Measuring progress towards energy for all

Power to the people?

Highlights

- Since our last *Outlook*, the number of people without access to electricity globally has decreased by 50 million and the number without clean cooking facilities has declined by nearly 40 million. This has been realised despite the growth in world population and has been spurred by reported improvements in many countries, including India, Indonesia, Brazil, Thailand, South Africa and Ethiopia.
- Yet nearly 1.3 billion people remain without access to electricity and 2.6 billion still do not have access to clean cooking facilities. These people are mainly in either developing Asia or sub-Saharan Africa, and in rural areas. Just ten countries account for two-thirds of those without electricity and just three countries – India, China and Bangladesh – account for more than half of those without clean cooking facilities.
- In the New Policies Scenario, we project that close to 1 billion people will still be without electricity and 2.6 billion people will still be without clean cooking facilities in 2030. In the case of electricity, the number of people in developing Asia without access almost halves compared to 2010 (led by progress in India) and Latin America achieves universal access before 2030 but, in sub-Saharan Africa, a worsening trend persists until around 2025. For cooking, developing Asia sees a significant improvement (led by China), but the number of people without clean cooking facilities in India alone in 2030 is still twice the population of the United States today. In sub-Saharan Africa the picture worsens by around one-quarter by 2030.
- The UN Secretary-General's Sustainable Energy for All initiative has been vital in raising awareness of the urgent need to increase modern energy access. But the energy access funding commitments it had received by the time of the Rio+20 Summit were only equivalent to around 3% of the nearly $1 trillion in cumulative investment we estimate is needed to achieve universal access by 2030 in our Energy for All Case. Any concerns that achieving modern energy access for all would unduly magnify the challenges of energy security or climate change are unfounded, as it would only increase global energy demand by 1% in 2030 and CO_2 emissions by 0.6%.
- We present an Energy Development Index (EDI) for 80 countries, to aid policy makers in tracking progress towards providing modern energy access. It is a composite index that measures a country's energy development at household and community level. Our EDI results reveal a broad-based improvement in recent years. Countries showing some of the greatest improvements include China, Thailand, El Salvador, Argentina, Uruguay, Vietnam and Algeria. There are also a number of countries whose EDI scores are stubbornly low, such as Ethiopia, Liberia, Rwanda, Guinea, Uganda and Burkina Faso. As a region, sub-Saharan Africa scores least well.

Introduction

Has 2012 been a breakthrough year for modern energy access? A review of the last year reveals new focus, new commitments and new actions towards a goal of achieving universal energy access by 2030. The United Nations designation of 2012 as the Year of Sustainable Energy for All, coupled with the decision by the UN Secretary-General to include universal access to modern energy within his Sustainable Energy for All initiative (SE4All), has set the tone. At the Rio+20 Summit,[1] countries recognised the critical role of energy in the development process, committed themselves to measures to improve energy access and emphasised the need for further action. They noted the SE4All initiative, and stated their determination to act to make sustainable energy for all a reality, though they did not make a binding commitment to achieve universal modern energy access by 2030. The last year has raised the level of attention given to improving modern energy access and also the level of expectation about the ultimate results (Spotlight).

Even in a year intended to shine a light on energy access, challenges have continued to emerge. Higher oil prices (over $110/barrel in the first half of 2012) have helped push oil-import bills up in net-importing less-developed countries to an estimated 5.7% of gross domestic product, impacting on growth prospects. Energy expenditure in households is creeping higher in many countries and having a disproportionate impact on the poorest. Finance for energy access improvements often remains hard to secure and the necessary five-fold increase in investment, highlighted in *WEO-2011*, is far from being realised.

In this chapter, we report where we stand on universal modern energy access, based on a comprehensive update of our electricity and traditional biomass databases.[2] We then present projections for modern energy access in the New Policies Scenario, the central scenario in *WEO-2012*, together with an Energy for All Case that is designed to highlight what more needs to be done to put us on course to achieve universal access by 2030 and what some of the implications might be.[3] For our projections, we define energy access as a household having reliable and affordable access to clean cooking facilities and a first electricity supply connection, with a minimum level of consumption (250 kilowatt-hours [kWh] per year for a rural household and 500 kWh for an urban household) that increases over time to reach the regional average.[4] Our analysis takes into account the need for different technological solutions, such as grid, mini-grid and off-grid solutions for electricity, and advanced biomass cookstoves, liquefied petroleum gas (LPG) stoves and biogas systems for cooking. Additionally, this chapter covers the critical issue of tracking a country's energy development over time. We present an enhanced and expanded Energy Development Index (EDI) for 80 countries, a composite index that includes relevant indicators relating to household access to electricity and clean cooking facilities and

