

Escaping the Vicious Cycle of Poverty: Towards Universal Access to Energy in Developing Countries

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Abstract

Despite the continuous efforts of developing countries and the international community to reduce energy poverty, some 2.7 billion people around the world still rely on traditional biomass for cooking and heating and 1.3 billion people do not have access to electricity. Over 80% of the energy poor live in rural areas and roughly two thirds in sub-Saharan Africa and India. While fossil fuels will inevitably play a major role in expanding on-grid energy supply, this study shows that renewable energy sources – and especially small decentralised solutions – have huge potential for providing reliable, sustainable and affordable energy services for the poor, particularly in rural areas of developing countries. Many challenges remain, including financing, capacity-building, technology transfer and governance reforms. A careful assessment of the environmental impacts of renewable energy technologies, particularly those on water, is an important prerequisite for donor finance. With the right design, energy access projects can also bring a host of developmental co-benefits. It should be possible for international initiatives including the UN's Year of Sustainable Energy for All and the EU's partnership with Africa to build on the rich experience and lessons learned from pilot projects over the last two decades in order to optimise donor effectiveness in this area.

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Executive Summary

Energy services are a principal enabler for socioeconomic development. On the one hand, the ability of the world's poor to earn a living depends on access to sustainable energy. On the other, poverty remains the key obstacle to energy access. Breaking this vicious cycle of poverty and energy access is thus essential to enable the four principle ways in which poor people earn a living: earning off the land, running a micro or small enterprise (MSE), getting a job, or earning from supplying energy (Practical Action, 2012). Yet, 133 years after Thomas Edison's invention of the light bulb and the subsequent development of the modern electricity utility industry, some 1.3 billion people of the world remain without access to electricity. Similarly, 2.7 billion people still rely on traditional biomass for cooking and heating. Energy poverty thus affects about a third of humanity with negative impacts on health, education, productivity, gender equality and the environment.

The majority of people in energy poverty live in rural areas in South Asia and sub-Saharan Africa. Meanwhile, parts of the developing world are undergoing rapid industrialisation, population growth and rising consumer demand, which will drive unprecedented power capacity additions over the next 20 years. Much of the new and planned generation will service mainly urban and industrial regions, further widening the gap between rich and poor.

Given these twin trajectories, energy poverty is receiving renewed attention amongst the international community, with an emphasis on economic, social and environmental sustainability. The United Nations declared 2012 as the *International Year of Sustainable Energy for All* with the goal of universal energy access by 2030. One of the highlights of this year will be the Rio+20 summit in June which will need to reflect the importance of access to energy for development in its outcome document, including binding targets and a roadmap on how to achieve universal energy access by 2030.

The IEA and IIASA (both 2011) show that universal energy access is feasible with annual costs of between \$36-48 billion until 2030. More than half of these investments (up to more than 90% in IEA projections) will flow into electricity generation, transmission and distribution. Fossil fuels are likely to continue to play a role in providing access to electricity, especially where on-grid generation is feasible. However, centralised power capacity and grid extension targets have often failed to improve energy services for the poor. In the last two decades, a learning curve in projects aimed at increasing access to energy has shown that decentralised solutions are often more successful and cheaper. Small-scale mini-grid and off-grid generation activities in sparsely populated rural areas are proving particularly effective.

In this context the use of renewable energy technologies is essential for developing countries to reduce their dependence on fossil fuel imports and related price volatility, as well as to foster a sustainable, low-carbon and green economy. Decentralised renewable energy systems such as hydro, solar, wind and modern biomass provide the opportunity for clean and cost-effective electricity and heat generation in rural off-grid regions. However, potential social and environmental consequences of new energy systems need to be thoroughly evaluated on a case-by-case basis.

The sustainable introduction of renewable energy technologies in developing countries requires a range of supporting tools and processes. In poor rural settings without access to modern energy, the success of a project relies on host government, donor and implementer's efforts to build national and local level governance and regulatory capacity, develop local markets, raise public awareness and develop appropriate skills through training activities. Furthermore, technology transfer is facilitated with more stringent and widespread environmental policies and incentives for adoption of low-carbon technologies in developing countries. Developed countries can provide assistance with the national design and roll-out of such policies.

In terms of finance, a number of funds and mechanisms have been set up to handle the energy investment requirements for developing countries, in particular through the mechanisms created by the UNFCCC, from the Clean Development Mechanism to the newly established Climate Investment Funds. The influence of the EU will depend on the internal coordination between the member states, its own institutions and the bilateral development banks. Efforts have been already undertaken internally through better coordination within the European Development Funds and programmes run individually by member states. Recently new grant and loan blending facilities have reinforced the collaboration between member state donors, the EU institutions, the European Investment Bank and European bilateral development banks. Concrete examples are the blending instruments created for Africa and Asia (Infrastructure Trust Fund, Investment Facility for Central Asia and the Asia Investment Facility) that could be expanded and reinforced to increase the bankability of access to energy projects.

However, it is not clear how the EU's development investments and the new international funding mechanisms will be coordinated to deliver additional finance for access to energy and the EU's development strategy for energy is not fully defined. For example, the Infrastructure Trust Fund (ITF) only finances large cross-border regional projects and cannot intervene in local energy programmes. In addition, with increasing focus on the use of public-private partnerships and attracting funds from private financiers, the financial attractiveness of local renewable energy projects may further be diminished. Such projects are less bankable than major, grid-connected projects, which often serve large industries. Services to more vulnerable, low-income population groups appear far riskier in terms of potential returns on investment. However, there are numerous policy and finance tools to enhance their bankability such as the feed-in-tariffs and other incentive schemes, which several developing countries are pursuing. The EU and some EU member states have an obvious technical advantage in these mechanisms and there is potential for increased coordination on experience sharing and technical training.

To ensure cost effectiveness, there is a need to analyse the best and most sustainable strategies for implementation based on needs and capacities on the ground. Experience has shown that in many cases, large-scale power generation projects (both fossil fuel and renewable) fail to benefit the poor. This CEPS Working Document argues that the EU should promote a focus on clean, small-scale renewable energy technologies and the governance capacity building to enable replication and scale-up.

1. Introduction

Energy plays a crucial role in socioeconomic development. In much the same way that energy transitions provided for the industrial revolution and thus for increasing productivity and wealth in Europe, today's developing countries require access to secure, affordable, clean and sustainable energy services to fight poverty. Yet, some 2.7 billion people continue to rely primarily on traditional biomass fuels such as wood, dung, crop residue and even old tyres and plastic for cooking and heating and 1.3 billion people do not have access to electricity at all (IEA, 2011). Most of these people live in South Asia and sub-Saharan Africa (SSA), in the rural areas of the world's poorest countries.

The implications of energy poverty are manifold (see IIASA, 2011, WHO/UNDP, 2009, UNDP, 2007a and IEA, 2002). First, the extensive use of biomass entails numerous *economic costs*, direct and indirect. These include the costs of fuel wood and other sources of energy, the cost of using wood instead of modern fuels for cooking in inefficient stoves, reduced agricultural productivity due to the drain of potential fertilisers towards household use, and the opportunity costs of collecting biomass (instead of going to school or generating income). Second, there are severe *health risks* associated with the indoor use of solid fuels which lead to almost 2 million deaths per year, or 4000 daily, mainly from pneumonia, chronic lung disease, and lung cancer (WHO/UNDP, 2009). Indoor smoke thus causes more deaths than tuberculosis, malaria or HIV/AIDS. Third, there is the *environmental dimension* resulting from the fact that fuel wood collection and charcoal production leads to ecological damage such as deforestation or reduced soil productivity. Fourth, there is a *gender dimension* because it is largely women and young girls that spend hours gathering traditional biomass. Women and children are also most exposed to the health effects of energy-inefficient appliances. Finally, insufficient access to modern energy sources in rural areas exacerbates *urbanisation*, putting additional pressure on cities to provide adequate services to their citizens and thus increasing the number of the urban poor further.

The reduction of energy poverty, although not one of the eight Millennium Development Goals (MDGs) itself, is thus vital for making progress towards most goals including the reduction of poverty and hunger, the elimination of gender disparities in primary and secondary education, the reduction of maternal health and child mortality and the achievement of environmental sustainability.

Against this background, this CEPS Working Document first reviews the current status and projected future development of access to energy services in developing countries (section 2). It then surveys current trends in donor financing for projects affecting access to energy and presents three case studies (section 3). The paper emphasises the role of renewable energy sources (RES) and assesses options to enhance their deployment in view of increasing access to energy in developing countries. Within this context, the study also looks at impacts of certain RES technologies on water resources (section 4). Finally, section 5 gives an assessment of the role of the EU in promoting sustainable access to energy vis-à-vis other development actors and its current funding mechanisms. The paper concludes with a number of policy recommendations on how access to energy services can be enhanced in developing countries and on where EU action should focus on.

The document focuses on SSA and South Asia - India in particular, as the largest proportion of the world's people without access to modern and clean energy live in these regions.

2. Overview of energy access in developing countries

There is no universally recognised definition or list of indicators to define “access to energy”. IIASA (2011) reports that modern energy access usually includes three forms of energy: clean household energy for cooking and heating, electricity for powering appliances and lights in households and public facilities, and mechanical power from either electricity or other energy sources that improve productivity of labour. A definition of “access to energy” should thus take into account the targeted beneficiary (e.g. households, public facilities, manufacturing, industry), the type of energy source provided (e.g. energy for cooking and heating, electricity, grid-connected or off-grid, fossil fuels or renewable energy sources), and the characteristics that make these energy services accessible (e.g. affordability, reliability, quality and adequacy) (IIASA, 2011). A common approach in line with the vision of sustainable development is to focus on secure, affordable, clean and sustainable energy for households, both for consumption and productive uses including lighting, cooking and water heating, space heating, cooling, and information and communications (cp. Practical Action, 2012; European Commission, 2011a; IEA, 2011; IIASA, 2011; AGECC, 2010).

Although there is no consensus on a basic minimum threshold of modern energy services, an initial target could be 50 kilowatt-hours (kWh) of electricity per person per year in rural areas and 100kWh in urban areas (IEA, 2011; AGECC, 2010). A similar minimum target for cooking and heating could be in the range of 50-100kgoe¹ annually per person (AGECC, 2010 based on IEA data).

A more comprehensive approach to energy access minimum standards has been brought forward by Practical Action (2012), which includes five energy services and nine related minimum standards, as shown in Table 1 below.

Table 1. Total energy access minimum standards

Energy service		Minimum standard
Lighting	1.1	300 lumens for a minimum of 4 hours per night at household level
Cooking and water heating	2.1	1kg wood fuel or 0.3kg charcoal or 0.04kg LPG or 0.2l of kerosene or biofuels per day, taking less than 30min per household per day to obtain
	2.2	Minimum efficiency of improved solid fuel stoves to be 40% greater than a three-stone fire in terms of fuel use
	2.3	Annual mean concentrations of particle matter (PM2.5) < 10µg/m ³ in households, with interim goals of 15µg/m ³ , 25µg/m ³ and 35µg/m ³
Space heating	3.1	Minimum daytime indoor air temperature of 18°C
Cooling	4.1	Households can extend life of perishable products by a minimum of 50% over that allowed by ambient storage
	4.2	Maximum apparent indoor air temperature of 30°C
Information and communications	5.1	People can communicate electronic information from their household
	5.2	People can access electronic media relevant to their lives and livelihoods in their household

Source: Practical Action (2012).

¹ Kgoe = kilograms of oil equivalent. 50kgoe are equivalent to roughly 630kWh.

2.1 Present situation of access to energy in developing countries

2.1.1 Access to electricity

The IEA (2011) estimates that 1.3 billion people – about 19% of the global population – lack access to electricity. The majority of these people live in South Asia and in sub-Saharan Africa, mostly in rural areas (Table 2). In many world regions, the absolute number of people without access to electricity has decreased in the past few decades. IASA (2011) notes that between 1990 and 2008, almost 2 billion people gained access to electricity. Progress has been particularly pronounced in Latin America, North Africa, the Middle East and East Asia. However, especially in SSA, population growth has outpaced electrification and the number of people without access to electricity increased (IASA, 2011).

