives associated with investment in the RD&D of RETs. Some of the most successful domestic financial mechanisms include subsidy programmes and the waiving of import duty.

28. Importantly, the mechanisms need to be clear and predictable in order to promote the effective transfer and deployment of locally appropriate RETs. Also, it is extremely important that these mechanisms be developed in such a way as to create self-sustaining competitive markets whereby the mechanisms can eventually be phased out.[35] This has been a key component of projects funded by the Dutch-German partnership Energising Development (EnDev), to give one example. One illustration of EnDev's approach is the subsidy programme in Ethiopia, which included a clear exit strategy. To help the market develop, a subsidy was provided for the first 100,000 stoves, in order to assist in the development of a self-sustaining market. After that, subsidies would be phased out.[36] In Argentina, as part of the World Bank–assisted Renewable Energy in the Rural Market project, the Congress approved a law reducing customs duties and value-added tax on RETs in order to reduce the costs associated with installing imported renewable energy equipment.[37] In Tunisia, as part of the country's efforts to reduce conventional energy consumption and to deploy RETs, households are encouraged to buy and install solar panels for water heating at a subsidized price. As a further example of targeted RET subsidization, box 2 presents the case of China's Renewable Energy Development Project.

Box 2. Domestic financial incentives to promote RETs in China

The objectives of China's Renewable Energy Development Project, which was set up in 2001, included improvements to solar PV product quality, warranties and after-sales service; increased business capabilities; and greater marketing efforts.

Renewable Energy Development Project funds were channelled through the National Development and Reform Commission to roughly 80 approved suppliers and 32 wholesale companies across China. These companies included private enterprises, joint ventures, companies wholly or partially owned by research institutes, and state-owned enterprises. They all had to meet strict standards of product quality, service and management, in order to be approved and to remain part of the programme. Technical workshops and training sessions were held to raise component quality, and suppliers who failed to meet the standards were offered support to achieve them.

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[34] UNCTAD (2009). *Trade and Development Report 2009.* United Nations publication. Sales no. E.9.II.D.16. New York and Geneva.

[35] GTZ (2009).

[36] GTZ (2009).

[37] World Bank (1999). Project appraisal document (PAD) for renewable energy in the rural market. Washington D.C.

Providing they passed regular standards tests, companies were paid a subsidy of $1.50 per Watt-peak (the maximum power output under standard test conditions) for each PV system they sold. As quality standards rose, so did the subsidy. By the end of 2006, an estimated 50 per cent of the sales of the participating companies were outside the subsidy programme, suggesting that installation of PV systems would continue to thrive even after subsidies had finished.

Source: World Bank (2009a); Ashden Awards (2008).[38]

29. Feed-in tariffs are an important domestic policy mechanism too, and they have been effective in promoting RETs, mainly in developed countries. Feed-in laws have been enacted in some 50 countries. They oblige utilities to purchase power generated from renewables at a certain price, with a per kilowatt/hour premium, set by the regulatory authority, thereby offering producers of electricity from renewables a guaranteed price for an agreed amount of electricity produced and fed in. When well designed and implemented, feed-in tariffs provide a long-term price guarantee that reduces the regulatory and market risks of renewable energy.

30. In order to complement domestic financial mechanisms such as subsidy programmes, countries should also look to take advantage of international financial mechanisms such as the Clean Development Mechanism (CDM). CDM was established by the Kyoto Protocol of the United Nations Framework Convention on Climate Change. It supports projects that reduce GHG emissions. Increasingly, more projects have been developed in the area of renewable energy technologies, although at present, the CDM project pipeline in terms of geographical distribution is unequal, with large emerging economies such as China, India, Brazil and Mexico being the leading host countries. The shares of Africa, the Middle East, and Europe and Central Asia remain small.[39] It has been argued that domestic policy measures have played an important role in allowing developing countries to reap the benefits of CDM. For example, in the case of China, a significantly lower tax is placed on revenues generated from the transfer of certified emission reductions in renewable energy technologies, thereby encouraging more projects to go into these sectors.[40]

31. Some other international financial mechanisms include the World Bank–administered Clean Technology Fund (CTF) and Scaling-up Renewable Energy Programme (SREP). The former is geared towards leveraging financial resources to support clean technology projects that have large-scale replicability potential.[41] The latter aims to supplement bank lending for renewable energy in projects focusing on electricity generation, rural electrification, clean cooking and heating fuels, and modern lighting.[42]

[38] World Bank (2009b). Implementation, completion and results report for renewable energy development project in China. World Bank. Washington D.C. Ashden Awards (2008). Bringing affordable, high-quality solar lighting to rural China. Case study for 2008 Ashden Awards for Sustainable Energy.