1. The United Nations Conference on Sustainable Development held in Rio de Janeiro, Brazil in June 2012.
2. We use 2010 data where available or an estimate based on latest available data.
3. While the *Outlook* period for *WEO-2012* is 2010 to 2035, analysis in this chapter is based exceptionally on the period 2010 to 2030, so as to be consistent with the goal of the Sustainable Energy for All initiative.
4. For more detail on our definition of energy access visit *www.worldenergyoutlook.org*.

to the use of modern energy for productive purposes (such as mechanical power) and public services (such as schools and hospitals). The objective is to provide an improved overall picture of a country's energy development. The EDI can support decision makers in ensuring that policy and financing commitments achieve maximum development impact.

SPOTLIGHT

What is the potential impact of new energy access commitments?

The UN Sustainable Energy for All initiative (SE4All) has had a big impact in raising global awareness of energy poverty and the urgent need to increase modern energy access. Over 150 commitments were submitted to the SE4All initiative across its three focus areas – energy access, energy efficiency and renewables – by the time of the Rio+20 Summit and more than 50 countries across Africa, Asia, Latin America and the Small Island Developing States confirmed their engagement (United Nations, 2012a).

The energy access commitments submitted vary significantly in terms of their size, scope and definition. For example, some are appliance driven goals (Solar Electric Light Fund, Nuru Energy LED lights programme, Toyola Energy cookstoves programme, Global LPG Partnership), some are capacity-driven commitments (ESMAP capacity building programme, Powering Agriculture Energy Grand Challenge and Schneider's BipBop programme), some focus more on additional financing (Energy+, OFID Energy for the Poor Initiative, African Development Bank investment programme and the GDF Suez Rassembleurs d'Energies programme) and some cut across different areas (the Rockefeller Foundation's "SPEED" initiative to demonstrate the potential for decentralised renewable energy provision in rural India) (United Nations, 2012b).

Across the three SE4All goals, the commitments equate to over $320 billion in direct investment. Of this total, around 10% is earmarked specifically for modern energy access, drawing the least investment of the three goals. Analysis of the commitments shows that, in line with our *WEO-2011* analysis, much of the energy access investment is sourced from multilateral development banks. Direct government sources were the second-largest source of energy access funding commitments, followed, some way behind, by the private sector. When compared to our projection that nearly $1 trillion of investment is required to achieve universal modern energy access by 2030 (see later section), it is clear that there is still a long way to go to achieve the financing required.

While the much-needed financing is not yet in place, there are encouraging signs with respect to achieving the necessary political commitment. Eight of the ten countries with the largest populations lacking electricity access today, and seven of the ten largest populations without clean cooking facilities, have signed up to the SE4All initiative. It is early days in the life of the SE4All initiative and, while significant additional funding and policy action is necessary, it has certainly had a positive impact in mobilising awareness and a greater unity of purpose to tackle this issue. Of paramount importance now is to ensure that it acts as a catalyst for even greater action in the future.

Global status of modern energy access

Hundreds of millions of people have attained modern energy access over the last two decades, especially in China and India. Rapid economic development in several developing countries, increasing urbanisation and ongoing energy access programmes have been important factors in this achievement. Despite this, in a world where the total population grows persistently, in 2010, nearly 1.3 billion people did not have access to electricity; though this is a reduction of 50 million, compared to our last *Outlook*, it is still close to one-fifth of the global population. Twice as many, around 2.6 billion people, relied on the traditional use of biomass for cooking (Table 18.1).[5]

Table 18.1 ▷ People without access to modern energy services by region, 2010
(million)

	Without access to electricity		Traditional use of biomass for cooking*	
	Population	Share of population	Population	Share of population
Developing countries	**1 265**	**24%**	**2 588**	**49%**
Africa	590	57%	698	68%
DR of Congo	58	85%	63	93%
Ethiopia	65	77%	82	96%
Kenya	33	82%	33	80%
Nigeria	79	50%	117	74%
Tanzania	38	85%	42	94%
Uganda	29	92%	31	96%
Other sub-Saharan Africa	286	66%	328	75%
North Africa	1	1%	2	1%
Developing Asia	628	18%	1 814	51%
Bangladesh	88	54%	149	91%
China	4	0%	387	29%
India	293	25%	772	66%
Indonesia	63	27%	128	55%
Pakistan	56	33%	111	64%
Philippines	16	17%	47	50%
Vietnam	2	2%	49	56%
Rest of developing Asia	106	34%	171	54%
Latin America	29	6%	65	14%
Middle East	18	9%	10	5%
World**	**1 267**	**19%**	**2 588**	**38%**