Almost 300 million people in India live without access to electricity, representing a quarter of the population. Lack of electricity access is mainly a rural problem with roughly 30% of the rural population lacking access compared to only about 6% in cities and towns (own calculations based on IEA, 2011 and India 2011 Census data). In recent years, India has installed substantial additional electricity generation capacity. However, some 32000MW of additional capacity of conventional power plants installed between 2002 and 2009 (mainly coal-fired power plants and large hydropower) have failed to sufficiently address the issue of electricity access for the rural poor (Rao et al., 2009; OCI et al., 2011). This is evident from the fact that the percentage of un-electrified households only decreased from 52% in 2002 to 45% in 2009 and that conventional power only contributed 5 percentage points to this reduction, with decentralised renewable energy solutions contributing another 2 percentage points (OCI et al., 2011). The priority of the Indian government is clearly to ensure electrification of urban centres, followed by rural household and finally villages (ibid.).

Table 2. Number of people without access to electricity (absolute number and share of population) by region in 2009 (millions)

	Rural	Urban	Total	Share of Population
Africa	466	121	587	58%
Sub-Saharan Africa	465	121	586	69%
Developing Asia	595	81	676	19%
India	268	21	289	25%
Developing countries*	1,106	208	1,314	25%
World**	1,109	208	1,317	19%

*Includes Middle East countries; **Includes OECD and transition economies

Source: IEA (2011).

The greatest challenge, however, is in sub-Saharan Africa. Despite the fact that SSA has considerable energy resources, its electricity production and consumption levels remain low. Nearly 70% of the total inhabitants do not have access to electricity (IEA, 2011, Table 2). This means that less than a third of the population can benefit from electricity. Countries with the lowest rates of electrification in SSA include DR of Congo (only 11% of the population have access to electricity), Tanzania (14%), Kenya (16%) and Ethiopia (17%) (IEA, 2011). Excluding South Africa, the electrification rate of SSA falls to 28%. To make a comparison with a developed country, the 19.5 million inhabitants of New York consume roughly the same

quantity of electricity per year (40 terawatt-hours) as the 791 million people of SSA (excluding South Africa) (IEA, 2010a; WHO/UNDP, 2009). Although SSA has experienced an average growth in installed capacity of 1.7% annually over the last two decades, it has been observed that countries with greater existing capacity and transmission and distribution grids tend to expand their capacity faster than countries with medium and small electricity systems (Bazilian et al., 2011). This is an indication of a kind of ‘energy poverty lock-in’, which is particularly evident in rural areas.

While the numbers provided in Table 1 give an indication of energy poverty in developing countries, they do not give the full picture due to the fact that even where access to electricity is available, it is often unreliable and prone to power shortages and interruptions. For example, Mathanpura, a grid-connected rural village in India, experiences frequent power outages that can last 10 to 15 days (OCI et al., 2011). In SSA, cumulative average interruptions are estimated at three months of lost service per year (IEA, 2010a) entailing economy-wide costs of up to 7% of GDP (Foster and Briceno-Garmendia, 2010). Costs are mainly associated with the provision of costly diesel generators for back-up power. Unreliable power supply can also damage industrial equipment, reduce agricultural productivity, and reduce the time available for working or studying after sunset.

2.1.2 Access to clean cooking facilities

The IEA (2011) estimates that about 2.7 billion people – roughly 40% of global population – still rely on traditional biomass for cooking (including wood, charcoal, tree leaves, crop residues, animal dung). As shown in Table 3, almost three quarters of these people live in developing Asia and about a third in India alone. In India 72% of the population does not have access to modern cooking fuels, the vast majority of whom live in rural areas. In SSA, some 653 million people rely on traditional biomass, equivalent to some 80% of the population. The dependence on traditional use of biomass is highest in DR of Congo, Tanzania (94% each) and Ethiopia (93%) (IEA, 2011), with rural areas being by far the most affected.

Table 3. Number of people relying on the traditional use of biomass (absolute numbers and share of population) by region in 2009 (millions)

	Rural	Urban	Total	Share of Population
Africa	480	177	657	65%
Sub-Saharan Africa	476	177	653	78%
Developing Asia	1,680	240	1920	54%
India	749	87	836	72%
Developing countries*	2,221	441	2,662	51%
World**	2,221	441	2,662	39%

*Includes Middle East countries. **Includes OECD and transition economies.

Source: IEA (2011).

IIASA (2011) reports that there has been little progress in expanding access to modern fuels and technologies for cooking and heating in developing countries over the past 25 years. In fact, it finds that “populations with no access to clean cooking fuels have continued to increase over the last decade, except in the case of China” (IIASA, 2011: 12).

2.2 Likely future developments without additional policies

Without additional policies aimed at increasing access to energy in developing countries, there will only be limited progress towards reducing energy poverty. The IEA (2011), for example, in its New Policies Scenario,² estimates that the share of the global population lacking access to electricity will decline from 19% in 2009 to 12% in 2030. This still leaves more than 1 billion people without electricity, mostly in rural areas. The absolute number of people without access to electricity is expected to decrease in all world regions until 2030, with the only exception being SSA where population growth outpaces the rate of new connections. As a result, the number of people without electricity access increases in SSA from 586 million people in 2009 to some 645 million people in 2030. The share of people lacking access to electricity, however, declines also in SSA from 69% in 2009 to 49% in 2030. Progress in rural electrification will be slowest, as projected by the Global Energy Assessment (IIASA, 2011). Rural electricity access in SSA is expected to increase from 10% in 2005 to 15-30% in 2030 in the no new policies case.³

In terms of clean cooking fuels, the IEA (2011) in its New Policies Scenario estimates that the number of people without access to clean cooking facilities will remain at 2.7 billion in 2030, which is the same level as in 2009, however representing a smaller share of the global population (33%, down from 40%). Similar to the electricity case, there are improvements all over the world in terms of reducing the absolute number of people without clean cooking facilities, except in SSA. The IEA projects that the number of people without access to clean cooking facilities in SSA will increase by 40% to reach more than 900 million by 2030. The largest share of this increase will take place in rural areas. Both IEA (2011) and IIASA (2011) project that the percentage of the population dependent on fossil fuels will decrease until 2030. Yet, according to IEA (2011 based on WHO data), household air pollution from the use of biomass in inefficient stoves would still lead to over 1.5 million premature deaths per year by 2030, more than from HIV/AIDS and malaria combined.

2.3 Achieving universal access to energy in developing countries

The year 2012 has been declared the International Year of Sustainable Energy for All by the UN, and is part of the Sustainable Energy for All initiative by UN Secretary-General Ban Ki-moon. This is an attempt to raise energy poverty on the international political agenda and to provide opportunities for business, government and civil society to partner for achieving the target of sustainable energy for all by 2030. Three objectives have been highlighted under this initiative, which are to be achieved by 2030: ensuring universal access to energy; doubling the global rate of improvement in energy efficiency; and doubling the share of renewables in the global energy mix.

Although the demand for energy services in developing countries is projected to rise rapidly in the coming decades (mainly due to economic and population growth), there is sufficient evidence that universal access to electricity and modern cooking facilities is possible.

The experience of several countries shows that strong government commitment can increase electrification rates substantially over a relatively short period of time. Figure 3 shows the

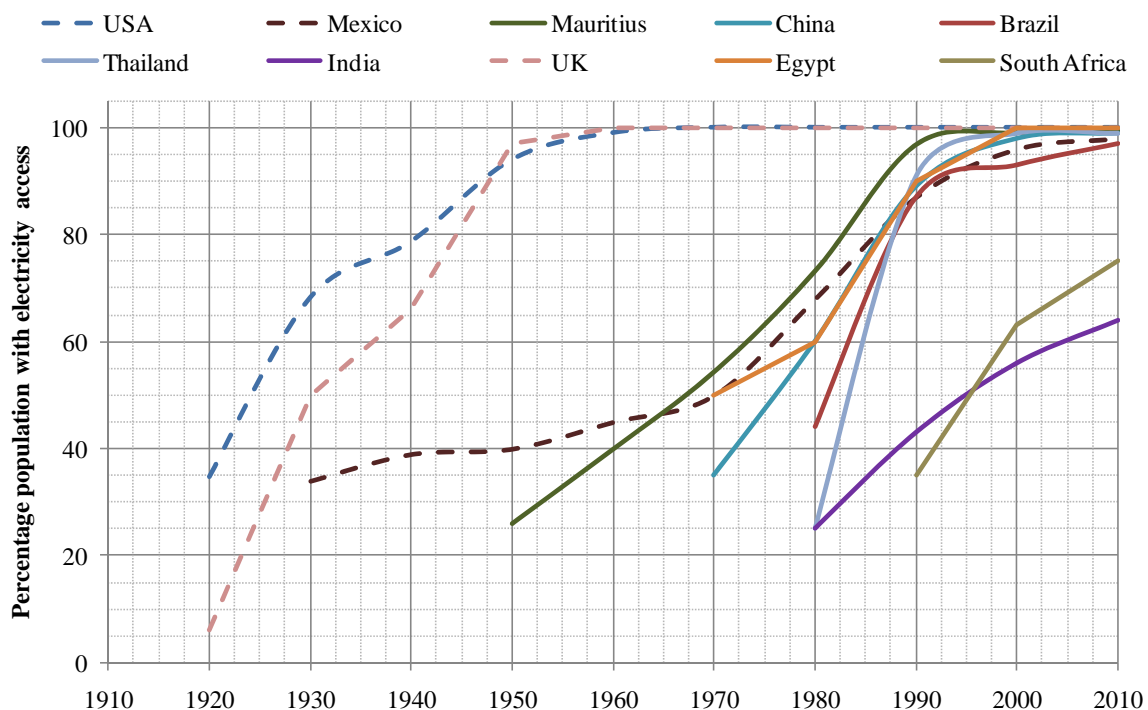
² The New Policies Scenario is one of the three scenarios of the world's energy future calculated by the International Energy Agency (IEA). It is based on current policies and new policy commitments that have already been announced.

³ It should be noted that IEA's New Policy Scenario is not fully compatible with IIASA's No New Policy case, however, they both project a world without much additional efforts to combat energy poverty and are thus included here to give a broader picture.

development of electrification rates in 10 countries. Some examples are particularly striking. Thailand achieved full electrification in just over a decade (in the 1980s). Brazil also made considerable progress in the 1980s. Not part of this graph but equally successful are Morocco and Tunisia, who with the help of public funds managed to increase electrification rates from below 30% in 1996 to more than 96% in 2009 (Practical Action, 2012). China has provided 500 million people in rural areas with access to electricity since the beginning of the 1990s and is expected to achieve universal electricity access by 2015 (IEA, 2011).

However, taking the countries represented in Figure 1 into account, it seems that many countries need at least three decades to move to full electrification and others much longer (see also Bazilian et al., 2010).

Figure 1. Evolution of household electrification over time in selected countries



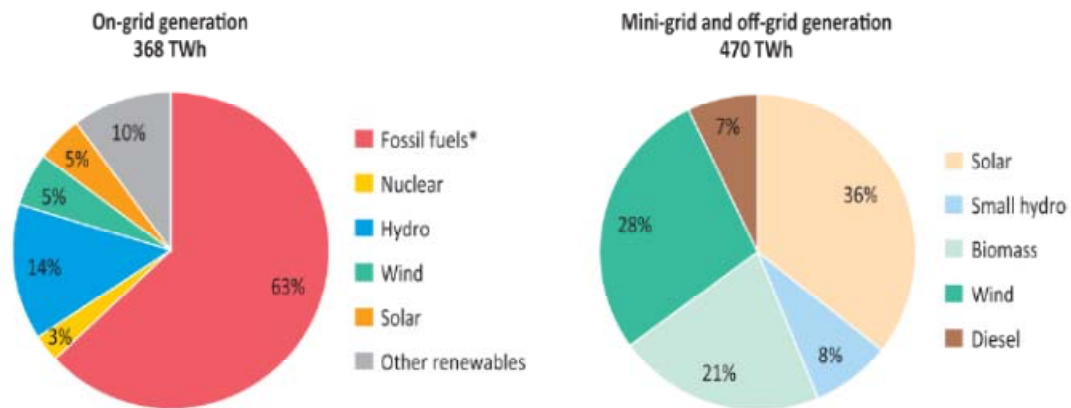
Source: Pachauri et al. (2011).