[39] Michaelowa A (2005). CDM: current status and possibilities for reform. Institute of International Economics. Hamburg.

[40] Ernst and Young (2009). China turns green on taxation. In: *China Tax and Investment News.*

[41] World Bank (2008). World Bank Board approves climate investment funds targeting $5 billion over next three years to support developing countries. World Bank press release no. 2009/001/SDN. Available at http://go.worldbank.org/38LJMD2BX0 (accessed on 6 February 2010).

[42] World Bank (2008). Strategic climate fund: scaling-up renewable energy programme for low-income countries (SREP). Climate investment funds consultation. World Bank. Washington D.C.

Both these funds are in their infancy, so it is not yet clear how well they are achieving their objectives.

32. Another financial mechanism that has worked in the development of vaccines and will soon be piloted for low-carbon technologies is the Advance Market Commitment programme currently being promoted by the United Kingdom's Department for International Development (DFID). The Advance Market Commitment guarantees a viable future market for a product, by means of a binding contract. In the electricity sector, an example is the case of "feed-in tariffs", whereby the future market is guaranteed by fixing the price of renewable electricity.[43] However, given that this programme is at the pilot stage, it will be some time before it can be properly evaluated.

C. Integrated strategies

33. As noted earlier, deployment of RETs and development of the associated local innovative capabilities are merely one aspect of a systemic shift to a low-carbon economy. Energy efficiency and conservation are equally important features. A systemic approach in the energy sector – that is to say, efficiency and conservation on the demand side, and use of renewables and increased efficiency on the supply side – must also be mirrored by a systemic approach in sectoral terms: a low-carbon energy policy must be integrated into a holistic low-carbon development strategy.

34. One approach to ensuring an integrated low-carbon strategy has been the Low-Carbon Growth Country Studies project, supported by the World Bank's Energy Sector Management Assistance Programme (ESMAP). These studies are undertaken by governments, with the aim of assessing their development goals and priorities in conjunction with opportunities to mitigate GHG emissions. The studies are specifically designed to ascertain consensus amongst policymakers and other stakeholders about lower-carbon development paths and to lay the foundations for building a framework for nationally appropriate mitigation actions. RETs may be one feature of the nationally appropriate mitigation actions, but these are combined, inter alia, with energy efficiency activities, land use changes, transport system modifications and capacity-building.[44] The ESMAP experience in six emerging economies – Brazil, China, India, Indonesia, Mexico and South Africa – has shown that structured and integrated engagement across the national economy on low-carbon development is highly beneficial, facilitates better dialogue, and increases national competitiveness.

35. In particular, an integrated approach makes use of existing national policies and ensures that deployment of RETs fits local needs and is therefore more likely to stimulate development. Box 3 presents the case of an integrated approach to promoting RETs in rural Cuba.

[43] DFID (2009). Supporting investments in green energy. Available at http://www.dfid.gov.uk/Media-Room/News-Stories/2009/Low-carbon-energy (accessed on 6 February 2010).

[44] ESMAP (2009). Low Growth Country Studies – Getting Started: Experience from Six Countries. World Bank. Washington D.C.

Box 3. Integrated approach to RETs in rural Cuba

Maintaining access to modern energy services as part of a national strategy of social equity and sustainable development, including a commitment to improving rural livelihoods and protecting the environment, led the Government of Cuba to promote the use of RETs.

In order to harness energy to achieve prioritized policy objectives of higher educational and health standards, the Government of Cuba tied expansion of access to modern energy services in rural areas to the promotion, installation and maintenance of systems that deliver energy to schools and medical establishments. Given the priorities of the local population and the aims of the Cuban Government, the expansion of RETs through modern, small-scale off-grid systems was the most appropriate and efficient way to do this.

By taking a sustainable livelihoods approach and ensuring that RETs form part of an integrated approach to development, improved energy access is more likely to achieve the goals of improved health and increased productivity.

