ENERGY FOR ALL

Financing access for the poor

H I G H L I G H T S

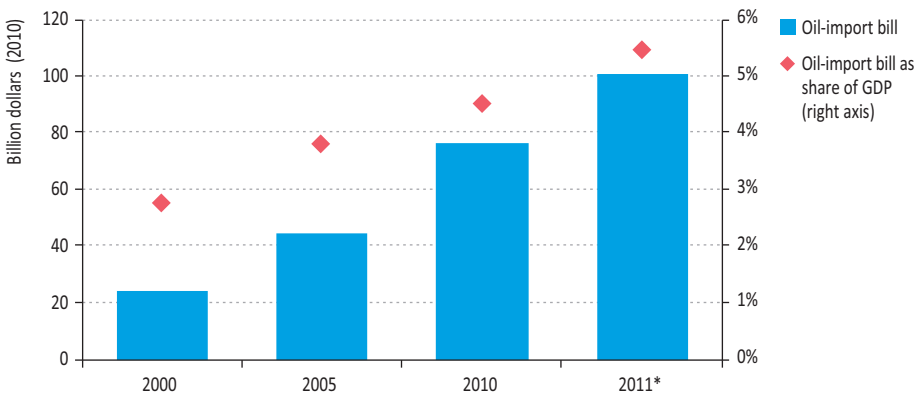
- Modern energy services are crucial to human well-being and to a country's economic development; and yet over 1.3 billion people are without access to electricity and 2.7 billion people are without clean cooking facilities. More than 95% of these people are either in sub-Saharan Africa or developing Asia and 84% are in rural areas.
- In 2009, we estimate that $9.1 billion was invested globally in extending access to modern energy services, supplying 20 million more people with electricity access and 7 million people with advanced biomass cookstoves. In the New Policies Scenario, our central scenario, $296 billion is invested in energy access between 2010 and 2030 – an average of $14 billion per year, 56% higher than the level in 2009. But, this is not nearly enough: it still leaves 1.0 billion people without electricity (more than 60% of this is in sub-Saharan Africa) and, despite progress, population growth means that 2.7 billion people will remain without clean cooking facilities in 2030. To provide universal modern energy access by 2030, cumulative investment of $1 trillion is required – an average of $48 billion per year, more than five-times the level in 2009.
- The $9.1 billion invested in extending energy access in 2009 was sourced from multilateral organisations (34%), domestic government finance (30%), private investors (22%) and bilateral aid (14%). To provide the $48 billion per year required for universal access, we estimate that around $18 billion per year is needed from multilateral and bilateral development sources, $15 billion per year from the governments of developing countries and $15 billion per year from the broad range of actors that form the private sector.
- Private sector investment needs to grow the most, but significant barriers must first be overcome. Public authorities must provide a supportive investment climate, such as by implementing strong governance and regulatory reforms. The public sector, including donors, needs also to use its tools to leverage private sector investment where the commercial case is marginal. At present, energy access funding tends to be directed primarily toward large-scale electricity infrastructure. This does not always reach the poorest households. Access to funding at a local level is essential to support initiatives that cater effectively for local needs, building local financial and technical capacity and stimulating sectoral development.
- Achieving universal access by 2030 would increase global electricity generation by 2.5%. Demand for fossil fuels would grow by 0.8% and CO_2 emissions go up by 0.7%, both figures being trivial in relation to concerns about energy security or climate change. The prize would be a major contribution to social and economic development, and helping to avoid the premature death of 1.5 million people per year.

Introduction

Energy is a critical enabler. Every advanced economy has required secure access to modern sources of energy to underpin its development and growing prosperity. While many developed countries may be focused on domestic energy security or decarbonising their energy mix, many other countries are still seeking to secure enough energy to meet basic human needs. In developing countries, access to affordable and reliable energy services is fundamental to reducing poverty and improving health, increasing productivity, enhancing competitiveness and promoting economic growth. Despite the importance of these matters, billions of people continue to be without basic modern energy services, lacking reliable access to either electricity or clean cooking facilities. This situation is expected to change only a little by 2030 unless more vigorous action is taken.

Developing countries that import oil are today facing prices in excess of $100 a barrel when, at a comparable stage of economic development, many OECD countries faced an average oil price of around $22 a barrel (in 2010 dollars). In little over a decade, the bill of oil-importing less developed countries[1] has quadrupled to hit an estimated $100 billion in 2011, or 5.5% of their gross domestic product (GDP) (Figure 13.1). Oil-import bills in sub-Saharan Africa increased by $2.2 billion in 2010, more than one-third higher than the increase in Official Development Assistance (ODA) over the year.[2] In contrast, oil exporters in sub-Saharan Africa, such as Nigeria and Angola, are benefitting from the oil price boom and tackling energy poverty is, financially at least, within their means. We estimate that the capital cost of providing modern energy services to all deprived households in the ten-largest oil and gas exporting countries of sub-Saharan Africa[3] would be around $30 billion, equivalent to around 0.7% of those governments' cumulative take from oil and gas exports.

Figure 13.1 ● Oil-import bills in net-importing less developed countries



*Estimated, assuming an average oil price of $100 per barrel.

Notes: Calculated as the value of net imports at prevailing average international prices. Oil-import bills as a share of GDP are at market exchange rates in 2010 dollars.

1. The group includes India and the oil-importing countries within the United Nation's classification of least developed countries (available at www.unohrlls.org). This group has a combined population of 1.8 billion people and accounts for 65% of those lacking access to modern energy.

2. Data available from the OECD/DCD-DAC database at www.oecd.org.

3. These countries include: Angola, Cameroon, Chad, Democratic Republic of Congo, Equatorial Guinea, Gabon, Ivory Coast, Mozambique, Nigeria and Sudan.

International concern about the issue of energy access is growing. While the United Nations Millennium Development Goals[4] (MDGs) do not include specific targets in relation to access to electricity or to clean cooking facilities, the United Nations has declared 2012 to be the "International Year of Sustainable Energy for All". Other strategic platforms to discuss the link between energy access, climate change and development include the "Energy for All Conference" in Oslo, Norway in October 2011 and the COP17 in Durban, South Africa in December 2011. These issues are also expected to be addressed at the United Nations Conference on Sustainable Development (UNCSD) in Rio de Janeiro, Brazil in June 2012. That conference will aim to secure renewed political commitment to sustainable development, to assess progress to date and to address new and emerging challenges. It will bring to centre-stage in the international debate the need to reconcile environment, development and poverty eradication issues such as energy access.

The *World Energy Outlook (WEO)* has focused attention on modern energy access for a decade, providing the international community with quantitative, objective analysis. This year our analysis tackles the critical issue of financing the delivery of universal modern energy access.[5, 6] The chapter begins by providing updated estimates of the number of people lacking access to electricity and clean cooking facilities, by country. It offers, to the best of our knowledge, for the first time in energy literature, an estimate of the total amount of investment taking place globally to provide access to modern energy services and provides details on the sources of financing. The chapter then examines what level of modern energy access might be achieved by 2030, in relation to the projections in the New Policies Scenario, our central scenario, and the level of investment involved (the New Policies Scenario takes account of both existing government policies and cautious implementation of declared policy intentions). While the *Outlook* period for *WEO-2011* is 2009 to 2035, analysis in this chapter is based exceptionally on the period 2009 to 2030. This period has been adopted to be consistent with the key goal proposed by the United Nations Secretary-General of ensuring universal energy access by 2030 (AGECC, 2010). Since the level of projected investment in the New Policies Scenario is not nearly enough to achieve universal access to modern energy services by 2030, we then estimate the level of additional investment that would be required to meet this goal – as defined in our Energy for All Case.[7] The chapter then examines the main sources of financing, and the types of financing instruments that appear to be the most in need of scaling-up in order to achieve the Energy for All Case (Figure 13.2). This is derived from a bottom-up analysis of the most likely technology solutions in each region, given resource availability, and government policies and measures. Throughout, we have drawn on experience from existing programmes using different financing and business models to provide modern energy access.

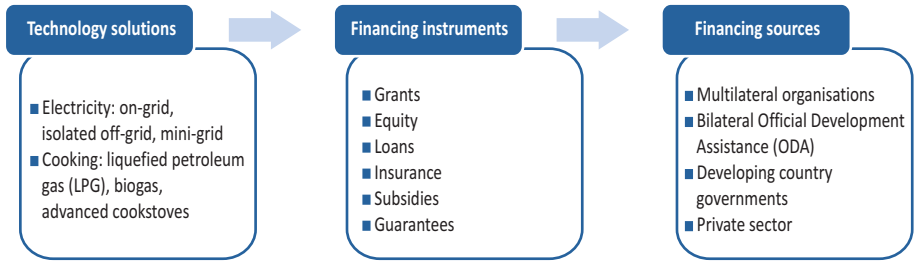
4. See www.un.org/millenniumgoals for more information.

5. This chapter benefitted from a workshop held by the IEA in Paris on 13 May 2011, and was presented for the first time to a meeting of government leaders and international institutions hosted by the government of Norway in Oslo on 10-11 October 2011.

6. Due to the focus of this chapter on financing, some elements of *WEO* analysis on energy access, such as the Energy Development Index (EDI), are not included here but have been updated and will be made available online at www.worldenergyoutlook.org.

7. Referred to in *WEO-2010* as the Universal Modern Energy Access Case. See Box 13.1 for the definition of modern energy access used in this analysis.

Figure 13.2 ● Financing modern energy access



Current status of modern energy access

We estimate that in 2009, 1.3 billion people did not have access to electricity, around 20% of the global population, and that almost 2.7 billion people relied on the traditional use of biomass for cooking, around 40% of the global population (Table 13.1).[8] This updated estimate reflects revised country-level data, where available. More than 95% of the people lacking access to modern energy services (Box 13.1 includes our definition of modern energy access) are in either sub-Saharan Africa or developing Asia and 84% live in rural areas. Sub-Saharan Africa accounts for only 12% of the global population, but almost 45% of those without access to electricity. Over 1.9 billion people in developing Asia still rely on the traditional use of biomass for cooking, with around 840 million of these in India and more than 100 million each in Bangladesh, Indonesia and Pakistan. In sub-Saharan Africa, Nigeria also has over 100 million people without access to clean cooking facilities.

Despite these sobering statistics, some countries have made notable progress in recent years in improving access to electricity and reducing the number of people relying on the traditional use of biomass for cooking. In India, the most recent data show that expenditure on electricity was reported by 67% of the rural population and 94% of the urban population in 2009 (Government of India, 2011), up from 56% and 93% respectively when surveyed in 2006 (Government of India, 2008).[9] In Vietnam, the electrification rate (the share of the population with access to electricity) has increased in the last 35 years from below 5% to 98%. Bangladesh and Sri Lanka have seen progress on access to both electricity and clean cooking facilities, but more so on increased electrification. Angola and Congo both have seen the share of the population with access to modern energy services expand considerably in the last five years, mainly in urban areas.

8. While throughout this analysis we focus on the number of people relying on the traditional use of biomass for cooking, it is important to note that some 0.4 billion people, mostly in China, rely on coal. Coal is a highly polluting fuel when used in traditional stoves and has serious health implications (United Nations Development Programme and World Health Organization, 2009).

9. See www.mospi.nic.in.

Table 13.1 • People without access to modern energy services by region, 2009 (million)

	People without access to electricity	Share of population	People relying on the traditional use of biomass for cooking	Share of population
Africa	587	58%	657	65%
Nigeria	*76*	*49%*	*104*	*67%*
Ethiopia	*69*	*83%*	*77*	*93%*
DR of Congo	*59*	*89%*	*62*	*94%*
Tanzania	*38*	*86%*	*41*	*94%*
Kenya	*33*	*84%*	*33*	*83%*
Other sub-Saharan Africa	310	68%	335	74%
North Africa	2	1%	4	3%
Developing Asia	675	19%	1 921	54%
India	*289*	*25%*	*836*	*72%*
Bangladesh	*96*	*59%*	*143*	*88%*
Indonesia	*82*	*36%*	*124*	*54%*
Pakistan	*64*	*38%*	*122*	*72%*
Myanmar	*44*	*87%*	*48*	*95%*
Rest of developing Asia	102	6%	648	36%
Latin America	31	7%	85	19%
Middle East	21	11%	n.a.	n.a.
Developing countries	**1 314**	**25%**	**2 662**	**51%**
World*	**1 317**	**19%**	**2 662**	**39%**

*Includes countries in the OECD and Eastern Europe/Eurasia.