To achieve universal energy access by 2030, electricity output needs to increase by 840 TWH and power generation capacity by some 220 GW (IEA, 2011). According to the Energy for All Case of the IEA (2011), around 45% of the additional electricity needed in 2030 would need to be generated and delivered through the extension of national grids (i.e. on-grid generation), another 36% through mini-grid generation and 20% by isolated off-grid generation.⁴ All urban areas and around 30% of rural areas are expected to be connected through grid extension. However, on-grid electricity access is not cost effective in more remote and sparsely populated rural areas. Therefore, about 46% of rural areas will need to be connected with mini-grids and the rest (25%) with small, stand-alone off-grid solutions (IEA, 2011).

⁴ Mini-grids are village and district-level electrical networks with loads of up to 500 kilowatts (this can adequately supply energy to approximately 25-30 households). A stand-alone system is an autonomous power system, i.e. it does not depend on the main grid.

Fossil fuels are projected to dominate additional on-grid generation, with more than 50% being coal-based and another 13% on other fossil fuels. Renewables, on the other hand, are expected to dominate additional mini-grid and off-grid generation, with 36% to be provided by solar, 28% by wind and 21% by biomass (see Figure 2).

Figure 2. Additional electricity generation by grid solution and fuel in the Energy for All Case, 2030



* Coal accounts for more than 80% of the additional on-grid electricity generated from fossil fuels.

Source: IEA (2011).

In terms of clean cooking facilities, efforts are likely to concentrate on advanced biogas cook stoves, on liquefied petroleum gas (LPG) stoves and on biogas systems. In total, some 560 million households will require additional access to clean cooking facilities. The IEA (2011) estimates that biogas cook stoves will need to be supplied to 250 million households, LPG stoves to nearly 240 million households and biogas systems to another 70 million households.

Providing universal energy access by 2030 is estimated to increase global energy demand by 179 million tonnes of oil equivalent (Mtoe) or by 1.1% compared to the New Policies Scenario. 54% of this increase will be based on fossil fuels, raising the question of the impact of universal energy access on global GHG emissions. However, according to the IEA (2011), the provision of universal energy access would increase global energy-related CO₂ emissions by a modest 0.7%, compared with the emissions levels calculated in the New Policies Scenario. IIASA (2011) presents similar findings. Also taking into account other climate forcing emissions (e.g. methane, Black Carbon etc.) it concludes that the climate impacts are negligible or even beneficial, also at high levels of LPG use. This is mainly due to the fact that new technologies and fuels displace large quantities of traditional biomass use, which are inefficient and associated with significant emissions, also (and in some cases particularly) of non- CO₂ Kyoto gases such as methane.

It should be noted, however, that current GHG emissions of the poorest countries, notably in SSA and in rural areas of many developing countries, are negligible due to the low levels of industrialisation. Therefore, even if fossil fuel consumption in these countries grew at a high annual rate until 2030, the per capita level of CO₂ emissions would still remain at low levels compared to those in high-income countries (World Bank/UNDP, 2005).

2.4 Potential requirements to fill the gap

2.4.1 Technology options for electricity services

In urban areas, using the conventional electricity grid and extending it to peri-urban areas is generally the most common solution to provide electricity to households. However, this does not necessarily ensure adequacy, reliability, and affordability of supply. Unreliable services and appliances can lead to high costs for consumers and the economy through impacts such as lost productivity and revenue for businesses, or as a result of damaged goods (e.g. if refrigeration capacity is lost) (see also section 2.1.1). In many poor urban areas, electricity is consumed from illegal and unsafe connections to the grid (as a response to high connection fees), putting additional pressure on the electricity system. The technical challenge is to provide safe household connections - often to improvised dwellings - that discourage theft. One successful example involved the use of service drops⁵ high on utility poles and prepayment cards for household meters in the Khayelitsha slum at the outskirts of Cape Town (USAID, 2004). The main barrier to the expansion of electricity to individual houses in urban and peri-urban areas, however, is not a technical one but high upfront costs associated with connecting a house to the grid (World Bank/UNDP, 2005). The initial costs could be overcome by providing connection subsidies for low-income populations (as is the case in a USAID-led slum electrification project in Mumbai for example, see section 3.1).

In rural communities with no electrical service at all, both centralised and decentralised approaches can be useful to provide access to electricity. The choice depends on many factors such as overall population density, geographical sparseness, average distance between community centres, availability of local renewable energy resources and pre-existing grid power (World Bank/UNDP, 2005). These factors determine the cost of transmission and distribution infrastructure, which is the main cost component when expanding electricity access to rural areas. For example, a centralised approach could be viable in high-density but dispersed settlements (like the population around Lake Victoria in East Africa). The average distance between community centres is generally no more than 2km allowing for networked options to be utilised (World Bank/UNDP, 2005).

However, as shown by recent efforts to expand electricity access in India (see section 2.1.1), this may not be the most efficient solution in many rural areas both in terms of quality (i.e. rated voltage and frequency) and quantity (i.e. hours of use and availability) of the electricity supplied and in terms of cost-effectiveness (OCI et al., 2011). Considering the typical low density of rural areas, the effective cost of creating new transmission infrastructures to extend the grid to rural communities can be very high. Moreover, the damages that households experience due to poor quality electricity and frequent power cuts are a major barrier to economic development. For example, many rural villages in India, which receive grid-connected electricity from conventional power, get access for just 2 to 6 hours per day. This is often not enough to light even a single tube-light (OCI et al., 2011). One way to address this issue could be to enable access to electricity through small-scale, decentralised energy technologies that do not depend on the main grid.

Decentralised technologies can help create economic opportunities and alleviate poverty (WHO, 2006). They include mini-grids or stand-alone systems (off-grid), which are powered by diesel or hybrid motors or rely on small-scale renewable technologies to create mechanical power and electricity. The electricity system in Urambo Village in Tanzania provides a good example of a successful application of a mini-grid system. The diesel mini-grid serves approximately 250 households, an estimated 2,000 people. However,

⁵ The point at which the electrical line running to a customer's building is connected to the utility pole.

decentralised technologies relying on renewable forms of energy (e.g. solar, wind, hydro or some combination of these technologies) may be the most promising approach to rural electrification (see section 4).

2.4.2 *Technology options for cooking and heating services*

It is important to provide cleaner and more efficient cooking and water heating options to all people still relying on traditional use of biomass. Three technologies will be critical: LPG stoves (both in SSA and in India), advanced biomass cook stoves (more so in India than in SSA) and biogas systems (more so in SSA than in India) (IEA, 2011). Which cook stoves are used depends on several factors, including cost effectiveness, ease of use, taste, cultural preferences and other contextual conditions like geography, whether, urban/rural setting etc. (IIASA, 2011). Adapting technologies to these circumstances is crucial for programmes to have a positive impact.

For those who are unable to switch to modern fuels for cooking, further measures to encourage the use of improved cooking stoves, increased sustainable biomass production, and cleaner use of biomass fuels should be taken (World Bank/UNDP, 2005). Passive installations can also provide cooking and heating services in both rural and urban environments – simple solar water heaters for example offer a cheap alternative to burning fuel to heat water if the initial financing and installation challenges can be overcome.

Policy reforms that encourage investment in energy infrastructures – including the handling, transport, and distribution of fuels, as well as measures that reduce the cost burden of LPG cylinders and stoves for the poor – are needed to improve the affordability and availability of safe cooking fuels (UNDP, 2007a; SEI, 2009).

2.4.3 *Investment needs*

Achieving universal energy access by 2030 will require a substantial increase in the level of investment geared towards the alleviating energy poverty. While in 2009 these investments amounted to \$9.1 billion, the IIASA (2011) suggests that they need to quadruple to between \$36-41 billion annually to achieve universal energy access by 2030. The estimates of the IEA (2011) are even higher, suggesting annual investments of \$48 billion (about five times the 2009 level). In fact, the Energy for All Case (IEA, 2011), estimates that a total of about \$1 trillion of additional cumulative investment will be required between 2010 and 2030 in order to achieve universal access to electricity and clean cooking facilities. More than 90% of the additional investment needs will be required for providing access to electricity and only \$95 billion (or less than 10%) for the provision of clean cooking facilities.

Most investment aimed at achieving universal electricity access will be required in SSA, mostly for connection with mini-grids and off-grid solutions in rural areas. Some 60% of additional finance will be needed in SSA, compared with around 20% in India (IEA, 2011). Together, these two regions are thus in need of 80% of the additional investments in electricity connection.

The region south of the Sahara will also need to be the largest recipient of investments in clean cooking facilities. Some 30% of the additional investments in clean cooking facilities will be required in SSA, compared with some 23% in India (IEA, 2011). Together, these two regions thus account for more than half of additional investment needs in clean cooking facilities.

In order to provide guidance on how much is required for one country, UNDP and the UN Millennium Project (2006) calculated the cost of providing universal energy access in Senegal. This study shows that \$12.2 per capita per year (or \$1.7 billion over 10 years) is

necessary to meet the targets of providing electricity for households and communities, cleaner cooking systems, and mechanical power for agro-processing and water. This amount is equivalent to 1.7% of GDP per capita, (based on a GDP per capita of approximately \$700) (UNDP, 2007b). This is a manageable amount to provide. The main challenge is finding an effective way to mobilise investments (see section 5).

3. On-going and planned projects to improve energy access

3.1 Access to energy projects and funding trends in Sub Saharan Africa and South Asia

On-going and planned donor-financed energy projects affecting access to energy range from multi-billion dollar thermal and hydroelectric power and transmission projects to NGO- or private sector-led community initiatives deploying energy services tailored to household needs.

Amongst the largest tranches of international donor funding for energy are directed at fossil fuel-related projects, particularly coal-fired power generation. These are aimed primarily at rapidly increasing reliability of power supplies in countries facing chronic shortages and rising demand. Several major international funders including the Asian Development Bank, the World Bank, the US Export-Import Bank, the Chinese Development Bank, the Chinese Export-Import Bank and the Korean Export-Import Bank have committed hundreds of millions of dollars to finance India's roll out of coal-fired supercritical Ultra Mega Power Plants (UMPPs). There is little attention devoted to households without electricity access and where promised, these account for a tiny percentage of total power generation (e.g. 0.1% of electricity generated by the 4000MW Tata Mundra coal-fired UMPP to be completed in 2012 in Gujarat, India). One of the most controversial power projects on the World Bank's lending portfolio is the 4800MW Medupi plant in South Africa.⁶ All donor financing for coal has come under severe criticism for its future impacts on the local and global environment, not just for GHG emissions but also the acid rain and land degradation that accompanies mining operations (e.g. CIEL, 2011; Co2Scorecard, 2011).

Hydropower is also a strong focus for the World Bank, ADB, AfDB, the EIB and countries with expertise in this area, namely China, Brazil and Norway. This form of energy currently provides around 60% of electricity in sub-Saharan Africa excluding South Africa, 21% in India and over 80% in Bhutan. In theory, there is huge untapped potential for energy from this source in both regions. Many of these projects also seek funding by the Clean Development Mechanism (CDM). One of the most ambitious proposals is for a fourth hydroelectric plant of 39,000MW on the Inga River in the Democratic Republic of Congo (DRC). This is intended to supply DRC and "light up Africa" but benefits to those without current access are unclear and current hydroelectric plants on the Inga do not supply energy to local communities and are mired in a history of poor governance. These and many other existing hydroelectric dams are aging and suffer from inefficiency and breakdowns. Refurbishment and retrofitting can have dramatic improvements to reliability of energy supplies – for example, the Akosombo Dam in Ghana underwent a successful World Bank funded retrofit in 1999 which added 108MW of additional capacity and an efficiency increase of 31%.

⁶ Although the justification for the project was framed in terms of development needs and lack of access, the project does not specify increasing grid connections. Rather, the Bank claims that financing the addition of major new supply will allow ESKOM to meet its target of connecting the remaining 19% of South Africa's population without electricity access (World Bank, 2010).

Nevertheless, these projects do not necessarily increase access for the poor. This aim is being better served through the rehabilitation and addition of mini hydro (under 1MW) or micro hydropower units (under 200kW) for local rural demand (Gaul et al., 2010). These avoid the social and environmental drawbacks of larger projects and have had success in supplying poor communities in Nepal, Bhutan and other hilly areas of Asia. There are several initiatives to increase their use in India and Africa, such as UNIDO-led projects in Zambia and Rwanda, which also aim to enable commercial upscale of rural hydro mini-grids. Small hydro projects are funded by a range of donors including the Global Environment Facility (GEF), the European Commission, UNIDO, UNEP and several European governments along with private investors.