Source: Cherni and Hill (2009).[45]

IV. Findings and recommendations

36. Achievement of the Millennium Development Goals is highly dependent on an increase in access to modern energy services. The deployment of RETs should be a key component of any strategy that aims at achieving this increase in access. RETs offer a way of improving national energy security and meeting international commitments on climate change. For electricity expansion in rural areas, decentralized RETs can be a particularly appropriate and often more economic alternative to grid-based electrification.

37. Achievement of a sustained RET deployment requires that: (a) the transfer of RET hardware be complemented by the development of indigenous capabilities so that technologies may be adapted to meet local needs; (b) innovative financial mechanisms be put in place in order to overcome barriers to investment in RETs; and (c) a RETs deployment strategy be integrated into national development agendas.

38. Technology transfer is an important facet of RETs deployment in developing countries. Technology transfer hardware must be complemented by the transfer of skills and expertise to operate such hardware and to adapt and modify it to local conditions. Where possible, technology options should be chosen that maximize the use of existing local capabilities. On top of this, efforts to expand existing and build new local innovative capabilities, through training centres and knowledge networks, are important for the effective and sustainable deployment of RETs.

39. Investors, project developers and consumers all face large disincentives to support RETs because of the costs involved. Government policy can do much to rectify this. In particular, mechanisms such as subsidy schemes, feed-in tariffs and the reduction of import duties can help to bring RETs to the market. Importantly, the market must be nurtured to ensure its sustainability once financial mechanisms have been phased out.

[45] Cherni J and Hill Y (2009). Energy and policy providing for sustainable rural livelihoods in remote locations – the case of Cuba. In: *Geoforum*, vol. 40.

40. Increasing the access to modern energy services must be tied to wider development goals. Access to energy facilitates services which improve health, education, productivity and so on. When planning the deployment of RETs, the priorities of local populations, as well as those of the government, must be taken into account if the deployment is to be sustainable.

41. The international community has a large role to play in assisting governments to promote the deployment of RETs. International organizations must continue to provide technical assistance in training, capacity-building, and strategic planning to promote new and renewable energy sources and technologies. International financial institutions should make concessionary finance a priority, in order to mobilize large-scale resources to finance the development and deployment of RETs. Given the importance of building local innovative capabilities in the technology transfer process, the international community can serve as an important knowledge hub for national governments that are looking for advice and are keen to learn from the experience of others.

42. Given that there is no "one policy fits all" approach,[46] a systemic review of a variety of approaches to low-carbon technology transfer and RET deployment would be highly valuable. Intergovernmental forums, such as the CSTD, could provide a platform for the sharing of examples of good practice, and for promoting North–South and South–South partnerships. For example, an in-depth study of projects such as India's Barefoot College might provide useful insights for strategies to promote renewable energy technologies for development, at the same time as promoting South–South cooperation.

43. UNCTAD is particularly well placed to play a role in supporting national governments' deployment of RETs. The following list outlines some recommended activities for UNCTAD:

(a) Carrying out – in collaboration with the International Renewable Energy Agency – a review of national experiences in developing local innovative capabilities related to RETs and to low-carbon technologies in general (such as education programmes and long-term training activities);

(b) Providing an online platform for the sharing of examples of good practice, including the setting-up of a clearinghouse on science, technology and innovation;

(c) Promoting North–South and South–South partnerships on RETs, and investigating the structure of internationally collaborative R&D mechanisms that might be effective in facilitating low-carbon technology transfer;

(d) Promoting an integrated and sustainable international collaborative approach to addressing low-carbon development. This may involve research into how low-income countries could integrate the deployment of RETs into their national development strategies. In addition, it could complement ESMAP's work in emerging economies;

(e) Conducting studies on energy efficiency – examining the issue from a developing country's perspective. Countries such as Ghana and Tunisia, as well as others that have a dedicated institution working to promote and raise awareness of RETs and energy efficiency, might offer fruitful insights;

(f) Mainstreaming a gender perspective in RETs;

(g) Seeking partnerships that would explore institutional models that facilitate the building of local capabilities. A roundtable discussion with other United Nations

[46] Ockwell et al. (2008).

agencies and interested governments to identify pilot studies may help to develop this idea further.

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