Box 13.1 • Defining modern energy access

There is no universally-agreed and universally-adopted definition of modern energy access. For our analysis, we define modern energy access as *"a household having reliable and affordable access to clean cooking facilities, a first connection to electricity and then an increasing level of electricity consumption over time to reach the regional average"*.[10] By defining access to modern energy services at the household level, it is recognised that some other categories are excluded, such as electricity access to businesses and public buildings that are crucial to economic and social development, *i.e.* schools and hospitals.

Access to electricity involves more than a first supply connection to the household; our definition of access also involves consumption of a specified minimum level of electricity, the amount varies based on whether the household is in a rural or an urban area. The initial threshold level of electricity consumption for rural households is assumed to be 250 kilowatt-hours (kWh) per year and for urban households it is

10. We assume an average of five people per household.

500 kWh per year.[11] In rural areas, this level of consumption could, for example, provide for the use of a floor fan, a mobile telephone and two compact fluorescent light bulbs for about five hours per day. In urban areas, consumption might also include an efficient refrigerator, a second mobile telephone per household and another appliance, such as a small television or a computer.

Once initial connection to electricity has been achieved, the level of consumption is assumed to rise gradually over time, attaining the average regional consumption level after five years. This definition of electricity access includes an initial period of growing consumption as a deliberate attempt to reflect the fact that eradication of energy poverty is a long-term endeavour. In our analysis, the average level of electricity consumption per capita across all those households newly connected over the period is 800 kWh in 2030. This is comparable with levels currently seen in much of developing Asia.

This definition of energy access also includes provision of cooking facilities which can be used without harm to the health of those in the household and which are more environmentally sustainable and energy efficient than the average biomass cookstove currently used in developing countries. This definition refers primarily to biogas systems, liquefied petroleum gas (LPG) stoves and advanced biomass cookstoves that have considerably lower emissions and higher efficiencies than traditional three-stone fires for cooking. In our analysis, we assume that LPG stoves and advanced biomass cookstoves require replacement every five years, while a biogas digester is assumed to last 20 years. Related infrastructure, distribution and fuel costs are not included in our estimates of investment costs.

Current status of investment in modern energy access

For the billions of people currently deprived, the lack of access to modern forms of energy tends to go hand-in-hand with a lack of provision of clean water, sanitation and healthcare. It also represents a major barrier to economic development and prosperity. The importance of modern energy access is being recognised increasingly by many organisations that provide development funding. We estimate that capital investment of $9.1 billion was undertaken globally in 2009 (Box 13.2 describes our methodology) to provide 20 million people with access to electricity and 7 million people with advanced biomass cookstoves ($70 million of the total). An incomplete set of past observations suggests that this is the highest level of investment ever devoted to energy access.[12]

11. The assumed threshold levels for electricity consumption are consistent with previous *WEO* analyses. However, we recognise that different levels are sometimes adopted in other published analysis. Sanchez (2010), for example, assumes 120 kWh per person (600 kWh per household, assuming five people per household). As another point of reference, the observed electricity consumption in India in 2009 was 96 kWh per person in rural areas and 288 kWh in urban areas *on average* over all people connected to electricity, implying a lower consumption for those that have been connected more recently (Government of India, 2011).

12. There are currently no comprehensive data available, and those that do exist employ varying methodologies. Our estimate is constructed from a variety of sources and includes some necessary assumptions. It is to be hoped that this shortcoming in the data receives greater attention in future.

Box 13.2 • Measuring investment in modern energy access

Our estimate of investment in modern energy access is based on the latest data available and has several components. The estimate is of the capital investment made to provide household access to electricity (both the cost of the provision of first connection and the capital cost to sustain an escalating supply over time) and the cost of providing clean cooking facilities to those who currently lack them. Operating costs, such as fuel costs and maintenance costs, are not included. Broader technical assistance, such as policy and institutional development advice, is also not included. In the case of on-grid and mini-grid solutions for electricity access, the estimate does not include the investment required in supportive infrastructure, such as roads.

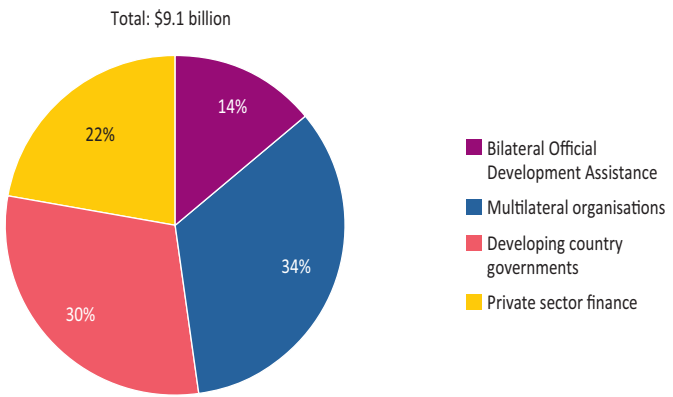
Our estimate is based on an average of high and low estimates of investment data from several sources:

- *Bilateral Official Development Assistance* (ODA) – In line with the Multilateral Development Banks' Clean Energy Investment Framework methodology,[13] our estimate of total ODA for energy access includes the investment flows for electricity generation, transmission and distribution in countries eligible for International Development Association (IDA) funding, *i.e.* the poorest countries. We have also included financing for off-grid generation and transmission for those countries eligible for International Bank for Reconstruction and Development (IBRD) funding (countries which, while not among the poorest, still have difficulty accessing commercial credit markets).
- *Multilateral organisations* (development banks,[14] funds, etc.) – This estimate is based on the organisations' own data when available,[15] or the same methodology as ODA where data is not available.
- *Domestic governments in developing countries* – This estimate includes investments made both directly by the governments and through state-owned utilities. It includes investment independently conducted by the governments as well as government investment leveraged through multilateral funding. In IDA countries, it is estimated that for every $1 spent in aid on energy access, it is matched by an additional equal amount from either the private sector or developing country governments. Countries eligible for IDA funding account for 82% of the total population lacking access to electricity, so the same leverage factor has been applied to all countries.
- *Private sector* – The broad range of private sector actors makes this the most challenging category for which to produce a comprehensive estimate. In constructing this estimate, which is based on data on private sector investment in infrastructure, including public-private partnerships (PPP), sourced from the World Bank PPI database,[16] we have assumed that the private sector component of PPP-funded projects is around 50% and that between 5% and 20% of the total investment goes towards energy access, depending on the region.

13. See www.worldenergy.org/documents/g8report.pdf.
14. Multilateral Development Banks are a channel for funds from bilateral sources and from bond markets.
15. Publicly available sources supplemented with bilateral dialogue.
16. See www.ppi.worldbank.org.

We estimate that bilateral ODA accounted for 14% of total investment in extending energy access in 2009, only slightly more than 1% of total bilateral ODA in the same year (Figure 13.3). Multilateral organisations, such as international development banks and funds, accounted for more than $3 billion of such investment in energy access, around 34% of the total. This was just over 3% of total multilateral aid in the same year. An estimated 30% of investment in energy access was sourced from domestic governments in developing countries. This included investments made directly by the governments and through state-owned utilities. The private sector is estimated to have accounted for 22% of the total investment in energy access. In the case of investment in energy access by domestic governments and the private sector, the share of total investment directed to energy access is estimated to be less than 1% of the gross fixed capital formation in these countries in 2009. While sources of investment are referred to separately here, in practice two or more often operate in conjunction to deliver an energy access project. Blending funds from different sources can bring important benefits, such as reducing funding risks and securing buy-in from project participants. Multilateral development banks generally enter into partnerships with developing country governments and/or the private sector to deliver projects, such as the Asian Development Bank's biogas programme in Vietnam.

Figure 13.3 • Investment in energy access by source, 2009



Outlook for energy access and investment in the New Policies Scenario

In the New Policies Scenario, our central scenario, we project that total cumulative investment in extending access to modern energy is $296 billion from 2010 to 2030, an average of $14 billion per year.[17] The projected annual average investment required is therefore 56% higher in the New Policies Scenario than the level observed in 2009. All sources of finance increase their investment in absolute terms to meet this requirement in the New Policies Scenario. Domestic finance in developing countries and multilateral developing banks are the largest sources of finance. But private sector finance is close behind and actually sees the most growth.

17. We focus primarily on the average level of investment per year over the projection period, as a better illustration of ongoing investment activity than the cumulative total.

In the New Policies Scenario, around 550 million additional people gain access to electricity and 860 million are provided with clean cooking facilities from 2010 to 2030. The increase in access to modern energy services is driven largely by rapid economic growth in several developing countries, accompanied by rapid urbanisation in some cases, but population growth acts as a countervailing force. For example, in the case of China, the 12th Five-Year Plan (covering the period 2011 to 2015) provides for rapid urbanisation, with plans to create 45 million new urban jobs and an expectation that the urbanisation rate will increase to 52% by 2015, the date by which the country also expects to achieve full electrification.

In several countries, national targets to increase electricity access succeed in delivering improvements over the projection period, but only on a limited scale: many such targets will not be achieved unless robust national strategies and implementation programmes are put in place. Access to clean cooking facilities has in the past often received less government attention than electricity access, with the result that there are fewer related programmes and targets in place at a national level. At an international level, an important step forward was taken in September 2010 when the UN Foundation launched the "Global Alliance for Clean Cookstoves". The Alliance seeks to overcome market barriers that impede the production, deployment and use of clean cookstoves in the developing world, so as to achieve the goal of 100 million households adopting clean and efficient stoves and fuels by 2020.[18]

Access to electricity

In the New Policies Scenario, around $275 billion of investment goes toward providing electricity access from 2010 to 2030. This represents annual average investment of $13 billion to connect around 26 million people per year. The capital-intensive nature of electricity generation, transmission and distribution means that this investment accounts for over 90% of total investment to deliver modern energy services over the projection period. The average annual level of investment in electricity access increases by almost 45%, compared with that observed in 2009. While the share of the global population lacking access to electricity declines from 19% in 2009 to 12% in 2030, 1.0 billion people are still without electricity by the end of the period (Table 13.2). The proportion of those without access to electricity in rural areas was around five-times higher than in urban areas in 2009, and this disparity widens to be around six-times higher in 2030. There are examples of progress in increasing rates of rural electrification, such as in Angola and Botswana, but this is often from a low base.

Annual investment to increase on-grid electricity access averages $7 billion in the New Policies Scenario. The main sources of investment for on-grid access are domestic government finance and the private sector. Almost 55% of total private sector investment is estimated to be in on-grid solutions. Over 40% of the investment made by multilateral development banks is also estimated to be in on-grid solutions. Investment in mini-grid and off-grid electricity generation together averages around $6 billion annually in the New Policies Scenario.[19] Private sector investment represents a significantly smaller share of the total for such projects, reflecting the obstacles to developing commercially viable projects.

18. See www.cleancookstoves.org.

19. Mini-grids provide centralised generation at a local level. They operate at a village or district network level, with loads of up to 500 kW. Isolated off-grid solutions include small capacity systems, such as solar home systems, micro-hydro systems, wind home systems and biogas digester systems.