Beyond geography, a key obstacle to getting electricity to the lowest income communities is national and local level governance and capacity. In India for example, the grid extends to many rural villages, but a lack of accountability and technical challenges related to connecting non-pukka (i.e. non-solid and non-permanent) dwellings to the grid often mean that no one bothers to connect individual homes. Several major initiatives focus on power sector governance reform and efficiency packages, sometimes linked to new generation or transmission and distribution. One example is the World Bank financed Uganda Electricity Sector Development Project, which has a specific target of 84,000 new customers (some 655,000 people) by 2025. It involves connecting the South Western region of the country to the national grid and providing technical assistance and capacity building for Uganda Electricity Transmission Company. Smaller initiatives funded by development aid may subsidise the electricity connection cost and provide technical training and quality control such as a GPOBA⁷ funded USAID/Reliance Infrastructure initiative to bring electricity to the Mumbai slums.

Increasingly, national projects specifying rural access also take into account local energy service needs more than just grid connection. For example, the World Bank financed Accelerated Electricity Access (Rural) Expansion programme in Ethiopia has succeeded in electrifying 320 towns over five years with a combination of new connections and the provision of energy efficient street lighting, lamps and improved cooking stoves. A similar programme in Benin, includes decentralised generation systems and modernisation of biomass services in rural areas, including training 300 workers in production of efficient woodstoves.

Given the difficulties of scaling up decentralised rural energy projects, and creating markets for renewable energies, several new or recent multi-country projects promote local SMEs in this field and work with governments to create a conducive legal and regulatory framework. The \$13.9 million multi-donor funded 'Lighting Africa' initiative aims to lower barriers to entry for the off-grid lighting - specifically solar - market (Ho, 2011 and www.lightingafrica.org). The EU is particularly active in this area within SSA.

The EU/Dutch-funded 'Energy Enterprises Project for East Africa' aims to enable the spread of energy enterprises to increase energy services to the rural and peri-urban poor whilst also creating local business opportunities. The €138 million German-Dutch Energy Partnership (GDEP)-financed multi-country Energising Development programme focuses on building self-sustaining markets and research centres for green energy services which will encourage scale-up. The latter now sits beneath the umbrella of the Africa-EU Energy Partnership (AEEP), which has specific targets on energy access within a wider-ranging strategic agenda (see section 5.3).

⁷ The Global Partnership on Output-Based Aid.

One recent private sector driven phenomenon is the link between ICT and energy services in developing countries. The mobile phone industry in particular is promoting solar charging posts in remote areas, which can often fulfil other energy needs (GSMA, 2011).

A host of smaller scale, decentralised energy projects (such as the small hydropower ones mentioned above) - are financed and implemented by a combination of international development agencies, local and international NGOs and private companies. Renewable energy solutions are now routinely employed, particularly in projects in remote rural areas (given the benefits described in section 4). A few of these are receiving funding by the Clean Development Mechanism (CDM).⁸

The more recent projects take on board the lessons learned over the last two decades in terms of building in measures to promote sustainability of energy services, most significantly in the design of tariffs, opportunities for local ownership and market linkages. The following case studies give three examples of the different models being piloted and their progress.

3.2 Three Project Case Studies

3.2.1 *The Lighting a Billion Lives Campaign (LaBL) in New Delhi*

The LaBL Campaign, managed by The Energy and Resources Institute (TERI) of India, aims to bring light into the lives of one billion rural people by replacing the kerosene and paraffin lanterns with solar lighting devices. This translates into 200 million solar lanterns to be installed, assuming that each lantern benefits five members of a family. The campaign has a twin objective: taking solar lanterns as a non-polluting means of night illumination to poor rural households that lack electricity and making such service self-sustainable after it is established.

The campaign started in 2008 and has until now managed to install around 70,000 lanterns and 1400 solar charging stations in about 1500 villages (see <http://labl.teriin.org>). It is estimated that close to 350,000 lives have benefited so far, through facilitated daily chores, educational activities, livelihood activities, and better access to health and sanitation facilities. Health services, ICT based educational services, water purification services etc. can be provided to the communities by expanding the capacity of the solar charging stations in future.

In lieu of these benefits, the user pays a rental fee to an entrepreneur for managing the charging station. Apart from providing lighting to households at an affordable rate, the Campaign thus also facilitates entrepreneurial development among rural communities by training rural entrepreneurs to manage and operate a central solar lantern charging/distribution centre where lanterns are rented.

In addition, the LaBL Campaign offers local and global environmental benefits. Each solar lantern in its useful life of 10 years displaces the use of about 500-600 litres of kerosene, thereby mitigating about 1.5 tonnes of CO₂. However, the market is still at an early stage of development. The campaign is largely financed by donations (both from individuals and corporations) and it will still need some time before it will become fully commercial.

⁸ The UNFCCC is now collecting evidence of developmental benefits, including access to energy, of CDM-funded projects. A list of these can be found at <http://cdm.unfccc.int/about/ccb/index.html>.

3.2.2 Yeelen Kura in Mali: Testing the feasibility of rural energy service companies (RESCOs)

Only around 2-3 percent of the rural population of Mali have access to grid electricity. In the mid-1990s, EdF (Electricité de France) developed the idea of Rural Energy Service Companies (RESCOs) and initiated the project in Mali based on three key criteria: profitability, sustainability, replicability. The idea was to bring decentralised electricity to 6,700 households in Southeastern Mali, replacing the use of polluting fuels with electricity from renewables and stimulating economic activity (see European Commission, 2001). The initial project cost was €5.5 million covering 2001-2005. A service company, Yeelen Kura (meaning “new light” in the Bambara language) was created, with EdF and Dutch energy and water company Nuon each taking a 50% share. The French Agency ADEME provided training to locals and support in the operation of electricity infrastructure and a Dutch Government grant subsidised the connection of 1500 Solar Home Systems (SHSs) (see also UNDP, 2007b).

By 2004, the project had increased rural electricity access, fulfilling domestic demand for lighting, television and radio but additional power (especially for business) was still lacking. Facing a variety of challenges after the service company had been transferred to local ownership and management (including a tariff structure that prevented access to electricity services to the poorest households), the project underwent a thorough evaluation by 2006, which resulted in a multilateral donor support package (chiefly through the World Bank) aimed at addressing the challenges. The involvement of the World Bank enabled the Malian government to establish an improved institutional framework and partial liberalisation of the electricity market to allow the model to be replicated by other companies. By 2008, Yeelen Kura had installed SHSs to 5000 households. The expansion plan also enabled low-voltage micro-networks powered by diesel generators. Subsidisation allowed a decrease in tariffs and the company appears to continue to increase rural access.

Environmental impacts have been minimal with substantial CO₂ savings from the use of SHSs in place of kerosene and candles and also from efficient diesel generators in place of car batteries and biomass. These also improved indoor air quality. There was initially a problem with lack of facilities for used battery disposal but EdF has provided assistance to establish recycling companies (Mazimpaka, 2007).

The fee-for-service model proved popular but showed that additional funding/subsidisation is likely to be necessary to offset start-up costs, serve the poorer households and insulate company from fragility of local economy. Pre-existing low level of skills and economic activity also need to be taken into account when planning financing as projects may need to set up the necessary supply chains and services. Transparent bidding processes should also be used to ensure the best technology. The World Bank’s intervention proved useful in helping the host Government to change legislation and implement regulation to facilitate operation of RESCOs. This would be helpful to renewable energy small- to medium-sized enterprises where there is a state monopoly on utility provision.

3.2.3 Grameen Shakti, Bangladesh: Microcredit to enable access to green energy and empower women

In Bangladesh, 55% of the population (over 90 million people) is not connected to the national grid. The government’s vision is electricity access for all by 2020.

The non-profit enterprise, Grameen Shakti (GS), established in 1996 uses microcredit to fund rural electrification (see also Bhuiyan, 2010). The idea is based on providing for the specific needs of the rural communities and businesses with an emphasis on transferring ownership

of the technology to local people. It works with various renewable energy sources (solar, wind, biogas from farm waste) to avoid fuels detrimental to health and the environment. In 2003, a government programme, supported by the World Bank's International Development Association (IDA) and the Global Environment Facility (GEF) embarked on a programme to install 50,000 Solar Home Systems (SHSs) by 2008. This was coordinated by the government owned Infrastructure Development Company Limited (IDCOL) and GS was chosen as one of the implementers. The target was reached by 2005, and by 2010, GS had installed over 450,000 SHSs (benefiting some 4 million people) and plans to reach 1 million by 2012. The success of the programme attracted additional funding from the German GTZ (now GIZ) and KfW, as well as from the Asian Development Bank (ADB) and the Islamic Development Bank (IDB).

IDCOL provides GS with the initial loan and a small subsidy for each solar panel supplied – this is then repaid to the government through collection of small payments from villagers over two or three years. The microcredit scheme entails an initial down payment plus service charge on repayments. Monthly repayments are based on the idea that household can own a SHS for the same amount it would spend on kerosene. The initiative in turn provides employment, often to women, through a scheme in which locals receive training on installation and repair of solar panels and wind generators. The user-training program and training of local engineers and a free/low cost maintenance scheme for customers are essential for sustainability of a high-tech system such as solar PV.

These schemes have increased economic activity, enabling households to generate additional income from home and the start up of small businesses (e.g. village pay phones operated by SHS, manufacturing industry for batteries and solar accessories). Environmental impact appears to be minimal or positive. GS maintains an agreement with one of its battery suppliers to take back, recycle, and safely dispose of used batteries. The replacement of kerosene and biomass reduce GHGs and benefit human health. However, critics point to a general problem with micro credits – they can drag poor families into a cycle of debt which forces them to take out additional loans with much higher interest rates to repay the initial loans. Adapted GS schemes thus include several families sharing the cost of one SHS and the improved cooking stoves program which offers cheap, locally manufactured stoves, producing clean methane gas from cow dung with the by-products usable for fertiliser and fish feed.

4. Improving access to energy by using renewable energy sources

4.1 Renewable energy sources in developing countries

The use of traditional renewable energy sources (RES) in form of biomass (e.g. burning wood, dung or agricultural residues) for cooking, heat and light is widespread in developing countries, especially in rural areas. As spelled out in the introduction, this practise has severe consequences for the health of (mainly) women and children. Whether the use of biomass in this context can be considered 'renewable' depends on the environmental effects, which in some regions can include deforestation, degradation of land and even desertification.

In contrast, fossil resources such as oil, gas and coal are available only in certain areas and subject to volatile prices on the world markets. The burden of fossil fuel imports is especially high for developing countries, which usually subsidise their domestic sales of fuel and electricity (IMF, 2011). Modern RES such as wind, sun and hydro have a huge potential to satisfy the demand for energy services in developing countries. They are available in some form in every country. Most of the developing countries are situated in areas with access to abundant renewable energy sources, especially wind and solar.

Replacing traditional biomass and conventional fuels with modern renewable energy applications offers a range of benefits. These include 1) infiniteness: RE sources cannot be depleted; 2) independence: local energy sources contribute to energy independence and reduce the exposure to volatile prices of resource imports; 3) health: hardly any impacts on health; and 4) environmental protection: comparatively small environmental effects, e.g. in terms of local air pollution (nitrates and sulphates) and climate change (greenhouse gas emissions).⁹ Nevertheless, the impact of modern RES on society and the environment is not necessarily neutral, as will be outlined in the next section.

Renewable energy sources provide the opportunity for large and small-scale as well as grid-connected and off-grid solutions. Historically, large-scale renewables projects (above 100 MW) have often been implemented to supply energy to industrial production or for export (Bast & Krishnaswamy, 2011) and have rarely increased access to energy for local communities. Connecting remote and poor rural areas to centralised on-grid RE facilities encounters similar difficulties as connecting them to conventional energy resources (see section 2). Poverty and social conflict may even increase due to the negative effects of large power projects on the local population. For example, the Three Gorges Dam in China mainly supplies high-paying customers such as those in the city of Shanghai while the local population is subject to the displacement of more than 1.3 million people, the flooding of cultural and archaeological sites and significant and on-going environmental damage, including an increased risk of landslides and contamination of drinking water (see e.g. International Rivers, 2008; Yang, 2007). In addition to large hydropower projects, large energy crop cultivation for the production of biofuels (mainly for export) has been criticised as it has large impacts on local livelihoods and may lead to resource conflicts. Problematic issues such as land grabbing, substitution of food production and land degradation are widely discussed in this context (e.g. World Bank, 2011).