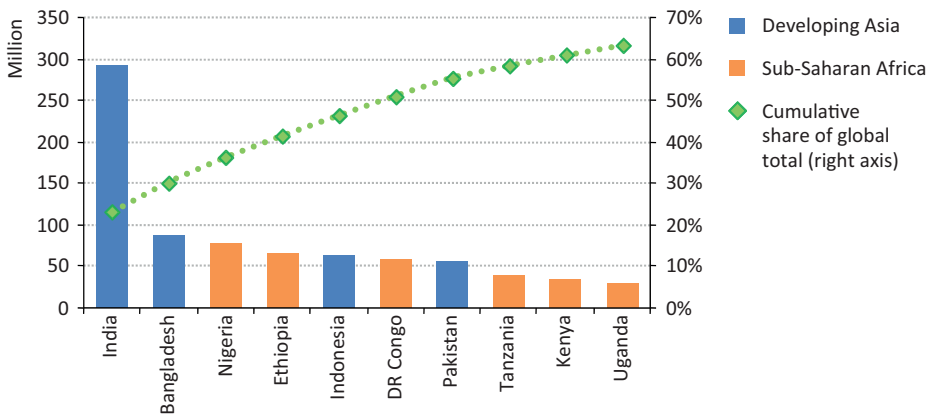
* IEA and World Health Organization databases. ** Includes OECD countries and Eastern Europe/Eurasia.

5. This chapter focuses on the traditional use of biomass for cooking, but there are also around 400 million people (not included in Table 18.1) that rely on coal for cooking and heating purposes, which causes air pollution and has serious potential health implications when used in traditional stoves. These people are mainly in China, but there are also significant numbers in South Africa and India.

Developing Asia and sub-Saharan Africa continue to account, together, for more than 95% of those without modern energy access. Across developing countries, the average electrification rate is 76%, increasing to around 92% in urban areas but only around 64% in rural areas. More than eight out of ten people without modern energy access live in rural areas, an important factor when seeking to identify the most appropriate solutions.

There are nearly 630 million people in developing Asia and nearly 590 million people in sub-Saharan Africa who lack access to electricity. Just ten countries – four in Asia and six in Africa – collectively account for nearly two-thirds of those deprived of electricity (Figure 18.1). While India has the largest population without electricity access, it has actually been a driving force in improving the trend in South Asia over the last decade, reducing the number of people without access to electricity by around 285 million. Large variations across the country persist, however: Goa and Himachal Pradesh, for example, report electricity use by around 97% of households, compared to only 16% in Bihar (Government of India, 2012). Other countries in developing Asia that report an improvement in the latest data include Indonesia, Myanmar, Nepal, Bangladesh and Pakistan. In sub-Saharan Africa, improvements in electricity access are reported in Ethiopia, Angola, Ivory Coast and Senegal, among others. Those countries with the lowest rate of electrification tend to be in sub-Saharan Africa.

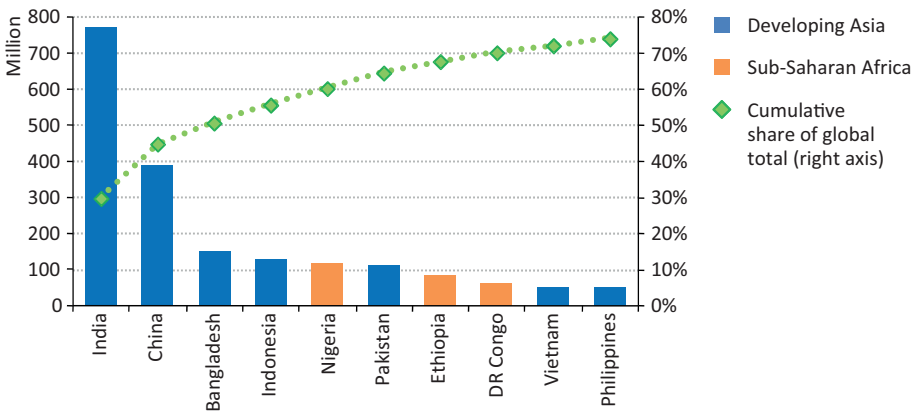
Figure 18.1 ▷ Countries with the largest population without access to electricity, 2010



A number of new initiatives to increase access to electricity or lighting across various regions have been announced over the last year. These include, for example: the Global Lighting and Energy Access Partnership (Global LEAP), which is intended to catalyse markets for off-grid energy products and services; D.Light Design, which is committed to providing solar lamps to 30 million people in more than 40 countries by 2015; the Energising Development programme, which aims to provide modern energy access to eleven million people by 2014; and Lighting India, which plans to bring clean lighting services to two million people by the end of 2015.