Table 13.2 • People without access to electricity by region in the New Policies Scenario *(million)*

	2009			2030		
	Rural	Urban	Share of population	Rural	Urban	Share of population
Africa	466	121	58%	539	107	42%
Sub-Saharan Africa	465	121	69%	538	107	49%
Developing Asia	595	81	19%	327	49	9%
China	*8*	*0*	*1%*	*0*	*0*	*0%*
India	*268*	*21*	*25%*	*145*	*9*	*10%*
Rest of developing Asia	319	60	36%	181	40	16%
Latin America	26	4	7%	8	2	2%
Middle East	19	2	11%	5	0	2%
Developing countries	**1 106**	**208**	**25%**	**879**	**157**	**16%**
World*	**1 109**	**208**	**19%**	**879**	**157**	**12%**

*Includes countries in the OECD and Eastern Europe/Eurasia.

At a regional level, the number of people without access to electricity in sub-Saharan Africa *increases* by 10%, from 585 million in 2009 to 645 million in 2030, as the rate of population growth outpaces the rate of connections. The number of people without access to electricity in sub-Saharan Africa overtakes the number in developing Asia soon after 2015. This increase occurs in spite of pockets of progress, such as the government electrification programme in South Africa, which has provided 4 million households with access to electricity since it was launched in 1990 and aims to achieve complete access nationally by 2020. Table 13.3 provides examples of national electrification programmes. While the adoption of national targets and programmes for modern energy access is important, in practice it has been relatively commonplace for initial ambitions to be downgraded subsequently.

The number of people without access to electricity in developing Asia is projected to decrease by almost 45%, from 675 million people in 2009 to 375 million in 2030. Around 270 million people in rural areas are given access to electricity but, despite this, the rural population still constitutes the great majority of those lacking access in 2030. China has provided 500 million people in rural areas with electricity access since 1990 and is expected to achieve universal electrification by 2015. In India, the Rajiv Gandhi Grameen Vidyutikaran Yojana Programme is making progress towards a goal of electrifying over 100 000 villages and providing free electricity connections to more than 17 million rural households living below the national poverty line. Our projections show India reaching a 98% electrification rate in urban areas and 84% in rural areas in 2030. In the rest of developing Asia, the average electrification rate reaches almost 93%. The difference in trajectory between developing Asia and sub-Saharan Africa is clear, with an improving situation in the former and a worsening one in the latter. In developing Asia, India accounts for much of the increased access to electricity, while in sub-Saharan Africa a more mixed story within the region does not, in aggregate, overcome the deteriorating picture, driven primarily by population growth.

Table 13.3 • Major programmes and targets for improving access to electricity in selected countries

	Programme name	Description	Financing arrangements
Bangladesh	Master Plan for Electrification – National Energy Policy of Bangladesh 1996-2004	Electricity for all by 2020.	Loans and grants from donors are passed on, under a subsidiary agreement, to the Rural Electrification Board. Domestic government funds cover all local costs of construction.
Brazil	Light for All	Launched in 2003, extended in 2011 to 2014. So far the programme has connected more than 2.4 million households and it aims for full electrification.	Funded largely by the extension of a Global Reversion Reserve tax incorporated into electricity rates. The scheme also benefits from an investment partnership of federal government, state agencies and energy distributors.
Ghana	National Electrification Scheme – Energy Plan 2006-2020	Electricity access for all by 2020.	Funded through grants and loans by donors and $9 million per year in domestic government budgetary support.
India	Rajiv Gandhi Grameen Vidyutikaran Yojana	Electrify 100 000 villages and provide free electricity connections to 17.5 million households below the poverty line by March 2012.	Total funds of $5.6 billion disbursed between 2005 and 2011. A government subsidy of up to 90% of capital expenditure is provided through the Rural Electrification Corporation. Those below the poverty line receive a 100% subsidy for connection.
Indonesia	Rural electrification programmes – National Energy Management	Electricity access for 95% of the population by 2025.	Investment costs are covered by cross subsidies by the state-owned power utility (PNL) and other costs are funded by donors.
Nepal	Rural Electrification Program – National 3-Year Interim Plan	Electricity access for 100% of the population by 2027.	A Rural Electrification Board administers specific funds for electrification of rural areas.
Philippines	Philippines Energy Plan, 2004-2013	Electrification of 90% of households by 2017.	Funded by grants and loans from a National Electrification Fund and PPPs.
South Africa	Integrated National Electrification Programme	Electricity access for 100% of the population by 2020.	Government funding disbursed by the Department of Energy to Eskom (state-owned utility) and municipalities.
Zambia	Rural Electrification Master Plan	Electricity access for 78% in urban areas and 15% in rural areas by 2015.	The government has created a Rural Electrification Fund that is administered by the Rural Electrification Authority.

Outside Asia and Africa, there are at present smaller, but significant, numbers of people without access to electricity in Latin America, but near-universal access is achieved there by 2030 in the New Policies Scenario. In Brazil, Luz para Todos (light for all) is a government programme, operated by a majority state-owned power utility company, and executed by electricity concessionaires and co-operatives. The project promotes renewable energy as the most practical solution in remote areas, with the government providing funding to help cover the costs for renewable energy projects in these areas.

Access to clean cooking facilities

In the New Policies Scenario, $21 billion is invested in total from 2010 to 2030 to provide 860 million people with clean cooking facilities. This is equivalent to an average annual investment of $1 billion to provide facilities to an average of 41 million people per year. After an initial increase, the number of people without clean cooking facilities drops back to 2.7 billion, the level of 2009, in 2030 (Table 13.4). The proportion of people globally without clean cooking facilities declines from 39% in 2009 to 33% in 2030.

Table 13.4 • People without clean cooking facilities by region in the New Policies Scenario (million)

	2009			2030		
	Rural	Urban	Share of population	Rural	Urban	Share of population
Africa	480	177	65%	641	270	58%
Sub-Saharan Africa	476	177	78%	638	270	67%
Developing Asia	1 680	240	54%	1 532	198	41%
China	*377*	*46*	*32%*	*236*	*25*	*19%*
India	*749*	*87*	*72%*	*719*	*59*	*53%*
Rest of developing Asia	554	107	63%	576	114	52%
Latin America	61	24	19%	57	17	14%
Middle East	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Developing countries	**2 221**	**441**	**51%**	**2 230**	**485**	**43%**
World*	**2 221**	**441**	**39%**	**2 230**	**485**	**33%**

*Includes countries in the OECD and Eastern Europe/Eurasia.

Over the projection period, almost 60% of the investment in clean cooking facilities is expected to be made in biogas solutions, with advanced cookstoves and LPG solutions each accounting for around 20%.[20] Private sector operators in parts of Asia have already made

20. Advanced biomass cookstoves, with significantly lower emissions and higher efficiencies than the traditional three-stone fires, are assumed to cost $50. An LPG stove and canister is assumed to cost $60. In the analysis, we assume that LPG stoves and advanced biomass cookstoves require replacement every five years, but only the cost of the first stove and half of the cost of the second stove is included in our investment projections. This is intended to reflect a path towards such investment becoming self-sustaining. The assumed cost of an average-sized biogas digester varies by region. Based on 2010 data provided by SNV, the Netherlands Development Organisation, the cost is $437 for India, $473 in China, $660 in Indonesia, $526 in other developing Asia, $702 in Latin America and $924 in sub-Saharan Africa. Related infrastructure, distribution and fuel costs are not included in the investment costs.

significant progress in establishing profitable markets for biogas solutions. In 2010, China led the market with 5 million biogas plants installed, while the next three largest Asian markets (India, Nepal and Vietnam) had another 0.2 million units collectively (SNV, 2011). In the case of LPG stoves, multilateral development banks and governments are often the source of the initial capital investment, but the private sector may subsequently be involved in fuel distribution. Advanced biomass cookstoves receive relatively more funding from bilateral and multilateral donors. Much of this goes to indirect subsidies intended to establish local, self-sustaining cookstove markets and to increase the demand for advanced cookstoves. Examples of how such funds are applied include the training of stove builders and information campaigns on the health and other benefits of more efficient stoves. Expenditure of this kind is not included in our calculation of the estimated investment cost of access.

In the New Policies Scenario, the number of people in sub-Saharan Africa without clean cooking facilities *increases* by nearly 40%, to reach more than 900 million by 2030, despite a fall in the proportion of population without access. Almost 65% of the increase in number occurs in rural areas. By 2030, one-third of the people without clean cooking facilities globally are in sub-Saharan Africa, up from one-quarter in 2009.

In developing Asia, the number of people without access to clean cooking facilities declines from 1.9 billion in 2009 to around 1.7 billion in 2030. In the New Policies Scenario, the number of people without clean cooking facilities in India peaks before 2015 and then declines, but India still has nearly 780 million people lacking them in 2030. India previously had the "National Programme for Improved Chulhas" (1985 to 2002), and has recently launched the National Biomass Cookstoves Initiative (NCI) to develop and deploy next-generation cleaner biomass cookstoves to households. The government is piloting the demonstration of 100 000 cookstoves during 2011 and 2012 – providing financial assistance for up to 50% of the cost of the stoves – and this will be used to formulate a deployment strategy for India's next five year plan (2012 to 2017).

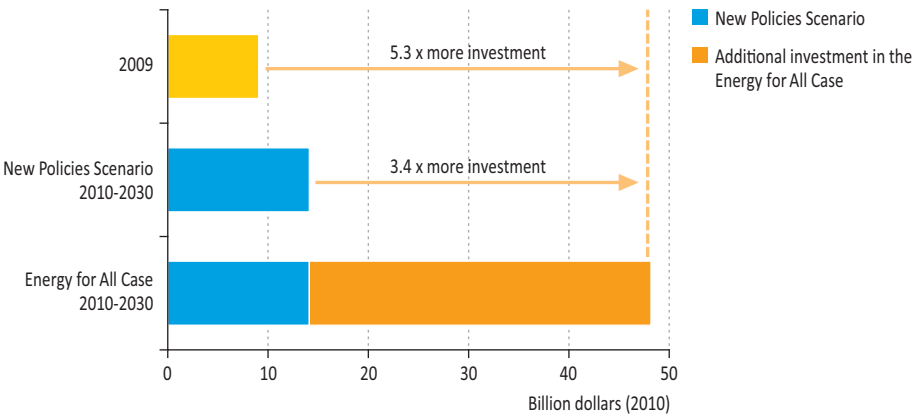
The number of people without clean cooking facilities in China maintains a declining trend and stands at around 260 million in 2030. China, like India, builds on previous national programmes, such as the National Improved Stove Program, to distribute cookstoves to rural areas. Together, China and India account for all of the fall in the number of people lacking clean cooking facilities in the region. Across the rest of developing Asia, the number of people without access increases by 4.5% to reach 690 million.

Investment needed to achieve modern energy access for all

The remainder of this analysis focuses on the investment required to achieve the goal of universal access to electricity and clean cooking facilities by 2030 – referred to here as the Energy for All Case – and the methods of financing that may be the most appropriate to support this. We have calculated the cost of achieving this goal to be $1 trillion (in year-2010 dollars). This estimate includes the $296 billion reflected in the New Policies

Scenario. Achieving modern energy access for all by 2030 would therefore require more than three-times the expected level of investment in the New Policies Scenario, growing from $14 billion per year to $48 billion per year (Figure 13.4).[21] This means that an additional $34 billion is needed every year, over and above investment already reflected in the New Policies Scenario. The total required is more than five-times the estimated level of actual investment in 2009. Nonetheless, the total investment required is a small share of global investment in energy infrastructure, around 3% of the total.

Figure 13.4 ● *Average annual investment in modern energy access by scenario*



Investment in electricity access

In the Energy for All Case, the additional investment required to achieve universal access to electricity is estimated to be around $640 billion between 2010 and 2030 (Table 13.5).[22] To arrive at this estimate, it was first necessary to assess the required combination of on-grid, mini-grid and isolated off-grid solutions. To identify the most suitable technology option for providing electricity access in each region, the Energy for All Case takes into account regional costs and consumer density, resulting in the key determining variable of regional cost per megawatt-hour (MWh). When delivered through an established grid, the cost per MWh is cheaper than that of mini-grids or off-grid solutions, but the cost of extending the grid to sparsely populated, remote or mountainous areas can be very high and long distance transmission systems can have high technical losses. This results in grid extension being the

21. The estimated additional investment required is derived from analysis to match the most likely technical solutions in each region, given resource availability and government policies and measures, with financing instruments and sources of financing.