In contrast, decentralised, small-scale RES applications can avoid the problems noted above and are more suitable for the low demand and specific needs of poor rural communities. Small-scale applications, such as run-of-the-river hydropower, wind and solar PV systems, provide electricity that can be used for lighting, water pumping, communications and small industry. Wind and hydropower can also provide mechanical energy for water pumping. Biofuels can be used as a fuel for existing diesel generators, thus reducing pollution and (partly) reducing fuel costs. Solar thermal, biomass or biogas applications can be used for space and water heating or cooling as well as for cooking (e.g. in improved cooking stoves, which use biogas instead of wood).

Passive infrastructure can also make use of RES directly to provide functions or services that would normally require fuel or electricity. These include solar water heaters, solar cookers, solar crop drying, water and wind-driven grain mills and air-cooling towers.

When tailored to the socio-economic context, decentralised renewable energy systems can result in developmental and environmental improvements as well as increasing access to energy. In Bangladesh, for example, the installation of biogas digesters at poultry farms reduced the environmental hazards and turned them into energy sources, hence also improving the economic performance of the farms in the longer run. The reduction of excrement and waste releases lead to an improvement of water quality and to a reduction of methane emissions (IISD, 2005). In India, the “Lighting a Billion Lives” project (see section

⁹ Further examples of negative environmental effects of traditional or conventional energy sources are landscape destruction and water contamination by coal mines, or the production of pollutants during electricity or heat generation such as ashes, heavy metals or nitrogen oxides, or the waste and radiation problems connected to nuclear energy.

3.2.1) improves access to lighting via the allocation of solar lanterns while improving air quality (and therefore health) by replacing paraffin lanterns. The Grameen Shakti example (section 3.2.3) also shows that an access to energy project can also address gender inequality when focused on training women technicians. In Rumpura, a small rural village in Northern India, a 8.7 kilowatt (kW) power plant powered by solar energy was set up by Norway-based Scatec Solar in 2009. The village community together with a local NGO, Alternative Developments, mobilised to take control of the management of the power plant. Since then, Rumpura has not been without energy for one day (OCI et al., 2011).

However, financing, ‘technological strangeness’ and a lack of local market development and governmental capacity can prove serious obstacles to the introduction, sustainability and up-scaling of such schemes due to the fact that the use of various RES technologies deployed at the local level depends on the local willingness and capacity to use, maintain and repair the equipment. Scaling-up the deployment of RES technology in a given area will require not only the necessary technical and business skills but also certain market conditions and supply chains. These issues will be dealt with in the following two sections.

4.2 Capacity constraints

The need for developing countries to have access to environmentally sound technologies to promote sustainable and low-carbon development has long been recognised on the international level. Under the United Nations Framework Convention on Climate Change (UNFCCC), developed and developing countries agreed that “all practicable steps [shall be taken] to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies and know-how to [...] particularly developing country Parties” (Article 4.5 of the UNFCCC). The successful transfer of modern renewable technologies to developing countries is a multi-faceted challenge: Even where the initial capital can be accessed to pay for a technology or make investment commercial viable, the transfer of RES technologies to developing countries is impeded by a set of economic, institutional, informational, and social barriers. These include *inter alia*:

Lack of market demand and fragile local economies: In developing countries, especially in rural areas, financial resources may be too limited to make the initial investment or to pay for services; the fragility of local economies may also lead to the sale or theft of RES installations or to the stripping for precious metals. Several mechanisms that involve individual household ownership or community bill-payment can work to discourage this practice.

Lack of skills and a supporting market: Communities in many developing countries generally do not have the appropriate skills and training to successfully adapt, install, and maintain technologies. Several decentralised RES projects have failed to deliver energy after a few years when equipment fell into disrepair and spare parts could not be obtained. RES projects in this context require an explicit connection between the technologies and training programs (Kumar et al., 2011). For example, the success of the Grameen Shakti solar home systems initiative in Bangladesh (see section 3.2.3) is largely due to the hands on, long-term support it provides to customers and the training of local engineers and technicians.

Most target regions will also lack a supporting service industry to provide for maintenance, spare parts, insurance and recycling services etc. These may need to be initiated by project implementers. For example, the disposal of used batteries for solar kits from the Yeelen Kura project in Mali (see section 3.2.2) became an environmental hazard so EdF created a company to recycle them.

Low public capacity to create an enabling environment: The public sector's low capacity to develop and enforce laws, policies and regulations to promote energy access, the ability to monitor progress and enforce laws, as well as the competence to measure progress has proved an obstacle to both introduction and scale-up of RES technologies. Technologies tend to flow towards countries where environmental policies incentivise their use (Kumar et al., 2011). The innovation rate and likelihood of transfer is likely to increase with more stringent and widespread environmental policies and incentives for adoption of low-carbon technologies. Many of the countries and communities will require help to develop enabling environments for the adoption of extant technologies and the institutions to support energy access campaigns (Marcellino & Gerstetter, 2010).

Insufficient transparency and accountability: Technology suppliers and/or installers are often imposed with a grant or loan which can result in a lack of accountability if there are problems with the equipment or service and may not result in the best value for money for the customers. In addition, technology suppliers often do not have sufficient knowledge and fail to provide support to correctly install, maintain and repair the applications.¹⁰

Low acceptance of the local communities: Local communities may not accept new energy applications due to a preference for traditional techniques. They may also not feel responsible for maintaining and repairing new devices, especially if they have not been involved in the decision-making process from the outset. In some cases, a technology may lack cultural acceptance. The use of human waste in biogas production, for example, was widely rejected by potential users in a study conducted in Burkina Faso (Aschaber, 2011).

These barriers should be thoroughly addressed when setting up renewable energy projects as they can impede the successful implementation and long-term use of the installations. The sustainable introduction of RES technologies in developing countries requires a range of supporting tools and processes. In poor rural settings without access to modern energy, the success of a project will rely to an even greater extent on the efforts of host government, donor and implementer to raise public awareness, conduct on-going training, build local and possibly national governance and regulatory capacity and help develop local markets.

Furthermore, the likelihood of technology transfer increases with more stringent and widespread environmental policies and incentives for adoption of low-carbon technologies. Developed countries can provide assistance with the national design and roll-out of these policies. Governments of emerging economies increasingly recognise that their own efforts can help to increase the number of renewable energy projects while benefitting from international financial sources. Most importantly, technology transfer should not be seen as a one-off event, but rather understood as part of a longer-term sustainable development relationship.

4.3 Special Focus: The Impact of Renewable Energies on Water Resources

Some of RES technologies rely on local water resources and in turn can affect water availability and quality. Water is crucial for ensuring communities' physical and economic resilience in developing countries. A lack of access to clean and sufficient water and

¹⁰ This may also link to the discussion about intellectual property rights (IPRs). IPR regimes are often cited as an impediment to technology transfer, as the majority of technology patents is registered by a handful of advanced economies. IPRs have received an inordinate amount of attention in the negotiations around technology transfer; however, research indicates that the attention IPRs have received does not match their impact on the issue of technology transfer (Marcellino & Gerstetter, 2010). This is especially true for "low tech" renewable applications such as basic biogas installations or solar cookers.

sanitation puts poor communities at risk for diseases including malaria, filariasis, schistosomiasis, and intestinal worms. Water is also crucial for poverty reduction in agrarian communities. In rural sub-Saharan Africa, between 80% and 90% of families are farmers whose livelihoods depend on access to water (UN-Water, 2007). Biofuels derived from energy crops, hydropower and concentrated solar power (CSP) provide the greatest potential conflicts between renewable energy and water resources.

4.3.1 Biofuels

Growing certain crops for the production of biofuels can have negative effects on water resources, first by increasing demand for water and depleting already scarce water resources, and secondly, by polluting groundwater and aquatic ecosystems through the increased use of pesticides and fertilisers. On average, a single litre of biofuel requires 820 litres of irrigation water. But in India, where biofuels are largely produced from irrigated sugarcane, nearly 3500 litres of irrigated water are withdrawn to produce one litre of bio-ethanol. Increased production of sugarcane-based fuels will thus further exacerbate regional and seasonal water shortages (de Fraiture et al., 2008). However, not all biofuel crops require increased water use. The *jatropha curcas* tree, a crop used to produce bio-diesel, consumes less water than natural vegetation in South Africa (Water Research Commission, 2008). *Jatropha* cultivation has been successful in villages in Mali, where the trees are grown as barriers between fields, *jatropha* oil runs machinery, and the 'press cake' left over from oil production serves as a high grade organic fertiliser (Mali Folke Center, 2007). However, others (Luoma, 2009) report that planting *jatropha* on agricultural irrigated lands in India has actually increased water use and puts the trees in competition with food crops.

Growing biofuel crops can also lead to increased water pollution. Pesticides and fertiliser use results in organically contaminated wastewater that, if released untreated, could increase eutrophication of surface water bodies (FAO, 2008). While rapeseed, corn, and millet are 'high risk' biomass crops, perennial plants raised with sustainable cultivation methods require fewer fertilisers and pesticides (Sachverständigenrat für Umweltfragen, 2007). Biofuel production may also impact water ecosystems more broadly. Africa's wetlands hold half of the world's freshwater. The conversion of wetlands and forests into palm oil plantations or sugarcane fields would decrease the quantity and quality of the water that reaches these rich ecosystems (Sielhorst et al., 2008).

4.3.2 Large-scale hydropower

Hydropower consumes very little water (only a limited amount is lost due to evaporation) but can alter water quality, change river ecosystems, cause sedimentation and erosion of river deltas and bring about conflicts over water usage (Nüsser, 2003; Kumar et al., 2011). The problems associated with hydropower mainly pertain to large dams and not to small and micro hydropower projects (for information on small hydro power, see Gaul et al., 2010). The impact on water quality mainly derives from filtering solid wastes from rivers and increasing water oxygen levels, yet dams may also redirect a river and alter timing of its flow, increasing the temperature of the water downstream, which impacts ecosystems such as fish populations. Furthermore, unlike swiftly flowing rivers, the reservoirs created by flooding in order to maintain spare capacity can breed waterborne diseases including malaria, river blindness, dengue or yellow fever. Water stored in reservoirs may also contain a harmful level of mercury (Kumar et al., 2011).

In arid and semi-arid areas, sediments get caught in hydropower plants, leading to land erosion in river deltas and to saltwater inundation of groundwater in river delta regions. The High Aswan Dam in Egypt has led to a lowering of the Nile bed by two to three meters and

interfered with irrigation (Helland-Hansen et al., 2005). In Tanzania, hydropower generation in the Rufiji & Pangani basins is situated downstream from agricultural lands. During dry months, electricity generation is prioritised over agricultural uses, reducing the water available for agriculture and affecting local farmers (Mdemu & Magayane, 2005).

Resettlement of inhabitants of the flood zone has rarely been successful and the effects can last for decades. For example, the Tonga people who were displaced by the building of the Kariba Dam in the 1950s between what is now Zambia and Zimbabwe still campaign to be compensated for the loss of their lands, livelihood and culture. In India, some dam projects have been delayed for decades due to civil society protests (e.g. the Narmada Valley Development Project in India). In some cases, it may be possible to avoid such problems with the proper social and environmental strategies. Run-of-river designs can avoid some of the above-mentioned impacts as they do not require substantial flooding of the upper part of the river – the 1450MW Ghazi-Barotha project in Pakistan, which has been running for 8 years, is one example.

4.3.3 Concentrated solar power

Concentrated Solar Power (CSP) systems use mirrors or lenses to concentrate solar energy and generate electricity through a steam cycle. CSP projects require two to four times the water used in natural gas plants for cooling during the steam cycle, and also require water to clean the mirrors. Because water is often scarce where sunlight is most plentiful, water is a limiting factor in CSP systems (US DOE, 2008). So far there are only few CSP plants in operation and none in a developing country. Thus, hardly any experience of possible water conflicts has been reported.