More than half of the population of developing Asia – over 1.8 billion people – and around 80% of people in sub-Saharan Africa – nearly 700 million people – live without clean cooking facilities. The global population lacking clean cooking facilities is heavily skewed towards a small number of countries – India, China and Bangladesh alone account for more than half of the global total – and towards developing Asia, in which seven of the ten largest populations without access are to be found (Figure 18.2). In developing Asia, the largest single change to our data relates to India, where the latest census results have prompted a significant revision, decreasing our estimate by more than 60 million people (Government of India, 2012). Nonetheless, nearly two-thirds of India's population remains without clean cooking facilities. Large differences can be seen at state level in India, with 85% of households in Odisha relying mainly on traditional biomass for cooking, compared to around 40% in Punjab. In developing Asia, China, Pakistan, Thailand and Vietnam show notable improvements. In sub-Saharan Africa, improvements are reported in South Africa, Senegal, Uganda and Ivory Coast, among others. Data for Latin America suggest a broad-based improvement, with the number of people without clean cooking facilities falling in many countries. New data for the Middle East permit a more accurate estimate, with its largest population without clean cooking facilities being in Yemen.

Figure 18.2 ▷ Countries with the largest population relying on traditional use of biomass for cooking, 2010



The inclusion of access to clean cooking facilities within the SE4All initiative was a welcome development, as was the launch in 2010 of the Global Alliance for Clean Cookstoves. A Global LPG Partnership has also been announced, which seeks to move at least 50 million people to LPG for cooking by 2018, with between $750 million and $1 billion of related investment. Another important development in the last year has been a new International Workshop Agreement (IWA), promulgated by the International Organization for Standardization (ISO), which provides guidance for rating cookstoves on four key performance indicators: fuel use/efficiency, total emissions, indoor emissions and safety (PCIA, 2012). It is the first international standard of its kind and it is hoped that it will be accepted as a benchmark against which to rate cookstove performance.

Outlook for energy access in the New Policies Scenario

Access to electricity

In our New Policies Scenario, the number of people without access to electricity is projected to decline to just over 990 million people in 2030, around 12% of the global population at that time (Table 18.2). Numbers larger than the population of China and the United States combined today – about 1.7 billion people – gain access to electricity over the projection period, but this achievement is counteracted, to a large extent, by global population growth. Our projection for the number of people without electricity access in 2030 is below one billion for the first time. The notable improvement, compared to *WEO-2011*, reflects a number of factors, including an improved economic outlook in many countries, stronger progress observed in some countries and reflected in our updated baseline, and a significant number of new commitments and policies aimed at improving electricity access. In the New Policies Scenario, total cumulative investment in electricity access is estimated to be $288 billion, or $14 billion per year on average.

Table 18.2 ▷ Number of people without access to electricity by region in the New Policies Scenario (million)

	2010				2030			
	Rural	Urban	Total	Share of population	Rural	Urban	Total	Share of population
Developing countries	**1 081**	**184**	**1 265**	**24%**	**879**	**112**	**991**	**15%**
Africa	475	114	590	57%	572	83	655	42%
Sub-Saharan Africa	474	114	589	68%	572	83	655	48%
Developing Asia	566	62	628	18%	305	29	334	8%
China	4	0	4	0%	0	0	0	0%
India	271	21	293	25%	144	8	153	10%
Rest of developing Asia	291	40	331	31%	161	20	181	14%
Latin America	23	6	29	6%	0	0	0	0%
Middle East	16	2	18	9%	0	0	0	0%
World	**1 083**	**184**	**1 267**	**19%**	**879**	**112**	**991**	**12%**

The number of people without electricity access in developing Asia is projected to nearly halve, going from around 630 million in 2010 to below 335 million in 2030. This continues an already positive trend, with China (reporting more than 99% access today) expected to reach universal access by the middle of this decade, and the remainder of East Asia having much reduced numbers without access in 2030. South Asia is also expected to see significant improvement, but India in 2030 continues to have the single largest population without electricity access, at around 150 million.

In sub-Saharan Africa, we project that the number of people without access to electricity will increase by around 11% to 655 million in 2030. Improved economic prospects and new commitments to action now suggest that the worsening trend will not extend beyond

about 2025; but the prospect of improvement is fragile – it can still be upset by a change in economic fortunes, higher energy prices or a failure to implement policy action. Due to significant improvements elsewhere, sub-Saharan Africa accounts for an increasing share of the global population without electricity access, going from 46% in 2010 to 66% in 2030. North Africa is projected to achieve universal access by 2020.