22. For illustrative purposes, if we instead adopted the assumed minimum consumption threshold of 120 kWh per person in Sanchez (2010), together with our own assumption of five people per household, *i.e.* a threshold electricity consumption level of 600 kWh per household, this would increase the additional investment required in the Energy for All Case by 4%, taking the total additional investment required to $665 billion to 2030.

most suitable option for all urban zones and for around 30% of rural areas, but not proving to be cost effective in more remote rural areas. Therefore, 70% of rural areas are connected either with mini-grids (65% of this share) or with small, stand-alone off-grid solutions (the remaining 35%). These stand-alone systems have no transmission and distribution costs, but higher costs per MWh. Mini-grids, providing centralised generation at a local level and using a village level network, are a competitive solution in rural areas, and can allow for future demand growth, such as that from income-generating activities.

Table 13.5 • *Additional investment required to achieve universal access to electricity in the Energy for All Case compared with the New Policies Scenario* ($2010 billion)

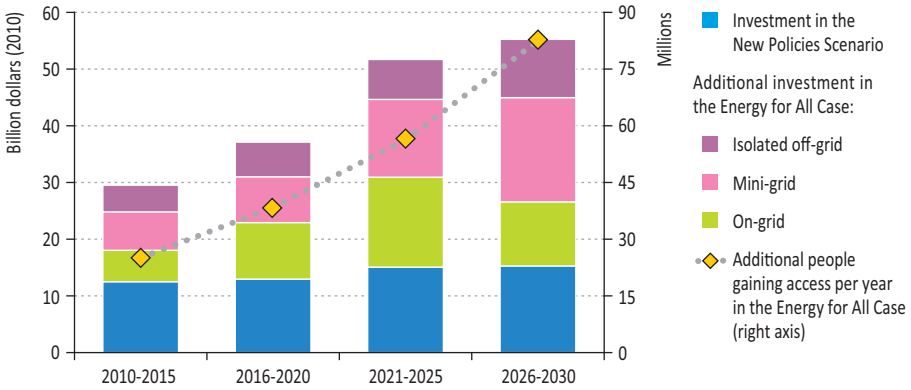
	2010-2020	2021-2030	Total, 2010-2030
Africa	119	271	390
Sub-Saharan Africa	118	271	389
Developing Asia	119	122	241
India	*62*	*73*	*135*
Rest of developing Asia	58	49	107
Latin America	3	3	6
Developing countries*	**243**	**398**	**641**
World	**243**	**398**	**641**

* Includes Middle East countries.

More than 60% of the additional investment required is in sub-Saharan Africa, with the region needing the equivalent of an extra $19 billion per year to achieve universal electricity access by 2030. There is greater dependency here on mini-grid and isolated off-grid solutions, particularly in countries such as Ethiopia, Nigeria and Tanzania, where a relatively higher proportion of those lacking electricity are in rural areas. Developing Asia accounts for 38% of the additional investment required to achieve universal electricity access. Achieving universal access to electricity by 2030 requires total incremental electricity output of around 840 terawatt-hours (TWh), and additional power generating capacity of around 220 gigawatts (GW) (Box 13.3 discusses the potential role of hydropower).

In the Energy for All Case, mini-grid and off-grid solutions account for the greater part of the additional investment, $20 billion annually. The annual level of investment is expected to increase over time, reaching $55 billion per year towards 2030 (Figure 13.5). This growth over time reflects the escalating number of additional connections being made annually in the Energy for All Case, going from 25 million people per year early in the projection period to more than 80 million by 2030, and the increasing shift in focus to mini-grid and off-grid connections. It also reflects the gradually increasing level of capital cost associated with the higher level of consumption expected from those households that are connected earlier in the period.

Figure 13.5 ● Average annual investment in access to electricity by type and number of people connected in the Energy for All Case



Box 13.3 ● What is the role of hydropower in increasing energy access?

Renewables play a large role in the Energy for All Case. As a mature, reliable technology that can supply electricity at competitive costs, hydropower is one part of the solution to providing universal access to electricity. It has a place in large on-grid projects and in isolated grids for rural electrification. The global technical potential for hydropower generation is estimated at 14 500 TWh, more than four-times current production (IJHD, 2010), and most of the undeveloped potential is in Africa and in Asia, where 92% and 80% of reserves respectively are untapped.

Water basins can act as a catalyst for economic and social development by providing two essential enablers for development: energy and water. Large hydropower projects can have important multiplier effects; creating additional indirect benefits for every dollar of value generated (IPCC, 2011). However, they may have adverse environmental impacts and induce involuntary population displacement if not designed carefully.

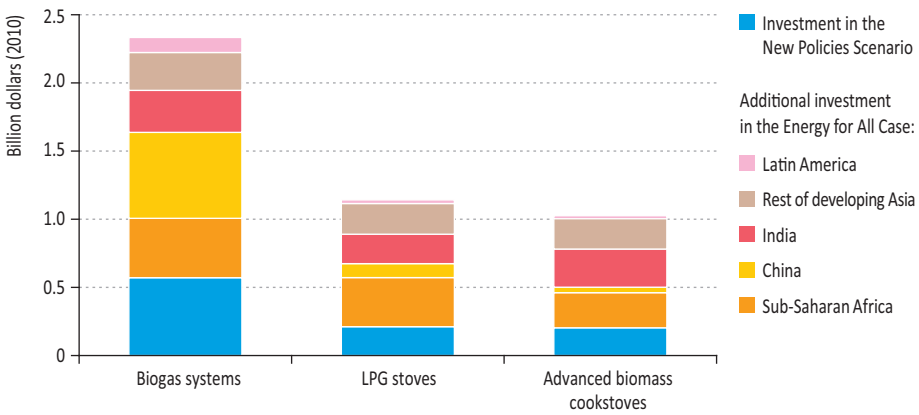
The Nam Theun 2 hydropower plant in Laos is an example of a project that has advanced economic and social goals successfully. While managing to achieve this, there are still lessons to be learned in terms of how governments, private developers and multilateral development banks partner to deliver projects more simply and efficiently. Small-scale, hydropower-based rural electrification in China has had some success. Over 45 000 small hydropower plants (SHPs), representing 55 GW, have been built and are producing 160 TWh per year. While many of these plants form part of China's centralised electricity networks, SHPs constitute one-third of total hydropower capacity and provide services to more than 300 million people (Liu and Hu, 2010).

In the Energy for All Case, hydropower on-grid accounts for 14% of additional generation, while SHPs account for 8% of off-grid additional generation. Overall, additional investment in hydropower amounts to just above $80 billion over the period 2010 to 2030. Successfully raising this investment will depend on mitigating the risks related to high upfront costs and lengthy lead times for planning, permitting and construction. Projects that provide broader development benefits and arrangements to tackle planning approval and regulatory risks are important to achieve the required level of investment for hydropower development.

Investment in access to clean cooking facilities

In the Energy for All Case, $74 billion of additional investment is required to provide universal access to clean cooking facilities by 2030, representing nearly four-times the level of the New Policies Scenario. Of this total, sub-Saharan Africa is estimated to need $22 billion. While the largest share of additional investment in the region is for biogas systems, a significant proportion (around 24%) is needed to provide advanced biomass cookstoves to 395 million people in rural areas. Developing Asia accounts for almost two-thirds of the total additional investment required for clean cooking facilities, the largest element ($26 billion) being for biogas systems, principally in China and India (Figure 13.6).

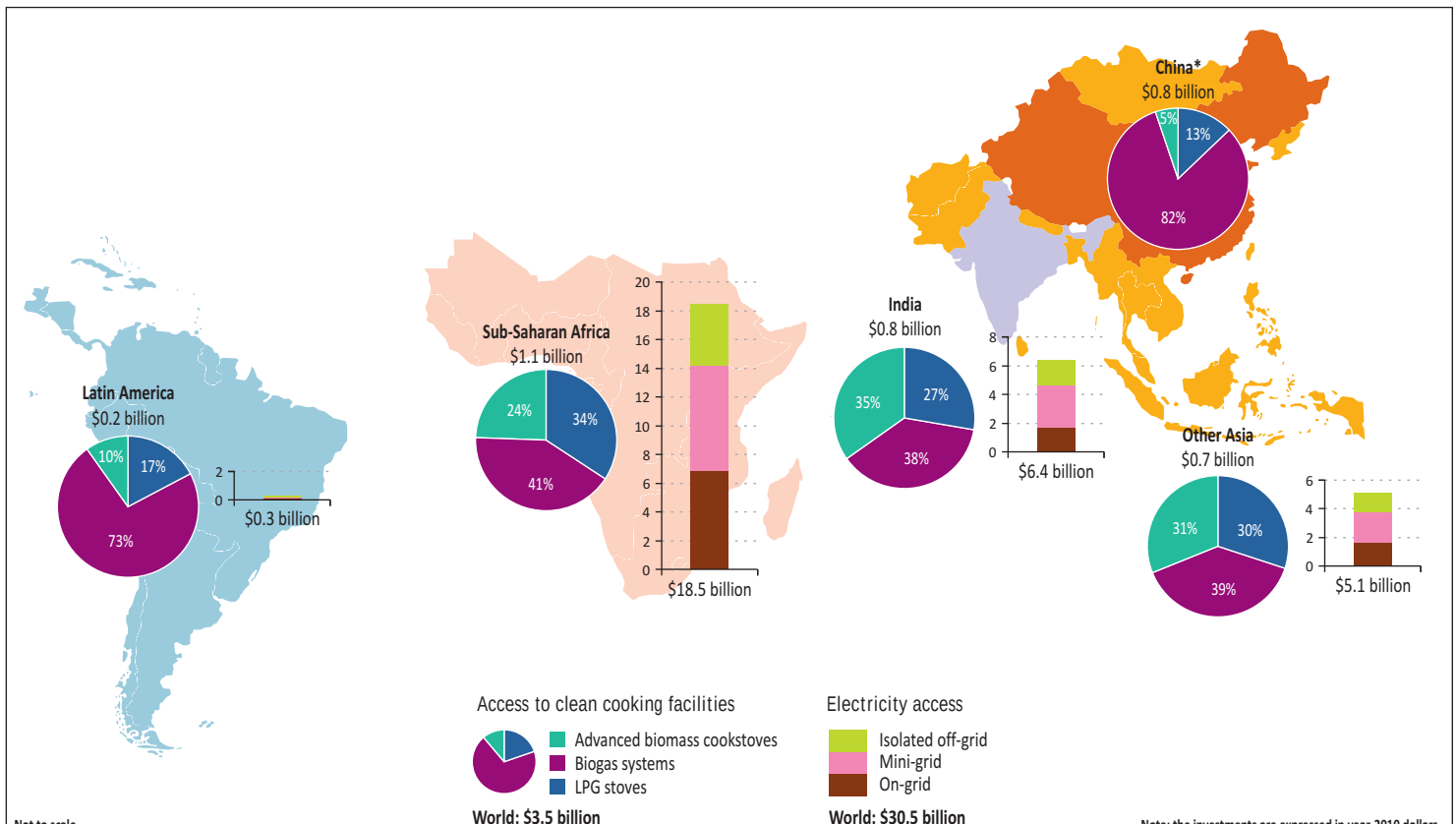
Figure 13.6 • *Average annual investment in access to clean cooking facilities by type and region, 2010-2030*



We estimate that to provide over 250 million households worldwide with advanced biomass cookstoves an additional cumulative investment of $17 billion will be needed to 2030 (Figure 13.7). Additional investment of $37 billion is required in biogas systems over the projection period, providing access to around 70 million households.[23] An estimated

23. Infrastructure, distribution and fuel costs for biogas systems are not included in the investment costs. Due to an assumed 20-year lifecycle, we assume one biogas system per household in the period 2010 to 2030, thus replacement costs are not included (see footnote 20 for cost assumptions for each technology).