To conclude, any RES project should be evaluated against local circumstances including sustainability criteria such as social and environmental effects. In India and sub-Saharan Africa, water resources are crucial to the economic development and health outcomes of poor communities and should thus be treated with special care. RES projects such as large-scale biofuels or hydropower projects may have a significant impact on water resources. Thus, local water scarcity and quality, as well as the livelihood of the populations need to be taken into account when planning especially large-scale projects. In particular, the participation of and added-value to rural communities must play a larger role than it does in the current decision-making framework.

5. Financing mechanisms, the EU role and prospects for coordination

Financing an average of \$36-48 billion required annually to reach universal access to basic energy services by 2030 is a major challenge. The public sector will need to cover the costs of creating the necessary investment climate, most importantly by establishing the necessary legal and regulatory framework. Moreover, it should encourage energy service providers to set cost-recovery tariffs and collection mechanisms that will allow all users to pay for energy services, including the poorest (World Bank/UNDP, 2005). It should also provide loans, leasing finance, grants, and subsidies to help households afford both the high upfront investment cost and operating costs (IEA, 2010a).

In addition, effective partnerships between the public sector (to establish appropriate institutions and regulations), the private sector (to develop, deploy and administer energy service utilities), and communities and local governments (which are in charge of managing public services for consumption of energy) will be necessary to expand access to sustainable energy services.

Microfinance has proved particularly useful – especially to poor women – for building energy businesses or purchasing energy services by providing small loans needed to run a small business. In many cases, however, the scale of microfinance is insufficient to make large inroads into energy poverty (IEA, 2010a).

Furthermore, international support will be essential to help developing countries with the challenge of scaling up energy access. Developed countries, through bilateral donors and multilateral agencies, will be important sources of finance (Weischer et al., 2011). Their support, for example, should consist in subsidised capital and risk mitigation to face investments needs and high upfront costs, as well as grant-based international financing to cover additional costs. However, the multiplicity of donors and lack of coordination require a further push to improve coherence in development aid in line with the Paris Declaration on Aid Effectiveness (2005) and the Accra Agenda for Action (2008). Finally and most importantly, the implementation of all international financing programs will improve only if they are grounded in national policies (Yumkella & Strivastava, 2011). Indeed, the role of the public sector is instrumental in enabling the right environment, creating effective regulatory frameworks, and developing energy implementation strategies.

5.1 Domestic finance

Some developing countries are lowering the barriers for grid-connected RES by introducing feed-in tariffs (FITs).¹¹ FITs ensure grid access, fixed tariffs per unit of energy and purchase agreements from the national utilities. However, the implementation of a FIT system raises one core challenge in developing countries: The incremental costs of the price premium paid to renewable electricity producers are generally divided between all electricity consumers. This puts an extra burden on consumers, which leads to social and related political difficulties in poor countries where consumers might not be in a position to cover the extra cost. Governments are addressing this problem in different ways. For example, Tanzania limits costs by determining the level of the FIT on a case-by-case basis instead of setting a general feed-in tariff; the Kenyan government has established a capacity limit for each type of renewable energy to limit the costs; in South Africa the Integrated Electricity Resource Plan determines the volume of each technology that the national energy regulator may license (IEA, 2010b; Mendonça, Jacobs & Sovacool, 2010; Global Feed in Tariffs, 2010).

Even in developing countries which already adopted policies supporting the deployment of RES, the resources to encourage private sector investment and kick-start RES capacity expansion are often lacking. Governments of developing countries already come up with a range of innovative ideas such as the Ecuadorian Government proposing the Yasuní ITT-Initiative¹² or the South African Government's South African Renewables Initiative (SARi). SARi seeks to spur renewable electricity growth at a scale that would unlock opportunities for local industrial development, regional development, export competitiveness and medium-term energy security. Domestic sources of finance include anticipated increases in the electricity tariff (which is currently heavily subsidised), as well as new policy measures, namely a "green energy purchase" contribution by energy intensive users and a non-renewable electricity levy. These are complemented by various sources of international

¹¹ Some of the emerging economies have opted for feed-in tariffs, including China and India. In Africa, five countries have adopted feed-in tariffs to date: South Africa, Algeria, Kenya, Tanzania and Uganda. Most of the feed-in tariff schemes have been introduced only recently, and almost no information on their implementation is yet available.

¹² The Ecuadorian Government offers to prevent oil drilling in the Yasuní national park if international donations are made available. Donations are likely to be spent mainly on renewable energy projects.

finance including concessional loans and donor grants. However, the concept is still under development and no final (financial) commitments have been made by either the South African government or international donor countries (Bausch et al., 2010).

Small-scale projects in the developing countries, especially for cooking, lighting and heating in rural areas, are financed by the campaigns or support programs of NGOs, often with international donor grants. These projects usually prioritise access to the poorest communities and tend to take into account the development needs of energy users. Examples are numerous: The Solar Cookers International (SCI) distributed or inspired more than 500,000 solar cookers focusing on developing countries that have abundant insulation and diminishing forest sources such as Kenya, Haiti, Zimbabwe, and Tanzania (Aid for Africa, 2011). Another example is the “Lighting a Billion Lives” project (see section 3.2.1) where the Energy and Resources Institute (TERI) is allocating solar lanterns to improve access to clean lighting and improve human health.

Another growing source of finance comes from energy customers themselves. Willingness-to-pay amongst even the lowest income communities is now widely acknowledged (OCI et al., 2011) if the right payment schemes can be applied. Fee-for-service and local ownership via micro finance are two models being applied by both private sector and non-profit enterprises (see case studies on Yeelen Kura and Grameen Shakti in section 3.2). Both models still require some subsidies but the element of local buy-in and engagement can help increase the sustainability of RES schemes and the potential for scale-up as well as actively discourage theft or resale of equipment. The Grameen Shakti model sets repayments for solar home systems based on the price a household would be paying kerosene on a monthly basis. After the payback period the monthly energy costs are much lower or even zero.

5.2 International level

At the international level, the volume of aid commitments to energy reached \$7 billion in 2007-2008 (OECD, 2010). After a steady decline since the mid-1980s, bilateral aid to energy increased by 16% annually between 2003 and 2008. However, actual disbursements differ substantially from commitments and only accounted for about two thirds of the aid to energy commitments made for 2007-2008. Major bilateral donors in terms of disbursements include Japan, the USA, Germany, Norway and France. Additional key multilateral donors include the World Bank’s International Development Association (IDA), the European Commission and the African Development Fund (AfDF). Between 2003 and 2008, aid flows primarily benefited Asia (61%) while Africa only benefited from just over a quarter of total funding (26%). Another finding of OECD (2010) is that the composition of aid has shifted from non-renewable and nuclear to renewable sources of energy.

The energy needs in developing countries are urgent and often complex. Ensuring that those needs are covered in a more equitable way and through a low carbon path calls for global solutions and concerted action amongst donors. This section considers new major funds that could contribute to this agenda and some of the challenges in maximising their effectiveness.

5.2.1 *New global climate investment funds*

Until recently energy investments for development have been dominated either by direct development aid from developed countries, loans from development banks or the Clean Development Mechanism (CDM) (often supported by development banks). The Global Environment Facility (GEF) also plays a role in financing energy projects aimed at mitigating climate change.

A new instrument with a focus on climate-related investments, and thus to a large extent for energy, is the Climate Investment Funds (CIF) administered by the multilateral development banks (MDBs).¹³ These are intended to manage the international financial commitments to climate change agreed at the COP-15 of the UNFCCC in the Copenhagen Accord of 2009. The CIF Funds are to be disbursed as grants, highly concessional loans or risk mitigation instruments.

The CIFs are composed of two trust funds, the Clean Technology Fund (CTF) and the Strategic Climate Fund (SCF). The mandate of the CTF is to promote scaled-up financing for demonstration, deployment and transfer of low-carbon technologies with significant potential for long-term greenhouse gas emissions savings. By May 2011, the Trust Fund Committee of the CTF had approved funding for 21 projects totalling almost \$1.5 billion. These projects are expected to leverage an additional \$10 billion in co-financing from the governments, MDBs, private sector, and other sources (CTF Trust Fund Committee, 2011).

The SCF, on the other hand serves as an overarching framework to support three targeted programs for forests, for climate resilience and one for 'Scaling-Up Renewable Energy in Low Income Countries (SREP)', which is aimed at promoting low carbon development pathways in the energy sector through renewable energy solutions. The SREP is focused particularly on renewables and energy access but is still in its initial phase.

5.3 EU Financing instruments for energy in developing countries

The EU has funded energy projects in developing countries through the European Development Fund (EDF) and partially through the neighbourhood policy, in particular in North African States. However, European Commission managed funds only represent approximately 20% of total development aid by the EU.

The biggest support to energy projects has been offered by the European Development Fund (EDF). The 9th EDF (2002-2007) offered €448 million mainly as interest rate subsidies and Technical Assistance through the European Investment Bank in ACP countries.¹⁴ For the 10th EDF (2007-2013) there should be a similar amount invested in energy, but no precise figures exist. The Energy Facility I programme (2005-2008) financed €220 million through EuropeAid on energy access and has been followed by Energy Facility II (2009-2013) with €200 million. The ENRTP¹⁵ programme financed between 2007-2010 €120 million on energy. The Global Energy Efficiency and Renewable Energy Fund (GEEREF) committed some €45 million in energy related investments (see also Behrens, 2009), but is not really taking off. Smaller programmes by EuropeAid have an energy component in particular for technical assistance. In addition, the recently established Infrastructure Trust Fund (ITF) for Africa which coordinates and blends EU budget and loans from EU development Banks is mobilising large sums for regional energy projects. The Fund itself dedicated around 40% of its €108 million fund to energy projects between 2008-2009 and is expected to again use around 40% of its €300 million fund on energy for 2009-2013. This fund is primarily used as a risk guarantee or interest rate subsidy, thus leveraging large funding from the EDF and other sources. Between 2009 and 2011 the ITF approved 19 projects with a grant value of €175 million, leveraging close to €1.3 billion in loans from EBFI and IFIs for a total project cost value of €2.2 billion (Núñez Ferrer & Behrens, 2011) (see also section 5.4).

¹³ African Development Bank, Asian Development Bank, European Bank for Reconstruction and Development, Inter-American Development Bank, and World Bank Group.

¹⁴ Countries from Africa, the Caribbean and the Pacific.

¹⁵ Environment and sustainable management of natural resources, including energy.

EU development aid finances energy programmes in developing countries through a number of instruments. However, for Africa the EU has recognised the need for a more concrete and well-structured policy on energy. As a result, in 2008, the EU launched the Africa-EU Energy Partnership (AEEP) one of 8 partnerships of the Africa-EU Joint Strategy for development. The aim of the strategy is to improve access to sustainable energy sources in Africa, focusing also on the need to achieve the MDGs. The Africa-EU Energy Partnership (AEEP) and its sub-programme for renewable energy seems primarily to focus on large projects and interconnectors with less emphasis to local energy solutions. There also seems to be a bias towards traditional large centralised power sources. The document has a very strong top down policy approach and does not seem to incorporate the increasingly promising potential of local solutions, which also bring higher local benefits and a sense of ownership. The emphasis on leveraging large amounts of private finance may create an excessive focus on the most profitable projects rather than on smaller yet financially sustainable projects which require lower margins.

Unfortunately, it is difficult to estimate the total EU assistance to developing countries in the area of energy, as approximately 20% EU development aid is managed by the European Commission through the EU budget and the EDF. The Road Map of the Africa-EU Energy Partnership does not record member state assistance.

5.4 Increasing cooperation of EU development assistance

The EU is the largest aid donor with a commitment to assist in the development of sustainable energy solutions in developing countries. This calls for internal and external coordination.

Within the EU, development assistance comes from a number of important players, which need to offer a coordinated response. These include the development aid budgets of the member states, the development funds of the European Union, the European Investment Bank (EIB) and a number of European bilateral development financial institutions (the largest ones being the KfW Bankengruppe of Germany and the Agence Française de Développement (ADF)).¹⁶ In addition there are other European international financial institutions, chiefly the European Bank for Reconstruction and Development (EBRD) which, although mainly engaged in the territories of the former Soviet Union, finances projects in developing countries through the Clean Development Mechanism (CDM). Other smaller development banks and institutions may also play a part, but will not be discussed here.