We project universal access to electricity in Latin America to be achieved by around the mid-2020s. This change from our last *Outlook* reflects the progress that continues to be made, both in terms of general economic development and improving modern energy access. Brazil is a particularly strong example, as it pushes ahead with its commitment to achieve universal access to electricity by 2014 (Box 18.1). Other examples of programmes active in Latin America include Enabling Electricity, which focuses on commercially viable solutions for isolated communities, and the "Luz en Casa" (Light at Home) programme, which focuses on solar home systems in northern Peru.

Box 18.1 ▷ Brazil's Luz Para Todos ("Light for All") programme

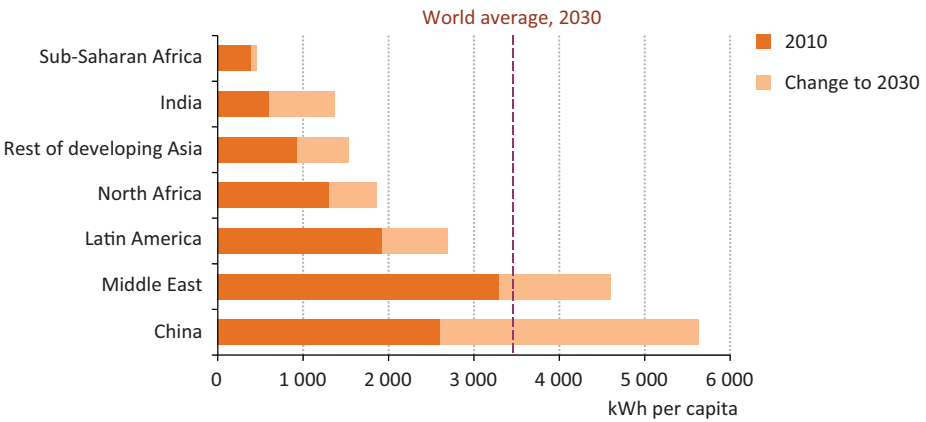
Launched in 2003, the Luz Para Todos programme aims to achieve universal access to electricity in Brazil by 2014. It had provided access to an estimated 14.5 million people by late 2011 and Brazil can now boast an electrification rate of almost 99% (Ministry of Mines and Energy, 2010). The programme is directed by the Ministry of Mines and Energy, co-ordinated by Electrobrás (the holding company of the Brazilian electricity sector) and executed by the utilities and rural electrification co-operatives. It provides an electricity connection free of charge, together with three lamps and the installation of two outlets in each home. Tariffs are regulated at a "social" rate, with a 65% discount for monthly consumption below 30 kWh, a 40% discount from 31-100 kWh, 10% discount from 101-220 kWh and no discount above this level.

Those people who remain without electricity in Brazil represent a particular challenge, as they mostly live in the Amazon, where the population is thinly spread (about four inhabitants per square-kilometre) and where extension of the power grid is difficult. Recognising this, the Luz Para Todos programme has created a handbook including ideas for setting up decentralised renewable energy systems, such as collective action by citizens to install solar and biogas power systems. The Ministry of Mines and Energy estimates that the Luz Para Todos programme has generated nearly 300 000 new jobs and a survey reported an increase in income in more than one-third of households after receiving electricity access (Ministry of Mines and Energy, 2009). Gómez and Silveira (2010) also found that the arrival of electricity stimulated social programmes providing health services, education, water supply and sanitation in Brazil.

Many of the trends observed in the New Policies Scenario in terms of access to electricity are mirrored when looking at electricity consumption per capita (Figure 18.3). Strong economic growth helps China's electricity consumption per capita to more than double

between 2010 and 2030, reaching the level of the European Union today. India sees a similar proportional increase, but from a much lower base; as a result, India's per capita electricity consumption in 2030 is still less than three-quarters the level in the United States in 1950. The increase in Latin America reflects successful action to reach relatively small, remote populations. Sub-Saharan Africa sees by far the smallest increase in electricity consumption per capita (in absolute terms) and a widening gap with the rest of the world.

Figure 18.3 ▷ Electricity consumption per capita in selected regions in the New Policies Scenario



Note: Includes electricity consumption across all sectors of the economy.