Figure 13.7 • *Average annual investment required by region and technology in the Energy for All Case, 2010-2030*



This map is for illustrative purposes and is without prejudice to the status of or sovereignty over any territory covered by this map.

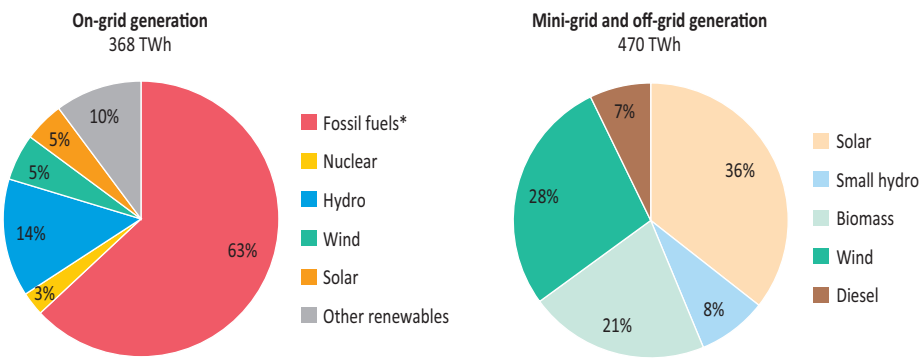
*In the Energy for All Case, China's investment in access to electricity is zero and therefore not shown on the map.
Note: World total includes Middle East countries.

additional investment of $20 billion for LPG stoves over the projection period provides clean cooking facilities to nearly 240 million households. Advanced biomass cookstoves and biogas systems represent a relatively greater share of the solution in rural areas, while LPG stoves play a much greater role in urban and peri-urban areas.

Broader implications of achieving modern energy access for all

Achieving the Energy for All Case requires an increase in global electricity generation of 2.5% (around 840 TWh) compared with the New Policies Scenario in 2030, requiring additional electricity generating capacity of around 220 GW. Of the additional electricity needed in 2030, around 45% is expected to be generated and delivered through extensions to national grids, 36% by mini-grid solutions and the remaining 20% by isolated off-grid solutions. More than 60% of the additional on-grid generation comes from fossil fuel sources and coal alone accounts for more than half of the total on-grid additions. In the case of mini-grid and off-grid generation, more than 90% is provided by renewables (Figure 13.8).

Figure 13.8 • *Additional electricity generation by grid solution and fuel in the Energy for All Case compared with the New Policies Scenario, 2030*



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

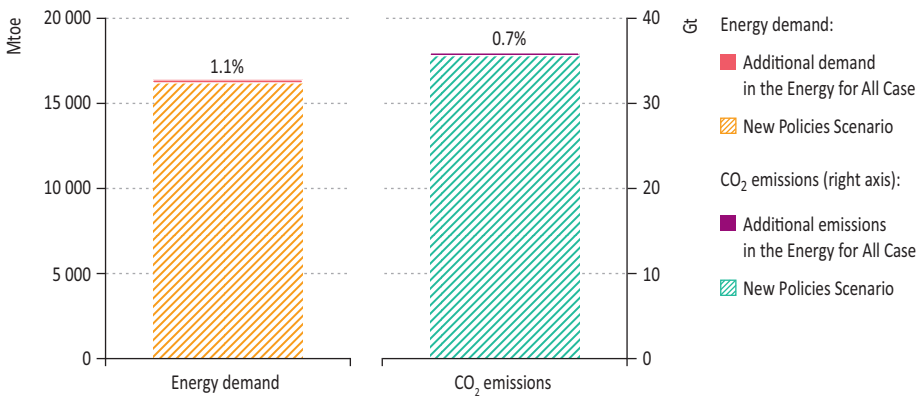
Achieving the Energy for All Case is projected to increase global demand for energy by 179 million tonnes of oil equivalent (Mtoe), an increase of 1.1% in 2030, compared with the New Policies Scenario (Table 13.6). Fossil fuels account for around 97 Mtoe, over half of the increase in energy demand in 2030. While an additional 0.88 million barrels per day (mb/d) of LPG is estimated to be required for LPG cookstoves in 2030, this is expected to be available largely as a by-product of increased production of natural gas liquids (NGLs) and refining crude oil. Coal demand increases by almost 60 million tonnes of coal equivalent (Mtce) in 2030, around the current production level of Colombia. Ample coal reserves are available globally to provide this additional fuel to the market (see Chapter 11). Other renewables, mostly solar and wind, enjoy the largest proportional increase in demand in 2030, providing additional deployment opportunities beyond those in the New Policies Scenario.

Table 13.6 • Additional energy demand in the Energy for All Case compared with the New Policies Scenario, 2020 and 2030

	Additional demand (Mtoe)		Change versus the New Policies Scenario	
	2020	2030	2020	2030
Coal	10	42	0.2%	1.0%
Oil	25	48	0.6%	1.1%
Gas	1	7	0.0%	0.2%
Nuclear	3	3	0.3%	0.2%
Hydro	6	8	1.5%	1.7%
Biomass and waste	8	31	0.5%	1.8%
Other renewables	12	41	4.0%	7.8%
Total	**64**	**179**	**0.4%**	**1.1%**

In 2030, CO_2 emissions in the Energy for All Case are 239 million tonnes (Mt) higher than in the New Policies Scenario, an increase of only 0.7% (Figure 13.9). Despite this increase, emissions per capita in those countries achieving universal access are still less than one-fifth of the OECD average in 2030. The small size of this increase in emissions is attributable to the low level of energy per-capita consumed by the people provided with modern energy access and to the relatively high proportion of renewable solutions adopted, particularly in rural and peri-urban households. The diversity of factors involved means that the estimate of the total impact on greenhouse-gas emissions of achieving universal access to modern cooking facilities needs to be treated with caution. However, it is widely accepted that advanced stoves and greater conversion efficiency would result in a reduction in emissions and thereby reduce our projection.

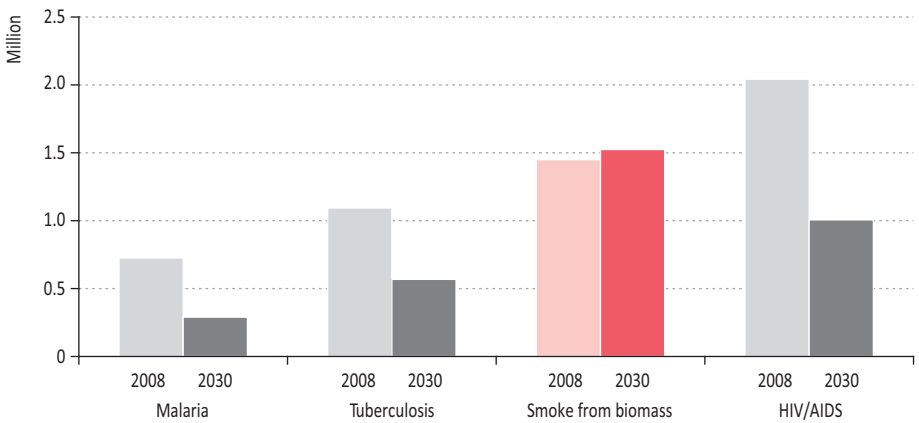
Figure 13.9 • Additional global energy demand and CO_2 emissions in the Energy for All Case compared with the New Policies Scenario, 2030



Notes: Percentages are calculated as a share of the total energy demand or CO_2 emissions respectively in 2030. Gt = gigatonnes.

As well as the economic development benefits, the Energy for All Case, if realised, would have a significant impact on the health of those currently cooking with biomass as fuel in basic, inefficient and highly-polluting traditional stoves. Based on World Health Organization (WHO) projections, linked to our projections of the traditional use of biomass in cooking,[24] the number of people who die prematurely each year from the indoor use of biomass could be expected to increase to over 1.5 million in the New Policies Scenario in 2030. The adoption of clean cooking facilities is expected to prevent the majority of deaths attributable to indoor air pollution.[25] The number of premature deaths per year attributable to indoor air pollution is higher than what the WHO projects for deaths from malaria and HIV/AIDS combined in 2030 (Figure 13.10). In addition to avoiding exposure to smoke inhalation, modern energy services can help improve health in other ways, such as refrigeration (improving food quality and storing medicines) and modern forms of communication (supporting health education, training and awareness).[26]

Figure 13.10 ● *Premature annual deaths from household air pollution and selected diseases in the New Policies Scenario*



Note: 2008 is the latest available data in WHO database.

Financing to achieve modern energy access for all

The size of the increase in investment that is required in the Energy for All Case is significant. We focus here on how the investment required to achieve the objectives of the Energy for All Case can best be financed. Whatever the possible sources, it is important to recognise

24. Estimates for premature deaths are based on *WEO-2010* projections for biomass use and on Mathers and Loncar (2006); WHO (2008); Smith *et al.*, (2004); and WHO (2004).

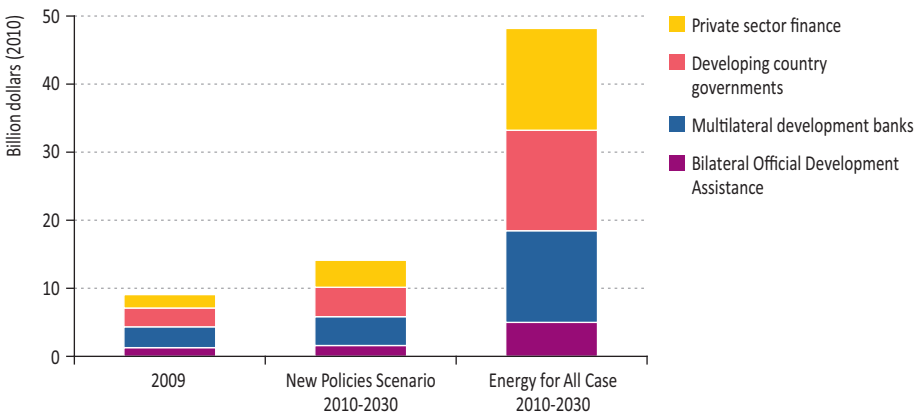
25. Evidence of fewer child deaths from Acute Lower Respiratory Infection can be expected soon after reductions in solid fuel air pollution. Evidence of averted deaths from chronic obstructive pulmonary disease would be observed over a period of up to 30 years after adoption of clean cookstoves, due to the long and variable time-scales associated with the disease.

26. See *WEO-2006* and *WEO-2010* for a detailed discussion of the harmful effects of current cooking fuels and technologies on health, the environment and gender equality; and for a broader discussion on the link between energy and the Millennium Developing Goals (IEA, 2006 and IEA, 2010).

that sufficient finance will not be forthcoming in the absence of strong governance and regulatory reform. Technical assistance in these areas from multilateral and bilateral organisations and non-governmental organisations (NGOs) will be essential. While such assistance is often important in influencing the success of energy access projects, the cost of its provision is difficult to quantify and the purpose and benefits are rarely confined only to the eradication of energy poverty. Moreover, the most appropriate potential sources of finance depend, in part, on the technical and social characteristics of the solutions best suited to each element of the requirement (on-grid, mini-grid, off-grid). A bottom-up analysis on this basis has been undertaken to suggest which financing instruments (*e.g.* loans, grants) and sources of financing (domestic government, multilateral or bilateral development funding, or the private sector) might be most appropriate.

As elaborated below, there will be demand for a significant increase in financing from all major existing sources (Figure 13.11). We estimate that investment from multilateral development banks and bilateral ODA collectively needs to average around $18 billion per year from 2010 to 2030, more than three-times the level projected in the New Policies Scenario. Such a scale up in financing from these sources would require a significant increase in underlying funds and a reordering of development priorities. In addition, average annual investment of almost $15 billion is required from governments in developing countries, including state-owned utilities. Developing country governments are expected to provide most of the finance required for mini-grid solutions and for the penetration of LPG for cooking, tailoring the financing instruments used according to the ability of households to afford the associated level of operating expenditure.