The EU could further coordinate the action of the different institutions involved to ensure coherence of objectives and optimum impact of aid and investments. A leap forward has been already achieved through the development of new region-specific EU loan and grant blending instruments to pool development assistance from the EU member states and to link the EU budget to the joint lending facilities of European bilateral development banks (see Núñez Ferrer & Behrens, 2011). These include the Infrastructure Trust Fund (ITF) for Africa, which has been involved in large regional energy projects, and two new instruments being developed for Asia: the Asia Investment Facility (AIF) and the Investment Facility for Central Asia (IFCA).¹⁷ Joint projects and the participation of MDBs in these facilities are

¹⁶ To give an idea of the role of the EIB, ADF and KfW have committed approximately €6650 million during 2009 to climate finance, mostly mitigation actions related to energy (UNDP, 2010).

¹⁷ Similar funds include the Neighbourhood Investment Facility (NIF) for countries under the EU Neighbourhood Policy and the Western Balkans Investment Framework (WBIF). In 2010, the Latin America Investment Facility (LAIF) was initiated. See Núñez Ferrer & Behrens (2011) for more information.

increasing,¹⁸ allowing for better coordination and greater leverage of funds. This is clearly in line with the Paris Declaration on Aid Effectiveness (2005) and the Accra Agenda for Action (2008) as well as the European Code of Conduct on Division of Labour in Development Policy (2007).

The design of EU-wide investment mechanisms also encourages participation of the private sector in developing country energy sector projects. Due to high upfront capital costs and increased investment risks in developing countries (which may include political and economic risks, lack of domestic financial institutions, infrastructure and regulatory and technical capacity), joint public-private partnerships tailored to local needs are preferable to pure grants and loans from development banks. The European blending instruments allow and encourage the participation of local financial institutions in the projects as partners, and have a central role in offering technical assistance.

5.5 Improving EU assistance in the area of access to energy in developing countries

The European Union can play an important role in assisting developing countries to provide energy access to their citizens. It is a large donor and advanced in the development of energy solutions. As a key member and donor of international initiatives such as IRENA and GEF the EU can play an important role. With the Africa-EU Energy Partnership the EU has a strong influence in Africa and is directly involved with partner countries to develop their energy strategies. This influence can help coordinating and streamlining the development of energy systems in Africa not only from European donors but also other donors and MDBs.

Additionally, as an important donor, the EU has a privileged position in shaping with the partner country a development path for the future. Questions thus need to be raised about the most appropriate kind of energy networks for partner countries. One key question is whether to focus on energy solutions for local communities or on larger more centralised energy sources. The choices can have strong repercussions on the development path of partner countries. Large energy installations may be favoured by donors and recipient governments for reasons of visibility, and by investors and financiers for the financial dividends, which are easier to monitor and appropriate. Large infrastructures may, however, not suit the economic and social structure of the country and fail to provide energy access to the poor, for whom smaller local energy sources may be more appropriate. The choice of different development paths and their environmental and social impacts needs to be analysed more closely. These questions have not been treated well enough to date.

6. Conclusions and policy recommendations

There is an urgent need to combat energy poverty by increasing access to energy, especially in rural areas, where about 85% of those without energy live. Improved access to energy is now widely acknowledged as essential for the achievement of the Millennium Development Goals, to which the EU has subscribed, and there is impetus at the UN level to catalyse efforts towards the goal of universal energy access by 2030. But challenges remain. Estimates show that some \$36-48 billion in investment is needed annually to meet this goal. With competing demands for development funding and straitened economic circumstances in many donor countries, it is not clear if this will be forthcoming. In light of these challenges and the EU's growing role in this area, this CEPS Working Document has surveyed the current status of energy poverty in the worst affected regions, reviewed the current

¹⁸ However, it should be noted that while collaboration is encouraged, the participation of the MDBs within the facilities as equal partners is a subject of controversy.

approaches in donor-funded energy projects and made specific observations relating to the promotion of environmentally-sustainable energy solutions.

In the short-term, the cheapest ways to increase power capacity or provide basic off-grid energy needs are often environmentally unsustainable with damaging impacts for the poorest groups. Concerns about developing countries building infrastructure today that will lock them into long-term dependence on volatile markets for fossil fuels and escalating GHG emissions are well documented. Moreover, this study makes clear that additions of large-scale grid connected electricity, for various economic and governance-related reasons, are unlikely to benefit the poorest communities who reside in slums or sparsely-populated rural areas. The latter still largely rely on the traditional use of biomass, coal and kerosene – with negative effects on their health and environment.

The need to improve health in the poorest social groups, and the longer-term human security requirement of setting a country onto a sustainable, low emissions path and ensuring biodiversity demand a more visionary approach. The market and current government policies in many countries suffering from energy poverty do not incentivise these longer-term goals. Therefore, there is a need not only for donor finance but also wide-ranging efforts to ensure that investments are sustainable, socially, environmentally and, in time, economically.

This presents a daunting challenge for both developing countries and donors because the demands to respond to immediate crises, e.g. in the power sector of industrialising economies are often pitted against the on-going hardships faced by those without access to modern energy services and with little consumer power. However, as this study showed, there are numerous advantages to be capitalised on – the abundant renewable energy resources available in developing countries; the economic opportunities to introduce off-grid solutions which avoid the high transmission and distribution costs of extending the grid and can better suit local needs; and the potential for energy access projects to bring a host of developmental co-benefits.

Progress in Thailand and China, for instance, shows what is possible given political will. In terms of donor-funded projects, there is now a growing literature on the lessons learned from pilots over the last two decades, which offer innovative ideas for bringing energy to poor rural and peri-urban communities. While fossil fuels will inevitably play a major role in expanding energy supply in developing countries generally, the examples given in this study show that renewable energy sources have huge potential to fulfil the needs of those without access, or with poor access, to modern energy services. The successful examples demonstrate the capacity for scale-up of decentralised, renewable energy solutions, which could avoid the expensive legacy of carbon-intensive development undergone in OECD countries.

The following points summarise the findings of this study, also drawing on relevant proposals made by other institutions, especially the African Development Bank (2011), the IIASA (2011), and the IEA (2010a; 2011). These are followed by a number of policy recommendations for donor governments in general and the EU in particular. These are put forward within the context of the principles of ownership and alignment,¹⁹ acknowledging the support that donor countries and organisations can offer developing countries in their efforts to increase access to modern and clean energy.

¹⁹ The principle of ownership is enshrined in the Paris Declaration on Aid Effectiveness (2005) and the Accra Agenda for Action (2008) and calls on developing countries to set their own strategies for poverty reduction, improve their institutions and tackle corruption. The principle of alignment requires donor countries to align behind these strategies and use local systems.

6.1 Summary of conclusions

- Donor countries have an important role to play in scaling up successful initiatives to expand access to modern energy services in a way that will help to alleviate negative health, environmental and economic impacts.
- Investments need to be scaled up considerably to achieve the UN target of universal access to energy by 2030. Estimates show that some \$36-48 billion will be required per year to meet this goal. About two thirds of the required investments will need to be borne by the public sector (multilateral and bilateral development sources and governments in developing countries in almost equal parts) and the rest by the private sector.
- Access to energy initiatives have the greatest chance of success where there is political will from the leadership to achieve energy access goals and well-defined national energy access targets built into development strategies, policies and programmes (including cost assessments). Conversely, lack of long-term political commitment and the necessary legal and regulatory framework to incentivise implementation is a barrier to mobilising investment and enabling the private sector. In addition to providing financial resources, bilateral and multilateral donors with the relevant experience may increase the success of investments by working with developing country governments to develop targets, policies and strategies and build the necessary capacity.
- There is no one-size fits all model for extending access to energy. Each country/region has specific energy resource endowments, infrastructure and needs. The most successful projects to increase access to energy have been those that take into account not only the national context but also the socioeconomic, cultural and capacity specificities of target communities. Flexibility and monitoring and evaluation in project design are key. Many initiatives have benefitted from adapting and evolving in response to experience.
- The involvement of local communities in the planning and implementation of the energy service strategies is likely to increase sustainability and can bring multiple co-development benefits from stimulating income-generating activities to empowering women. Human capacity enhancement through education, training and research can provide for a better involvement of local communities and needs to focus on all stakeholders, including planners, technicians, community workers and businesspeople.
- Decentralised, small-scale and off-grid solutions are often more appropriate than centralised large scale power projects in meeting the specific needs of poor rural communities. In terms of access to electricity, off-grid solutions can be more economical than grid extension in many parts of rural sub-Saharan Africa and South Asia due to the low population density, relatively low energy demand and lack of existing infrastructure.
- Market conditions have usually deterred the private sector from financing the start-up and service costs for small-scale projects in poor regions so they are dependent on donor aid and/or state subsidy. However, the willingness to pay amongst even very low-income groups is now widely acknowledged and their financial contribution can help to increase the sustainability of a project. Specially-designed mechanisms such as micro-finance, affordable tariffs, community billing and a shares in a service company can also help improve the commercial viability of a project, helping to attract private sector participation.
- The EU can make a significant contribution to the goal of universal energy access, as a strategic trading partner for sub-Saharan Africa, as a major development donor with influence at the international level and with its wealth of member state experience in innovative energy solutions. Its role in the coming years will involve both helping to harness the necessary finance internationally and ensuring the effectiveness of its own aid and investment transfers.

- Climate-related funds could increase access to energy in some cases. However, the Clean Development Mechanism (CDM) is not necessarily the best fit for increasing access to energy. There remains low capacity to access such funds in sub-Saharan Africa. The Climate Investment Funds (CIFs) (and in particular the SREP: Scaling-Up Renewable Energy in Low Income Countries) and support from the European Development Fund (EDF) and other EU and member state development assistance offer more promising mechanisms.

6.2 Recommendations

- The EU's development assistance to enhance energy access in rural areas should focus on harnessing renewable energy sources rather than on fossil fuel alternatives, although there are cases where the deployment of these, e.g. in the case of diesel generators and LPG, is preferable to the traditional use of biomass. Support for small-scale energy solutions tailored to individual community needs and capacities should be prioritised. Large-scale, on-grid power generation capacity can improve supplies to on-grid consumers, but should not be conflated with access to energy objectives.
- Renewable energy investments will require a range of capacity building activities and innovative financing mechanisms, which should be supported by the EU. Several on-going initiatives by the EU or EU member states promote local SME operation to scale-up delivery of energy services to the poor and increase developmental benefits. The EU could, in its capacity in the high level UN group, encourage the learning curve by facilitating opportunities for sharing experience and best practice with other donors and partners.
- The EU should develop clear guidelines on environmental sustainability criteria for renewable energy project financing. These would address the impacts on the local communities, the environment and other resources, particularly water quality and availability and advise on the circumstances in which certain technologies and practices should be avoided. These guidelines would help EU, EU member states and partner organisations better navigate this area. The consultations surrounding the World Bank's review of its energy strategy should be useful in this regard.
- The EU and its member states should advocate a stronger focus on sustainable universal access to energy in relevant international negotiations. The Rio+20 summit in June 2012 is an opportunity to propose concrete targets on how to abolish energy poverty and a roadmap on how to achieve them as an integral strategy for greening the economy.
- The EU should further coordinate the action of the different institutions and countries involved in development assistance. A leap forward has been the establishment of region-specific EU loan and grant blending instruments to pool development assistance from the EU member states and to link the EU budget to the joint lending facilities of the European bilateral development banks. These initiatives should be expanded and reinforced.
- New efforts aimed at increasing energy access for the poor should be guided by the experience of programmes or projects that have developed contextually appropriate models of production, financing, and distribution and that can be self-sustaining. The lessons learnt need to be carefully assessed against the local conditions they originate from and best cases adapted where possible. The EC could provide an online resource to collect and organise member country and global experience to assist with this learning curve.