Access to clean cooking facilities

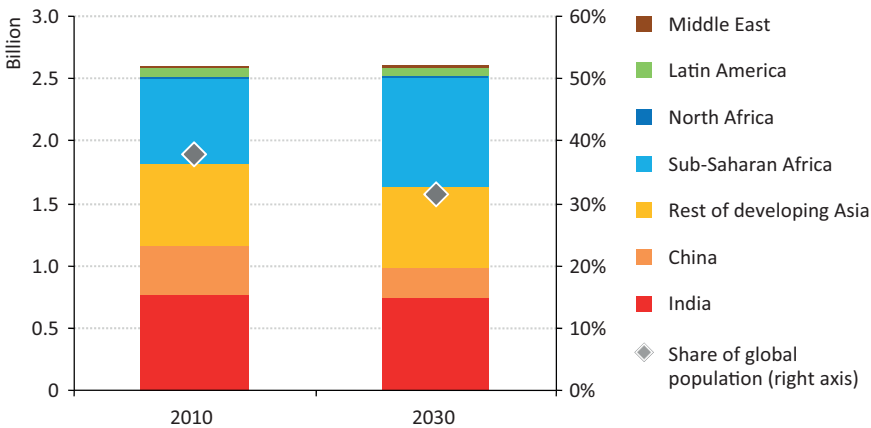
The number of people without clean cooking facilities is projected to remain almost unchanged in our New Policies Scenario, continuing at around 2.6 billion in 2030 – more than 30% of the global population at that time (Table 18.3). China achieves the single biggest improvement, with almost 150 million fewer people lacking access to clean cooking facilities by 2030, mainly as a result of economic growth, urbanisation and deliberate policy intervention, such as action to expand natural gas networks. Over the *Outlook* period, we project that, on average, around $635 million per year will be invested in clean cooking facilities. Despite this effort, population growth limits the global achievement only to ensuring that there is no significant worsening of the situation between now and 2030.

The regional picture shows that developing Asia is projected to see a large reduction in the number of people without clean cooking facilities by 2030 – around 175 million. China and, to a lesser extent, India account for most of the net improvement (Figure 18.4), but India still has nearly 30% of the global population without clean cooking facilities in 2030. The story is grim in sub-Saharan Africa, where our projections reveal a worsening situation, with the number of people without clean cooking facilities increasing by more than one-quarter, reaching around 880 million in 2030.

Table 18.3 ▷ Number of people without clean cooking facilities by region in the New Policies Scenario (million)

	2010				2030			
	Rural	Urban	Total	Share of population	Rural	Urban	Total	Share of population
Developing countries	**2 155**	**433**	**2 588**	**49%**	**2 139**	**456**	**2 595**	**39%**
Africa	518	180	698	68%	629	257	886	56%
Sub-Saharan Africa	516	179	696	81%	627	256	883	65%
Developing Asia	1 580	234	1 814	51%	1 458	182	1 640	39%
China	345	42	387	29%	220	20	240	17%
India	698	75	772	66%	680	55	735	50%
Rest of developing Asia	538	117	655	61%	558	106	664	50%
Latin America	47	18	65	14%	45	18	62	11%
Middle East	9	1	10	5%	8	0	8	3%
World	**2 155**	**433**	**2 588**	**38%**	**2 139**	**456**	**2 595**	**31%**

Figure 18.4 ▷ Number of people without clean cooking facilities by region in the New Policies Scenario



Energy for All Case

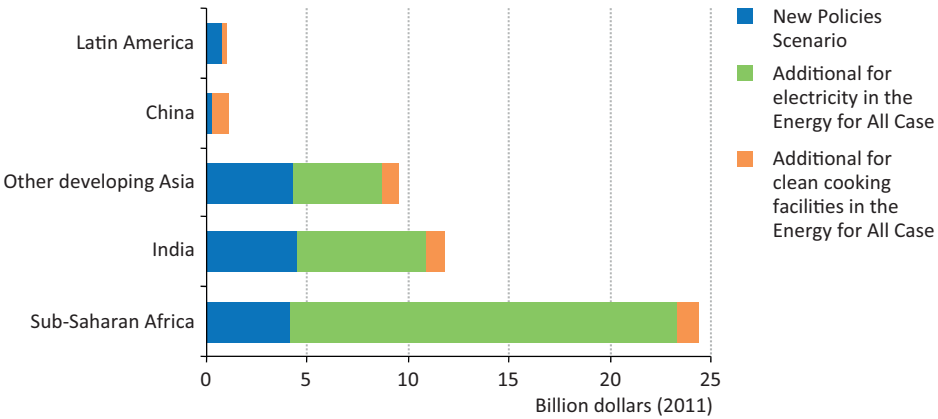
In our Energy for All Case, we examine the trajectory that would be required to achieve the goal of universal access to electricity and clean cooking facilities by 2030 and what the implications would be of doing so. We estimate that total investment of nearly $1 trillion ($979 billion) would be required to achieve universal energy access by 2030, an average of $49 billion per year (from 2011 to 2030). This requirement is small when compared to global energy-related infrastructure investment, equivalent to around 3% of the total.[6]

6. The additional investment in the Energy for All Case, compared to the New Policies Scenario, is equivalent to just over 2% of global energy-related infrastructure investment.