Figure 13.11 • *Average annual investment in modern energy access by source of financing and scenario*



Investment of around $15 billion per year, on average, is required from the diverse range of actors that collectively constitute the private sector. The private sector accounts for almost 35% of the total investment needed to expand on-grid connections and around 40% of the investment needed to provide households with biogas systems for cooking. It is expected to focus particularly on higher energy expenditure households, due to their greater capacity

to pay. In these areas, the share of private sector investment is expected to increase over the period, as structural barriers are overcome, permitting more rapid expansion and for its potential to be increasingly realised. By contrast, a breakthrough is still required in developing commercially-viable business models for providing modern energy services to the rural poor on a significant scale. Until such models are developed, private sector investment is not expected to contribute substantially in this area, meaning that the public sector plays the dominant role.

In examining financing for access to both electricity and clean cooking facilities, we draw a distinction between lower and higher household energy expenditure. For electricity, this is based on the classification used by the International Finance Corporation (IFC) in its report on Energy Access Business Models (IFC, forthcoming). It is estimated that around half of the 270 million households currently lacking access to electricity spend up to $5.50 per month on traditional energy for lighting services:[27] we refer to these as lower energy expenditure households and those above this threshold as higher energy expenditure households. For financing clean cooking facilities, a similar distinction, based on IFC energy expenditure thresholds, does not prove meaningful for our purposes.[28] Instead, we adopt a classification based on the international poverty line of receiving income of $1.25 per day: those living under the poverty line are classified as lower income and those above the poverty line as higher income.[29]

Electricity access – financing on-grid electrification

In the Energy for All Case, on-grid electrification requires additional annual investment of $11 billion. This is $4 billion per year higher than projected in the New Policies Scenario and provides access to electricity to an additional 20 million people per year. Table 13.7 shows a breakdown of the additional annual investment required for universal access to electricity, together with an indication of what the main and supplementary sources of finance are anticipated to be in each area.

We estimate that around 60% of the additional investment required relates to higher energy expenditure households. For this category, private investors may be expected to bid for a concession or to enter into a public-private partnership (PPP) with a local utility to extend the grid and provide universal access in an agreed area.[30] It may be important to include electricity generation, often the financially more attractive element, together with transmission and distribution, as it can be difficult to generate interest in the latter separately. Such concessionaire grid extensions have taken place in Argentina, Chile, Guatemala and Uganda (World Bank, 2009a). Private investors may also be able to source

27. Lighting services includes kerosene, candles and disposable batteries.

28. Available information on household expenditure thresholds for cooking fuels results in 95% being placed in one category, therefore resulting in little differentiation.

29. See www.worldbank.org.

30. Public-private partnerships are contractual arrangements typified by joint working between the public and private sector. In the broadest sense, they can cover all types of collaboration across the interface between the public and private sectors to deliver policies, services and infrastructure.

loans from international or local banks on the basis of the financial attractiveness of the project, backed by multilateral development bank guarantees. Attracting private investment to such projects depends crucially on investors being able to charge tariffs that generate a reasonable return. In some instances, a state-owned utility mandated by the government to provide universal access may be able to attract private sector loans at competitive rates to supplement internal financing. In other instances, a utility (in private or public ownership) may not be sufficiently creditworthy to raise finance commercially, and may require support, such as through a partial risk guarantee.

Table 13.7 • *Additional financing for electricity access in the Energy for All Case compared with the New Policies Scenario[31], 2010-2030*

	Additional annual investment ($ billion)	People gaining access annually (million)	Level of household energy expenditure	Main source of financing	Other sources of financing
On-grid	11.0	20	Higher	Private sector	Developing country utilities
			Lower	Government budget	Developing country utilities
Mini-grid	12.2	19	Higher	Government budget, private sector	Multilateral and bilateral guarantees
			Lower	Government budget	Multilateral and bilateral concessional loans
Off-grid	7.4	10	Higher	Multilateral and bilateral guarantees and concessional loans	Private sector, government budget
			Lower	Multilateral and bilateral concessional loans and grants	Government budget

In providing on-grid electrification for lower energy expenditure households, there is a stronger case for explicit public sector funding, such as targeted government subsidies or an equity investment.[32] For example, in the case of Vietnam's successful rural electrification programme, significant cost sharing by local government and the communities being electrified was an important element of the financing model. Cross-subsidisation between higher energy expenditure households or business customers and those with lower energy expenditure may also be pursued (though not desirable on a long-term basis), such as the state-owned utility Eskom has done in South Africa.

31. See www.worldenergyoutlook.org/development.asp for more on the methodology related to this table.

32. An equity investment is one in which the investor receives an ownership stake in a project, giving entitlement to a share of the profits (after all associated debts have been paid), but also liability to bear part of any residual losses.

Electricity access – financing mini-grid electrification

In the Energy for All Case, mini-grid electrification requires additional annual investment of $12 billion per year. This area requires the largest increase in financing, relative to the New Policies Scenario, with more than $8 billion per year in additional investment required, on average, to connect an additional 19 million people annually.

Often financed initially by government programmes, mini-grids (diesel and small-hydro) have played an important role in rural electrification in China, Sri Lanka and Mali (World Bank, 2008). Under a Global Environment Fund (GEF) Strategic Energy Programme for West Africa, renewable energy powered mini-grids are being established in eight countries.[33] Hybrid mini-grids, integrating renewable generation with back-up capacity, have expanded rapidly in Thailand (Phuangpornpitak *et al.*, 2005), and are becoming competitive compared with 100% diesel-based generation (ARE, 2011a). In Laos, a successful public-private partnership, has been established to fund a hybrid (hydro, solar PV and diesel) mini-grid, serving more than 100 rural households. In the project, public partners fund the capital assets, while the private local energy provider finances the operating costs (ARE, 2011b).

The most appropriate type of technical and financing solution for mini-grid projects can vary significantly. In some cases, mini-grid projects can be run on a cost-recovery basis with a guaranteed margin, and therefore attract private sector finance on commercial terms (particularly diesel systems). In the case of more marginal projects, output-based subsidies may be used to support private sector activity in the sector. For many high energy expenditure households, an auction for concessions, combined with output-based subsidies, can keep subsidies low while giving concessionaires incentives to complete promised connections. In such cases, electricity providers bid for the value of subsidies that they require (referred to as "viability gap funding") or for the number of electricity connections they will make during a specified period at a pre-determined rate of subsidy per connection. Ideally, such auctions are technology-neutral, as in Senegal's recent programme, allowing providers to determine the most cost-effective solution. Loans or grants to the government from multilateral and bilateral sources could provide financing to support the initial auction and subsidy costs, as the International Development Association (IDA) and GEF grants did in Senegal (GPOBA, 2007). Such sources may also help support end-user financing programmes which offer assistance to cover the connection charges through the concessionaire or local banking system. For example, the IDA and GEF helped Ethiopia's Electric Power Corporation offer credit to rural customers (GPOBA, 2009).

An important form of financing for mini-grid electrification for low energy expenditure households is expected to be government-initiated co-operatives and public-private partnerships.[34] Bangladesh and Nepal provide examples of such co-operatives (Yadoo and

33. See www.un-energy.org.

34. Many forms of business co-operatives exist but, in general, the term refers to a company that is owned by a group of individuals who also consume the goods and services it produces and/or are its employees. A utility co-operative is tasked with the generation and/or transmission and distribution of electricity.

Cruickshank, 2010). There is a relatively high assumed capital subsidy from the government in this model, typically with support in the form of concessional loans from multilateral and bilateral donors.

Electricity access – financing off-grid electrification

Isolated off-grid electricity solutions require additional investment of $7 billion per year to 2030. This represents an increase of $5 billion per year, compared to the New Policies Scenario, in order to provide electricity access to an additional 10 million people per year. In general, off-grid connections are less attractive to the private sector and require different technical solutions and related financing. In the Energy for All Case, the main financing model for off-grid electrification of high energy expenditure households involves enhancing the capacity of dealers in solar home systems and lanterns to offer financing to end-users. Examples of this may be found in the Philippines (UNEP, 2007) and Kenya (Yadoo and Cruickshank, 2010). Government and concessional funds could also be used directly to support microfinancing[35] networks or local banks that, in turn, provide loans down the chain to end-users, as has happened, for example, in UNEP's India Solar Loan Programme (UNEP, 2007) and in several African countries under the Rural Energy Foundation, which is supported by the government of the Netherlands (Morris *et al*., 2007). In some cases, where microfinance is not available, local agricultural co-operatives might be a channel for funds. Government and concessional funds could also be used for output-based subsidies in some countries. Different sources of financing can play complementary roles in different stages of a programme or project to deliver energy access. For example, a programme for small hydro systems in rural areas in Nepal received over 90% of its funding from public sources at the beginning, much of which was dedicated to capacity development. The share of public financing gradually declined to about 50% at a later stage, suggesting that public investments in developing national and local capacities subsequently attracted private financing (UNDP, AEPC, Practical Action, 2010).

Off-grid electrification of low energy expenditure households is the most challenging area in which to raise finance. A potentially attractive solution for many such cases is sustainable solar marketing packages, pioneered by the World Bank and GEF in the Philippines and later introduced in Zambia and Tanzania. They are based on a service contract to install and maintain solar photovoltaic systems to key public service customers, such as schools, clinics and public buildings. Such contracts include an exclusive right to provide such services also to households and commercial customers, and provide a subsidy for each non-public system installed in the concession area. As for many other solutions, the development of end-user financing is also important. The first phase of the "Lighting Africa" programme by the IFC and World Bank saw the most basic needs met through solar home systems (SHS) provided on a fee-for-service basis. While donor-based models remain, and SHS are still an important and growing segment, the lighting market is now entering a new phase that is being led

35. The term microfinance typically refers to the provision of financial services to low income people that lack access to such services from mainstream providers, either due to the small sums involved or because they are on terms that are not considered commercially attractive. The stated intention of microfinance organisations is often to provide access to financial services as a means of poverty alleviation.

by entrepreneurs providing solar portable lights. The scale of these operations is currently small, and the cost can still be a barrier, but the technology is improving at a rapid rate and business models are maturing (IFC and World Bank, 2010).

Clean cooking facilities – financing LPG stoves

In the Energy for All Case, of the additional $3.5 billion per year in investment needed to achieve universal access to clean cooking facilities, $0.9 billion is required for LPG stoves to supply an additional 55 million people per year with a first stove and financing for 50% of the first replacement after five years (Table 13.8). Households supplied with LPG stoves are concentrated in urban and peri-urban areas or may be in areas with high levels of deforestation. As in most countries where LPG stoves have been successfully introduced, such as Kenya, Gabon and Senegal, the government has a role to play in market creation, such as developing common standards and the distribution infrastructure. This will require a certain amount of investment on the part of the government, which may be financed in part by concessional loans from multilateral and bilateral institutions. Besides investment in supporting public infrastructure, such as roads, the government may need to ensure that loans are available for entrepreneurs wishing to invest in LPG distribution. This could be done through a guarantee programme for a line of credit made available through participating local banks, possibly ultimately supported by a multilateral development bank.