Bibliography

- African Development Bank (2011), *Energy Strategy*, Abidjan.
- AGECC (United Nations Advisory Group on Energy and Climate Change) (2010), “Energy for a Sustainable Future: The Secretary-General’s Advisory Group on Energy and Climate Change (AGECC) Summary Report and Recommendations” (<http://www.un.org/wcm/webdav/site/climatechange/shared/Documents/AGECC%20summary%20report%5B1%5D.pdf>).
- Aid for Africa (2011), “Member Charities: Solar Cookers International” (<http://www.aidforafrica.org/member-charities/solar-cookers-international/>).
- Aschaber, A. (2011), “Factors for the Implementation of Biogas Plants in Burkina Faso”, in M. Schäfer, N. Kebir and D Phillip (eds) (2011), *Micro Perspectives for Decentralized Energy Supply*, pp. 47-55.
- Bast, E. and S. Krishnaswamy (2011), *Access to Energy for the Poor: The Clean Energy Option*, United States Agency for International Development (USAID).
- Bausch, C., K. Wentrup, D. Marcellino, E. Dreblow, L. Gardner, P. du Plooy, M. Jooste, A. Gilder and M. Parramon (2010), *Financing Needs and Preconditions for the South African Renewables Initiative (SARi)*, December.
- Bazilian, M., P. Nussbaumer, H.-H. Rogner et al. (2010), *Energy Access Scenarios to 2030 for the Power Sector in sub-Saharan Africa*, United Nations Industrial Development Organization (UNIDO), Vienna, Austria.
- Behrens, A. (2009), “The Financing of the Global Energy Efficiency and Renewable Energy Fund”, CEPS Policy Brief No. 190, Centre for European Policy Studies (CEPS), Brussels, June.
- Bhuiyan, M.A.U. (2010), “Grameen Shakti (Energy): A Successful Renewable Energy Program in Bangladesh”, presentation by the Assistant General Manager, Grameen Shakti at the Bangladesh International Conference on Conservation, Energy Efficiency & Solar, organised by Pakistan Engineering Council and USAID, Islamabad, Pakistan, 25-29 October (<http://www.womeninenergy.org.pk/iccee/downloads/Presentations/28%20oct/Session-I/Grameen%20Shakti-A%20Successful%20RET%20Program%20in%20Bangladesh2.pdf>).
- CIEL (The Centre for International Environmental Law) (2011), *Fossilized Thinking: ESKOM, The World Bank and the Real Cost of Coal*, March (http://www.ciel.org/Publications/FossilThinking_Eskom_21Mar11.pdf).
- Co2 Scorecard (2011), *The World Bank’s Coal Headache*, Shakeb Afsah & Kendyl Sancito, 24 May (<http://www.co2scorecard.org/home/researchitem/19>).
- CTF Trust Fund Committee (2011), *Semi-annual report of CTF operations*, CTF/TFC.7/4, 8 June.
- De Fraiture, C., M. Giordano and Y. Liao (2008), “Biofuels and Implications for Agricultural Water Use: Blue Impacts of Green Energy”, *Water Policy* 10, Supplement 1.
- European Commission (2011a), “Increasing the impact of EU Development Policy: an Agenda for Change”, COM(2011) 637 final, Brussels.
- European Commission (2001), “YEELLEN KURA: A decentralised service company for rural electrification in Mali” (http://ec.europa.eu/energy/idae_site/deploy/prj058/prj058_1.html).

- FAO (2008) *The State of Food and Agriculture 2008*, FAO, Rome.
- Foster, V. and C. Briceño-Garmendia (2010), *Africa's Infrastructure: A time for transformation*, Agence Française de Développement and World Bank.
- Gaul, M., F. Kölling and M. Schröder (2010), "Policy and Regulatory Framework Conditions for Small Hydro Power in Sub-Saharan Africa", Discussion Paper, GTZ (<http://www.gtz.de/de/dokumente/gtz2010-en-HERA-EUEI-PDF-framework-conditions-hydropower.pdf>).
- Global Feed in Tariffs (2010), Online Data Base at www.globalfeedintariffs.com.
- GSMA (2011), *Green Power for Mobile Charging Choices 2011: Mobile Phone Charging Solutions in the Developing World*, July (<http://www.gsma.com/documents/green-power-for-mobile-charging-choices-2011/19225/>).
- Helland-Hansen, E., T. Holtedahl and O.A. Lye (2005), *Environmental Effects Update*, NTNU, Department of Hydraulic and Environmental Engineering, Trondheim, Norway.
- Ho, M.-W. (2011), *Lighting Africa*, Institute of Science in Society (ISIS) Report, 6 April (<http://www.i-sis.org.uk/LightingAfrica>).
- IEA (2002), *World Energy Outlook 2002*, IEA/OECD, Paris.
- IEA (2010a), *World Energy Outlook 2010*, IEA/OECD, Paris.
- IEA (2010b), *Global Renewable Energy Database*, OECD/IEA, Paris (<http://www.iea.org/textbase/pm/?mode=re>).
- IEA (2011), *World Energy Outlook 2011*, OECD/IEA, Paris.
- IIASA (2011), *Global Energy Assessment*, Deliverable: Summary Report Access to Modern Energy Forms and Technologies for Developing and Emerging Regions, IIASA, September.
- IMF (2011), *Impact of High Food and Fuel Prices on Developing Countries - Frequently Asked Questions* (<http://www.imf.org/external/np/exr/faq/ffpfaqs.htm>).
- IISD (International Institute for Sustainable Development) (2005), *Operating Sustainably: Fifteen Years of Progress. Sustainable Development Report 2004-2005* (http://www.iisd.org/pdf/2005/sd_report_2005.pdf).
- International Rivers (2008), *Three Gorges Dam: The Cost of Power*, October (http://www.internationalrivers.org/files/3Gorges_factsheet.lorenz.pdf).
- Kumar, A., T. Schei, A. Ahenkorah, R. Caceres Rodriguez, J.-M. Devernay, M. Freitas, D. Hall, A. Killingtveit and Z. Liu (2011), "Hydropower", in O. Edenhofer, R. Pichs-Madruga, Y. Sokona, K. Seyboth, P. Matschoss, S. Kadner, T. Zwickel, P. Eickemeier, G. Hansen, S. Schlomer and C. von Stechow (eds), *IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation*, Cambridge and New York, NY: Cambridge University Press.
- Luoma, J.R. (2009), "Hailed as a Miracle Biofuel, Jatropha Falls Short of Hype", *Yale Environment* 360, 4 May (<http://e360.yale.edu/content/feature.msp?id=2147>).
- Mali Folke Center (2007), "Biofuels in West Africa - Case of Jatropha in Mali", Key Note Presentation, UNIDO/AU/Brazil Conference, Addis Ababa, Ethiopia.
- Marcellino, D. and C. Gerstetter (2010), *Technology Transfer in the International Climate Negotiations - Assessment of Proposals and Discussion of Open Questions*.

- Mazimpaka, E. (2007), *Solar Home Systems Integration in Rural Area: case of SSD-Yeelen Kura in Mali*, Energy Research Centre, University of Cape Town, South Africa (http://active.cput.ac.za/energy/web/duw/papers/2007/025E_Mazimpaka.pdf).
- Mdemu, M.V. and M.D. Magayane (2005), *Conflict of Water Use Between Hydropower and Irrigation in Tanzania: The Conundrum of Sectoral Policy Approaches to Water Resources Development* (<http://www.tzonline.org/pdf/conflictowaterusebetweenhydropowerandirrigationintanzania.pdf>).
- Mendonça, M., D. Jacobs and B. Sovacool (2010), *Powering the green economy, The feed-in tariffs handbook*, London.
- Núñez Ferrer, J. and A. Behrens (2011), *Innovative Approaches towards EU Blending Mechanisms for Development Finance*, CEPS Special Report commissioned by the German Ministry for Economic Cooperation and Development.
- Nüsser, M. (2003), "Political Ecology of Large Dams: a Critical Review", *Petermanns Geographische Mitteilungen*, 147 (1).
- OCED (2010), *Measuring Aid for energy*, Paris.
- OCI et al. (Oil Change International/Actionaid/Vasudha Foundation) (2011), *Access to Energy for the Poor: The Clean Energy Option* by Elizabeth Bast and Srinivas Krishnaswamy, June (<http://priceofoil.org/wp-content/uploads/2011/06/Access-to-Energy-for-the-Poor-June-2011.pdf>).
- Pachauri, S., A. Brew-Hammond, D.F. Barnes, D.H. Bouille, S. Gitonga, V. Modi, G. Prasad, A. Rath and H. Zerriffi (2011), "Energy Access for Development", in *The Global Energy Assessment: Toward a More Sustainable Future*, IIASA, Laxenburg, Austria and Cambridge University Press, Cambridge and New York, NY.
- Practical Action (2012), *Poor people's energy outlook 2012*, Practical Action Publishing Ltd, Warwickshire.
- Rao, S., V. Chirkov, F. Dentener, R. Dingenen, S. Pachauri, P. Purohit, et al. (2011), "Estimating Global Health Impacts from Outdoor and Household Air Pollution: Modeling and Methodology for the Global Energy Assessment", paper submitted to Environmental Health Perspectives.
- Sachverständigenrat für Umweltfragen (2007), *Klimaschutz durch Biomasse*, Sondergutachten, Berlin, Erich Schmidt Verlag.
- Schäfer, M., N. Kebir and D. Phillip (eds) (2011), *Micro Perspectives for Decentralized Energy Supply*, Proceedings of the International Conference, Technische Universität Berlin, 7-8 April.
- SEI (2009), *Energy Access, Climate and Development*, Stockholm Environment Institute (SEI), Johnson, F.X and F. Lambe (<http://www.ccdcommission.org/Filer/commissioners/Energy.pdf>).
- Sielhorst, S., J.W. Molenaar and D. Offermans (2008), *Biofuels in Africa: An Assessment of Risks and Benefits for African Wetlands*, Amsterdam, Wetlands International (<http://www.wetlands.org/LinkClick.aspx?fileticket=vPIIvbwvqTs%3D&tabid=56>).
- UN-Water (2007), *Coping with Water Scarcity: Challenge of the Twenty-First Century*, 2007 World Water Day, 22 March (<http://www.fao.org/nr/water/docs/escarcity.pdf>).
- UNDP (2007a), *Human Development Report 2007/2008, Fighting climate change: Human solidarity in a divided world*, New York.

- UNDP (2007b), *Rural Electrification in Mali: Improving Energy Accessibility to the Rural Poor*, New York.
- UNDP (2010), *Bilateral Finance Institutions and Climate Change, A Mapping of 2009 Climate Financial Flows to Developing Countries*, New York.
- UNDP/UN Millennium Project (2006), *Energy Costing Tool for use in costing MDG-based national energy needs*, New York.
- UNFCCC (1992) *United Nations Framework Convention on Climate Change*, FCCC/INFORMAL/84.
- US Department of Energy (2008), *Concentrating Solar Power Commercial Application Study: Reducing Water Consumption of Concentrating Solar Power Electricity Generation*.
- USAID (2004), *Innovative Approaches to Slum Electrification*, Bureau for Economic Growth, Agriculture & Trade, US Agency for International Development, December (http://pdf.usaid.gov/pdf_docs/PNADB219.pdf).
- Water Research Commission (2008), *Jatropha Curcas: Measuring the Impact of Large-scale Planting on Water Resources*, Technical Brief (<http://www.biodieselsa.co.za/TB-Jatropha-curcas-techn-br-water-usage%20.pdf>).
- Weischer, L. et al. (2011), *Grounding Green Power. Bottom-up perspectives on smart renewable energy policy in developing countries*, The German Marshall Fund of the United States (GMF), World Resource Institute (WRI), Heinrich Böll Stiftung.
- WHO (2006), *Fuel for life: household energy and health* (<http://www.who.int/indoorair/publications/fuelforlife.pdf>).
- WHO/UNDP (2009), *The Energy Access Situation in Developing Countries*, New York.
- World Bank (2010), *Eskom Investment Support Project: Questions and Answers*, 14 April (http://siteresources.worldbank.org/INTSOUTHAFRICA/Resources/Q_A_Eskom_Investment_Support_Project_031810.pdf).
- World Bank (2011), *Rising global interest in farmland - Can It Yield Sustainable and Equitable Benefits?*, International Bank for Reconstruction and Development/The World Bank, Washington, D.C.
- World Bank/UNDP (2005), *Energy Services for the Millennium Development Goals*, Washington, D.C., New York.
- Yang, Lin (2007), "China's Three Gorges Dam under Fire", *Time World*, 12 October (<http://www.time.com/time/world/article/0,8599,1671000,00.html>).
- Yumkella, K. and L. Srivastava (2011), *Energy for all*, United Nations Industrial Development Organisation (UNIDO), The Energy and Resources Institute (TERI), accessed from *The Energy Bulletin*, No. 2(11).



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