Our estimate includes both the $301 billion of investment we project to be forthcoming in the New Policies Scenario and the additional $678 billion that we estimate is required in the Energy for All Case. The additional investment required is derived from our analysis that seeks to match the most likely technical solutions within each region, given resource availability and government policies and measures.[7]

In the Energy for All Case, we find that around an additional $602 billion in investment is required to provide universal access to electricity by 2030, an average of $30 billion per year.[8] Sub-Saharan Africa accounts for 64% of the additional investment required, while developing Asia accounts for 36% (Figure 18.5). The additional investment provides electricity connections for almost 50 million people per year on average.

Figure 18.5 ▷ Average annual investment in modern energy access in selected regions, 2011-2030



In our Energy for All Case, additional investment of just under $76 billion is required in order to achieve universal access to clean cooking facilities by 2030, an average of $3.8 billion per year. This investment provides clean cooking facilities to an additional 135 million people per year on average, through a combination of advanced biomass cookstoves, LPG stoves and biogas systems. Advanced biomass cookstoves and biogas systems are relatively more common solutions in rural areas whereas LPG stoves play a more significant role in urban

7. For more on financing and investment for modern energy access, see the *WEO-2011* special early excerpt "Energy for All: Financing Access for the Poor" (October, 2011), *www.worldenergyoutlook.org*.

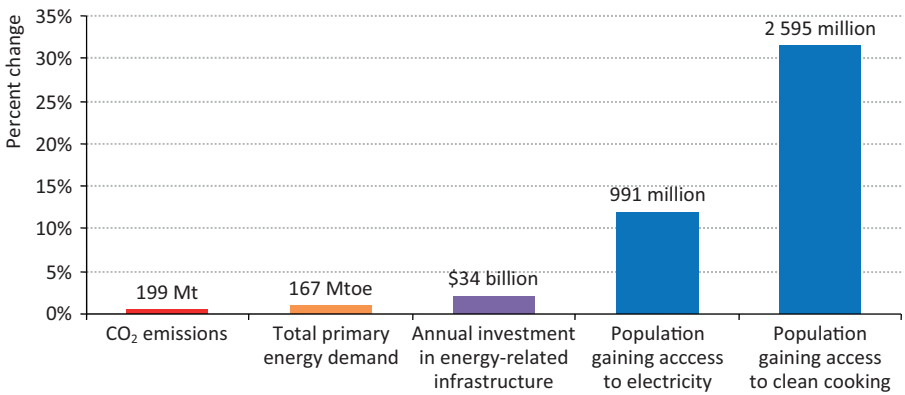
8. To arrive at our estimate, we assess the required combination of on-grid, mini-grid and isolated off-grid solutions in each region. We take account of regional costs and consumer density in determining a regional cost per megawatt-hour (MWh). When delivered through an established grid, the cost per MWh is cheaper than other solutions, but extending the grid to sparsely populated, remote or mountainous areas can be very expensive and long distance transmission systems can have high technical losses. This results in grid extension being the most suitable option for all urban zones and around 30% of rural areas, but not in more remote rural areas. The remaining rural areas are connected either with mini-grids (65% of this share) or small, stand-alone off-grid solutions (the remaining 35%), which have no transmission and distribution costs.

areas. While the target population is much larger, and the operational challenge no less significant, it is striking how much lower the investment need is to provide universal access to clean cooking facilities, compared with electricity.

The Energy for All Case will require an increase in financing from all sources, including development banks, country governments, bilateral official development assistance and, perhaps most importantly, the private sector. Various forms of financing are required, from the large project level down to the micro level. However, money alone will not do the job. Adequate government policies and planning, regional and sectoral target setting, monitoring and evaluation, training and capacity building for engineers and local workforces (for implementation, maintenance and repair) are needed also. Where possible, plans need to provide for the supply of energy efficient lighting systems and electric appliances, such as telephone chargers, batteries, fridges and information technology equipment. If those appliances are not highly efficient, the volume of electricity initially available may not be sufficient to meet even basic needs.

Global primary energy demand is 167 Mtoe higher in 2030 in the Energy for All Case (Figure 18.6). Less than half of the additional energy demand for electricity generation comes from burning fossil fuels. While fossil fuels play a major role in on-grid electricity solutions, renewables dominate for mini-grid and off-grid solutions. By 2030, an additional 0.85 million barrels per day (mb/d) of LPG is estimated to be required for cooking in the Energy for All Case. The significant role of renewables in the Energy for All Case means that the overall impact on global CO_2 emissions is relatively small, increasing by around 0.6% in 2030.