Table 13.8 • *Additional financing for clean cooking facilities in the Energy for All Case compared with the New Policies Scenario, 2010-2030*

	Additional annual investment ($ billion)	People gaining access annually (million)	Level of household energy expenditure	Main source of financing	Other sources of financing
LPG	0.9	55	Higher	Government budget, private sector	Multilateral and bilateral development banks, microfinance
			Lower	Government budget, multilateral and bilateral development banks	Private sector
Biogas systems	1.8	15	Higher	Private sector	Microfinance, government budget, multilateral and bilateral development banks
			Lower	Government budget, multilateral and bilateral development banks	Private sector, microfinance
Advanced biomass cookstoves	0.8	59	Higher	Private sector	Government budget, multilateral and bilateral development banks
			Lower	Government budget, multilateral and bilateral development banks	Private sector

Higher income households are assumed either to purchase their LPG stove and first cylinder directly from their own resources or to obtain credit from banks or microfinance institutions to do so. For example, access to credit through microfinance institutions has helped to promote a relatively rapid uptake of LPG in Kenya (UNDP, 2009). In many countries, urban and peri-urban areas are those where most LPG penetration is expected and also those that are more likely to be served by microfinance institutions. However, some microfinance institutions may initially require a partial credit guarantee provided by the public sector to generate confidence in lending to a new market. Lower income households receiving LPG stoves in the Energy for All Case are expected to benefit from a loan or subsidy that covers the initial cost of the stove and the deposit on the first cylinder. This loan or subsidy is assumed to be funded in part by the government and in part by multilateral and bilateral donors. Experience in Senegal has shown that LPG sometimes requires subsidies to be maintained for a period in order to keep costs below the monthly amounts that households previously spent on competing wood fuel or charcoal. Indonesia has undertaken a programme to distribute free mini-LPG kits to more than 50 million households and small businesses in an attempt to phase out the use of kerosene for cooking (and reduce the fiscal burden of the existing kerosene subsidy). Analysis of the programme indicates that a capital investment of $1.15 billion will result in a subsidy saving of $2.94 billion in the same year (Budya and Yasir Arofat, 2011).

Clean cooking facilities – financing biogas systems

In the Energy for All Case, additional annual investment of $1.8 billion is required in biogas systems over the projection period. This is an increase in investment of $1.2 billion annually, compared with the New Policies Scenario, and provides an additional 15 million people each year with a biogas system for cooking. In the Energy for All Case, an output-based subsidy programme for trained and certified installation companies is assumed to cover about 30% of the cost of a biogas digester. In 2010, a subsidy of 26% of the total cost was available for a home biogas plant of an average size in Bangladesh and Nepal, while in China subsidy levels have been as high as 69% of total costs (SNV, 2011). A subsidy may be provided to the builder via a rural development agency or equivalent after verification of successful installation. In return for receiving the subsidy, the installer can be obliged to guarantee the unit for several years. Assistance from multilateral and bilateral donors or NGOs can help train biogas digester builders, as the Netherlands Development Organisation (SNV) has done in several of countries.

Both higher and lower income households may require a loan to cover part of the cost of a biogas system. For example, the Asian Development Bank (ADB) has worked with the Netherlands' SNV to add a credit component to a biogas programme in Vietnam (ADB, 2009). The Biogas Partnership in Nepal has on-lent donor and government funds to over 80 local banks and microfinance institutions to provide end-user financing (UNDP, 2009 and Ashden Awards, 2006). This programme involved support for the development of local, private sector biogas manufacturing capacity, as well as training and certification facilities to ensure that quality standards were maintained. Between 35% and 50% of the capital costs were subsidised through grants from international donors, such as the German development finance institution, KfW. Loan capital was available for the remaining capital investment.

The government, through a national development bank or rural energy agency, may need to support microfinance institutions or rural agricultural credit co-operatives to expand their coverage and lending to rural areas. This can be done by offering grants, or by temporarily offering partial credit guarantees or loans at below-market interest rates that enable on-lending, until financial institutions are confident to operate in the new market. In some cases, lower income households may also lower the unit price by contributing their labour, which can be around 30% of the cost (Ashden Awards, 2010).

Clean cooking facilities – financing advanced cookstoves

In the Energy for All Case, additional annual financing of $0.8 billion is required in advanced biomass cookstoves. This is an increase of $0.6 billion per year, compared with the New Policies Scenario, and serves to provide a first advanced cookstove to an additional 60 million people per year and financing for 50% of the first replacement after five years. While advanced cookstoves can help cut wood fuel use substantially, the economic arguments alone may not be compelling for many households, especially if wood fuel is considered "free" and the time of the persons collecting it – typically women and girls – is not sufficiently valued. Comprehensive public information and demonstration campaigns to explain the health and other benefits are therefore likely to be required to increase household acceptance. In addition, funding will be required to ensure adequate quality control of cookstoves.[36] Such campaigns are expected to be funded with grants, either from the government or multilateral and bilateral development partners, and will benefit from international support through initiatives such as The Global Alliance for Clean Cookstoves. Public information and demonstration campaigns have successfully led to market transformation in Uganda, Mali and Madagascar among others (AFD, 2011). In Sri Lanka, an estimated 6 million advanced cookstoves have been sold over the last ten years using innovative business models, such as "try before you buy". The programme has been supported by several international donors and the government of Sri Lanka (IEA, 2011).

Of the additional investment in the Energy for All Case, an estimated 70% is directed to lower income households. For these, the provision of credit to help purchase advanced cookstoves may be appropriate in some cases, as successfully implemented by Grameen Shakti in Bangladesh (Ashden Awards, 2008). Unfortunately, use of microcredit may be problematic for advanced stoves, particularly because of the high transaction costs compared with the purchase price and the traditional focus of microcredit on income-generating activities (Marrey and Bellanca, 2010). As an alternative, the government may help develop dealer financing through certified cookstove builders, *e.g.* using a partial credit guarantee with funds provided by the government or by multilateral and bilateral development partners. Experience in some countries has shown that large subsidies (and especially give-aways) can actually undermine the market for advanced stoves and create expectations of a subsidy for replacement stoves (AFD, 2011).

36. Funding for quality control is not included in our estimates of the required investment costs.

Sources of financing and barriers to scaling up

This section considers the main sources of financing in more detail, and the types of projects and instruments to which they are, or may become, most effectively committed. These sources are summarised under the main categories: multilateral and bilateral development sources, developing country government sources and private sector sources. It is recognised that there are instances in which these categories may overlap or change over time. For example, countries currently focused on investing in energy access domestically may also invest in other countries. Rapidly industrialising countries, such as China and India, may be such cases. Within each broad category, several different types of organisations may offer one or more types of financing instrument to improve energy access. Table 13.9 shows different financing instruments and a summary of the sources that might typically offer them.

Table 13.9 • Sources of financing and the financing instruments they provide

	Grants / credits	Concessionary loans	Market-rate loans	Credit line for on-lending	Partial credit guarantees	Political risk insurance	Equity	Quasi-equity	Carbon financing	Subsidy / cross-subsidy	Feed-in tariff	Technical assistance
Multilateral development banks	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓
Bilateral development agencies	✓	✓	✓	✓					✓			✓
Export-import banks / guarantee agencies			✓			✓						✓
Developing-country governments	✓	✓					✓	✓		✓	✓	
State-owned utilities							✓			✓	✓	
National development banks		✓	✓	✓	✓							✓
Rural energy agencies/ funds	✓									✓		✓
Foundations	✓						✓		✓			
Microfinance			✓									
Local banks			✓									
International banks			✓					✓	✓			
Investment funds							✓		✓			
Private investors							✓		✓			✓

Multilateral and bilateral development sources

Multilateral development sources include the World Bank Group,[37] the regional development banks[38] and major multilateral funds, such as the Organization of the Petroleum Exporting Countries Fund for International Development (OFID) and the Scaling-up Renewable Energy Program for Low-Income Countries (SREP) (Box 13.4 considers the International Energy and Climate Partnership – Energy+). Bilateral sources are primarily official development assistance provided by the 24 OECD countries that are members of the OECD Development Assistance Committee (DAC). These OECD member countries account for the bulk of global development aid (99% of total ODA in 2010), including that provided via multilateral sources, but this situation continues to evolve. The major financing instruments used by these sources for energy access projects are grants, concessional loans and investment guarantees.[39] Carbon financing is another instrument that has begun to be utilised for energy access projects.

Credits from the International Development Association (IDA) have been the main instrument employed by the World Bank Group for energy access projects, followed by grants, including from special funds such as the GEF and the Carbon Funds. However, obtaining grants can require long proposal preparation periods and the need to satisfy multiple criteria. The International Bank for Reconstruction and Development (IBRD) also provides concessional loans to medium-income governments, which are typically applied to large electricity infrastructure projects. The IFC is able to lend to the private sector and organise loan syndications that give international banks greater confidence to invest in projects in developing countries. It also lends to local financial institutions for on-lending to small and medium businesses, and is increasingly creating guarantee products that help develop the capacity of the local banking sector and making equity investments. The UN Development Programme (UNDP) and UN Environment Programme (UNEP) have been particularly active in helping develop schemes for end-user finance.

Political risk insurers, such as the Multilateral Investment Guarantee Agency (MIGA), and bilateral programmes such as Norway's Guarantee Institution for Export Credit (GIEK), have a mission to promote foreign direct investment in developing countries by insuring private investors against risks such as breach of contract, non-fulfilment of government financial obligations and civil disturbances. Obtaining such risk insurance can have leveraging effects, making it easier for projects to obtain commercial finance, or to do so at lower cost. Financing from most multilateral and bilateral development sources is usually accompanied by technical assistance, such as policy and institutional development advice to ensure the efficient use of the provided funds. Such investment in technical assistance can be important in ensuring that an adequate number of private projects enter the financing pipeline.

37. World Bank Group includes the World Bank, International Development Association, International Bank for Reconstruction and Development, International Finance Corporation and Multilateral Investment Guarantee Agency.

38. Regional development banks include the Asian Development Bank, African Development Bank and Inter-American Development Bank.

39. Bilateral development sources offer many of the same financing products as multilaterals sources.

Potential barriers to scaling up the financing instruments provided by multilateral and bilateral sources for energy access include: the significant amount of regulatory and financial sector reforms that may be necessary to enable some countries to absorb increases in development (and other) financing; the need to satisfy multiple criteria in order to apply much of the available development assistance to energy access projects, particularly those related to renewable sources and climate change; and, the reordering of development priorities that may be required of organisations (and the governments behind them) in order to increase the share of energy-access projects within their portfolios.

Box 13.4 • International Energy and Climate Partnership – Energy+

The International Energy and Climate Partnership – Energy+, an initiative that aims to increase access to energy and decrease or avoid greenhouse-gas emissions by supporting efforts to scale up investments in renewable energy and energy efficiency, is a pertinent example of the increasing international recognition of the importance of providing modern energy access to the poor. It focuses on the inter-related challenges of access to modern energy services and climate change, recognising that both issues require a serious increase in capital financing. The initiative seeks to engage with developing countries to support large-scale transformative change to energy access and to avoid or reduce energy sector greenhouse-gas emissions. It seeks to apply a results-based sector level approach and to leverage private capital and carbon market financing. The Energy+ Partnership aims to co-operate with governments and to leverage private sector investment, to develop commercially viable renewable energy and energy efficiency business opportunities to meet the challenge of increasing access to energy in a sustainable manner. The intention is to facilitate increased market readiness by creating the necessary technical, policy and institutional frameworks. The government of Norway has initiated dialogue with possible partners to develop the initiative.

Carbon financing

Carbon finance offers a possible source of income for energy access projects that also help reduce greenhouse-gas emissions. The revenue is raised through the sale of carbon credits within the Clean Development Mechanism (CDM) and voluntary mechanisms. The value of carbon credits produced from new CDM projects reached around $7 billion per year prior to the global financial and economic crisis. However, low income regions so far have made little use of carbon finance mechanisms to mobilise capital for investment in energy access. Up to June 2011, only 15 CDM projects, or 0.2% of the total, have been designed to increase or improve energy access for households.[40]

The potential for projects to serve both energy access and climate change purposes in sub-Saharan Africa is estimated to be large, nearly 1 200 TWh (150 GW) of electricity

40. Data available at UNEP RISOE CDM Pipeline Analysis and Database at www.uneprisoe.org.

generation at an investment cost of $200 billion. In total, these projects could possibly generate $98 billion in CDM revenue at a carbon offset price of $10 per tonne of CO_2 (World Bank, 2011).

Substantial obstacles must first be overcome. Getting any project approved for CDM is at present often a long, uncertain and expensive process. Upfront costs are incurred to determine the emissions baseline and to get the project assessed, registered, monitored and certified. These high transaction costs mean that CDM is not currently practical for small projects. The CDM Executive Board has taken steps to simplify the requirements for small-scale projects and for projects in the least developed countries and it is hoped that these and other ongoing initiatives, such as standardised project baselines, will facilitate the application of the CDM for energy access projects. The increasing development of programmatic CDM should help reduce transaction costs by consolidating the small carbon savings of individual access projects. National governments in developing countries can act to reap the benefits from such candidates, as recent projects have shown for advanced cookstoves in Togo, Zambia and Rwanda, and for household lighting in Bangladesh and Senegal. Rural electrification agencies or national development banks can act under government direction as co-ordinating and managing entities for bundling energy access projects.

Consensus is building on the importance of using carbon finance to support the development agenda in poor countries. EU legislation provides that carbon credits from new projects registered after 2012 can only be used in the EU Emissions Trading System if the projects are located in the least developed countries. Such steps provide a more bankable basis for raising capital. To get capital flowing into energy access projects backed by carbon finance in low income countries, it remains for national governments fully to empower the relevant national authority to simplify the regulatory requirements and to create the secure commercial environment necessary to win investor confidence. A recent report by the UN Secretary-General's High-level Advisory Group on Climate Financing (AGF)[41] recognised carbon offset development as a stimulant for private sector investment. Building private sector understanding of the process of using carbon finance and confidence in it is an important objective for all parties.

Developing country government sources

Important sources and forms of finance from within developing countries include the balance sheet of state-owned utilities, subsidies provided by the government, grants and loans offered by developing country national development banks, and specialised national institutions and funds, such as rural energy agencies. In many developed countries, grid expansion is financed from the internally generated funds of private or state-owned utilities. This option is not available where state-owned utilities in developing countries often operate at a loss or rely on state subsidies for capital investment and, sometimes, operating

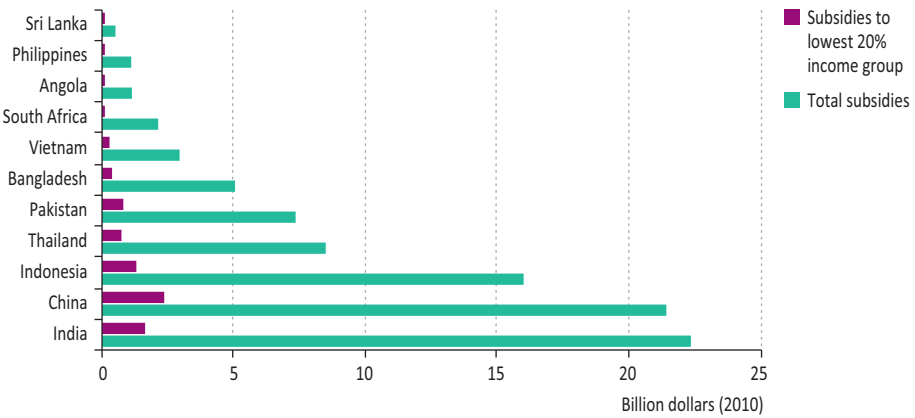
41. The UN Secretary-General established a High-level Advisory Group on Climate Change Financing on 12 February 2010 for a duration of ten months. This Group studied potential sources of revenue that can enable achievement of the level of climate change financing that was promised during the United Nations Climate Change Conference in Copenhagen in December 2009. See www.un.org/climatechnage/agf.

expenditures. Government utilities are nonetheless often a conduit for government funds in practice. While some are able to borrow on the international or local market, based on a government guarantee or good financial track record, many others are not.

Failure by government entities to pay for utility services and politically-imposed limitations on utilities' ability to enforce payment through disconnection are additional important barriers to balance sheet financing by state-owned utilities. Pre-payment meters, which gained widespread use in South Africa's electrification programme over the past decade, have helped power companies in many developing countries address the non-payment issue, although the capital costs of such metering programmes can be a barrier.

Subsidies can be provided from the government budget, sometimes supported by donor funds (Chapter 14 examines developments in energy subsidies). It is important that subsidies are used sparingly and are precisely targeted at those unable to pay and at the item they may have difficulty paying for, usually the connection fee. Unfortunately, many government subsidies in the energy sector are not well targeted (Figure 13.12). A typical example is the provision of consumption subsidies, including "lifeline" tariffs that provide the first 20 to 50 kWh of electricity at below cost to all customers regardless of income. Not only does this waste scarce funds that could be better targeted at poor people, but it foregoes an opportunity to collect cross subsidies from those customers who could afford to pay more. Cross subsidies from customer groups that pay more for their power than the cost to supply them can be an initial source of funds to help provide energy access to the poor, but are not an efficient long-term solution.

Figure 13.12 • Fossil-fuel subsidies in selected countries, 2010



Many developing countries have established development banks to help channel government and donor finance to priority sectors that are not receiving sufficient private investment. National development banks are useful entry points for multilateral and bilateral development institutions seeking to use their lending to the energy-sector,

including to end-users, to generate complementary funding from other sources. Some have on-lending and credit guarantee programmes with the local banking sector that might be adapted to lending for energy access projects. National development banks may sometimes be able to serve as an official guarantor for lending programmes supported with donor financing. In recent years, several developing country governments have established agencies specifically to fund and facilitate rural electrification. Some also promote modern cooking facilities, renewables and energy efficiency. Use of rural energy agencies has been particularly prevalent in Africa, including in Mali, Tanzania, Zambia, Senegal and Uganda, though they exist in several Asian countries too, including Cambodia and Nepal.

There are many reasons why domestic governments have difficulty in attracting or repaying financing for energy access. The most notable is poor governance and regulatory frameworks. The absence of good governance increases risk, so discouraging potential investors. The issue must be tackled.

Private sector sources

Private sector financing sources for energy access investments include international banks, local banks and microfinance institutions, as well as international and domestic project developers, concessionaires and contractors. Private finance may also come from specialist risk capital providers, such as venture capital funds, private equity funds and pension funds. The main forms of instruments favoured by private sources include equity, debt and mezzanine finance.[42] An increasingly important instrument, offered through local banks, is the extension of credit to end-users, often with guarantees arranged in partnership with multilateral development banks.

Private investors, enjoying a choice of where to place their money, across countries and across sectors, respond to tradeoffs between risk and reward. Important issues to tackle when seeking to increase private sector investment therefore include the provision of a competitive rate of return that incentivises private sector performance while representing value for money to the public sector, and the clear allocation to the most appropriate party of responsibility for risk. Existing experience reveals that justifying the business case is not always easy, and many private sector participants in energy access projects are doing so on the grounds of broader benefits to the company, such as corporate social responsibility. Despite the challenges, there is significant innovation taking place with several models, products and services in a pilot stage of development. Many potential private sector participants currently view a PPP-type model to be among the most attractive. In instances where the business case for private sector investment is marginal, but there are clear public benefits, government support to enhance or guarantee investment returns may be appropriate.

Countries that are seen to be particularly risky, in terms of macroeconomic, political or regulatory stability, either have to assume more of the risks themselves, by offering credible

42. Mezzanine finance is a hybrid of debt and equity financing. Mezzanine financing is basically debt capital that gives the lender the right to convert to an ownership or equity interest in the company under certain pre-agreed conditions.

guarantees, or seek to have these risks covered by some form of insurance. A strong track record of introducing and implementing robust and equitable government policies can reduce the need for financing guarantees. Important factors for private investors in the power sector typically include (Lamech and Saeed, 2003):

- A legal framework that defines the rights and obligations of private investors.
- Consumer payment discipline and enforcement.
- Credit enhancement or guarantee from the government or a multilateral agency.
- Independent regulatory processes, free from arbitrary government interference.

International commercial banks have an established record of financing projects in the energy sector in emerging markets, predominantly in power generation. Pricing finance at market rates according to perceived risk, they offer debt financing, mezzanine finance and, in some cases, equity. They can lend to project developers directly or to a special purpose vehicle set up to conduct the project. Commercial bank financing terms can be less onerous if certain risks are covered by guarantees from a multilateral development bank or the host government.

Local financial institutions in many developing countries are unable or unwilling to provide credit to rural energy projects or to the end-users of such projects. The World Bank, UNDP and UNEP, among others, have been involved in pilot projects to create links between local banks and renewable energy service providers and help them design suitable credit instruments. Understanding households' existing energy expenditures is one important step towards unlocking end-user finance: poor people often are able to afford the full price of modern energy because it costs less than the traditional forms it replaces, *e.g.* kerosene lamps and dry cell batteries, but may be unable to overcome the important hurdle of the initial capital cost.

Microfinance has been used as part of several programmes to tackle the problem of end-user financing for energy access, particularly in India and Bangladesh. It has been found to be particularly useful for grid connection fees and LPG stoves. The scale of the transaction is important. Microfinance has proved more problematic in relation to large solar home systems, where the loan size and consequent payment period can be greater than microfinance institutions are used to handling, or in relation to wood-burning stoves, where the transaction costs can be large relative to the loan amounts involved. Microfinance institutions are often part of networks, which act as wholesale lenders to them: these networks may be able to develop guaranteed lines of credit and related technical assistance from larger organisations. However, microfinance institutions and associated networks are often less prevalent in rural areas, in particular in parts of sub-Saharan Africa.

The main obstacle to obtaining greater private sector financing, apart from uncertain investment and regulatory environments and political risks in many developing countries, is the lack of a strong business case for tackling the worst cases of energy deprivation, because of the inability of users to pay. This issue needs to be squarely faced, through some form of public sector support, if there is to be a breakthrough to universal access to modern energy. In addition, local financial institutions and microfinance institutions find it difficult

to be sufficiently expert regarding new technologies and may underestimate the potential credit-worthiness of poor households, based on the large amount they already pay for more traditional sources of energy.

Implications for policy

Modern energy services are crucial to economic and social development; yet escalating global energy prices are pushing this fundamental building block further out of reach of those most in need. Even with the projected level of investment in modern energy access of $14 billion per year in the New Policies Scenario, the absolute numbers of people without access to modern energy in 2030 will be scarcely changed (though the proportion of the global population so deprived will have fallen). In sub-Saharan Africa, the numbers without modern energy access will have actually increased. Neither the policies adopted today nor the plausible new policies allowed for in the New Policies Scenario will do nearly enough to achieve universal access to modern energy services by 2030.

Global energy access is a necessary prerequisite of global energy security. The barriers to achieving modern energy access are surmountable, as many countries have proven. What actions does this analysis suggest that are essential to transform the situation? There are five:

- Adopt a clear and consistent statement that modern energy access is a political priority and that policies and funding will be reoriented accordingly. National governments need to adopt a specific, staged energy access target, allocate funds to its achievement and define their strategy, implementing measures and the monitoring arrangements to be adopted, with provision for regular public reporting.
- Mobilise additional investment in universal access, above the $14 billion per year assumed in the New Policies Scenario, of $34 billion per year. The sum is large, but is equivalent to around 3% of global energy infrastructure investment over the period.
- Draw on all sources and forms of investment finance to reflect the varying risks and returns of the particular solutions adapted to the differing circumstances of those without access to modern energy. To realise the considerable potential for stepping up the proportional involvement of the private sector, national governments need to adopt strong governance and regulatory frameworks and invest in internal capacity building. Multilateral and bilateral institutions need to use their funds, where possible, to leverage greater private sector involvement and encourage the development of replicable business models.
- Concentrate an important part of multilateral and bilateral direct funding on those difficult areas of access which do not initially offer an adequate commercial return. Provision of end-user finance is required to overcome the barrier of the initial capital cost of gaining access to modern energy services. Operating through local banks and microfinance arrangements, directly or through guarantees, can support the creation of local networks and the necessary capacity in energy sector activity.

- While the *World Energy Outlook* has sought to shed light in this area, it is important that energy access programmes and projects make provision for the collection of robust, regular and comprehensive data to quantify the outstanding challenge and monitor progress towards its elimination. In many ways, providing energy access is an objective well suited to development frameworks such as output-based financing, but accurate data needs to be collected to measure progress.