Figure 18.6 ▷ Additional impact of the Energy for All Case compared with the New Policies Scenario



Notes: Percentages are as a share of global energy-related CO_2 emissions (2030); global primary energy demand (2030); global energy-related infrastructure investment (annual average, based on the New Policies Scenario) and global population (2030). Mt = million tonnes; Mtoe = million tonnes of oil equivalent.

Energy Development Index (EDI)[9]

An essential part of any successful initiative to achieve universal modern energy access will be to have the means to track progress, so as to be able to inform governments and other stakeholders of what is being achieved and what more needs to be done. Since 2004, the IEA has published an Energy Development Index (EDI), which is designed as a composite measure of a country's progress in making the transition to modern fuels and modern energy services. It is intended to help understanding of the role that energy can play in human development. This year, we have sought to improve the methodology of the EDI and present here updated and enhanced results for 80 countries.

Energy development framework

The perspective on modern energy access varies widely, from the individual user or supplier, through regional, national and supra-national levels. Our ambition for the EDI is to develop a multi-dimensional indicator that tracks energy development country-by-country, distinguishing between developments at the household level and at the community level (Figure 18.7). In the former, we focus on two key dimensions (as reflected earlier in this chapter), access to electricity and access to clean cooking facilities.[10] When looking at community level access (not to be confused with the term community services, which is sometimes used to describe health, education and other services), the categories are necessarily broader. In the case of public services, our focus is on the use of modern energy in schools, hospitals and clinics, water and sanitation, street lighting and other communal institutions or services. In the case of productive use, the focus is on modern energy use as part of economic activity, for example, agriculture (ploughing, irrigation and food processing), textiles and other manufacturing, etc. An additional aspect of modern energy use, captured to an extent within productive use, is transport. This is important because, particularly in the early stages of economic development, a significant share of energy consumed in the transport sector is used for productive economic purposes.

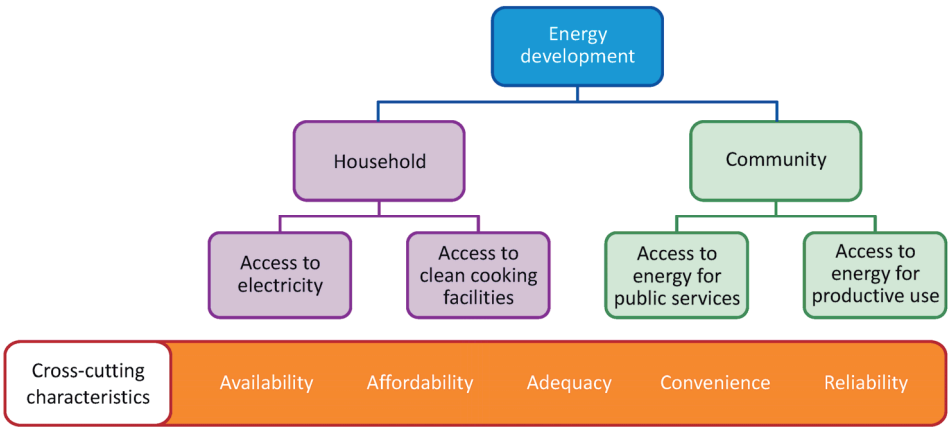
Within these broad categories, access to modern fuel and the appliances to utilise it are considered together *i.e.* a person has adequate access only if they have access to both. However, it is recognised that, in respect to both access to energy and access to appliances, there is also a progression. For instance, in the case of electricity, the first move might be from candles and batteries to solar lanterns, solar home systems or, possibly, a mini-grid. Similarly, first access is likely to involve only a small number of basic appliances, with greater diversity coming later. In addition, there are a number of issues that are sometimes referred to generically as "quality of supply". For any energy supply to provide a genuine

9. This analysis benefited from a roundtable meeting held by the IEA in Paris on 25 May 2012.

10. Access to heating is another important variable sometimes mentioned in this context. However, it is often excluded either due to the lack of data or because it is strongly related to cooking (the same means are often used for both). In some cases, clean cooking solutions can pose an additional challenge for policy makers because they are less effective at providing space heating than more traditional methods.

opportunity to use modern energy services there needs to be a technical possibility to use it (availability), a price that is not prohibitive (affordability), sufficient supply (adequacy) and a supply that is easy to use (and pay for), including being located nearby, available at desired hours of the day and safe to use (convenience). Importantly, the supply must be of the right quality (*e.g.* voltage level) and be usable for most of the time (reliability). At a more sophisticated level, it is also recognised that it may be desirable to track the quality of policies, regulations and institutions involved and, certainly, whether there is sufficient funding to support realisation of the objectives.

Figure 18.7 ▷ Energy development framework

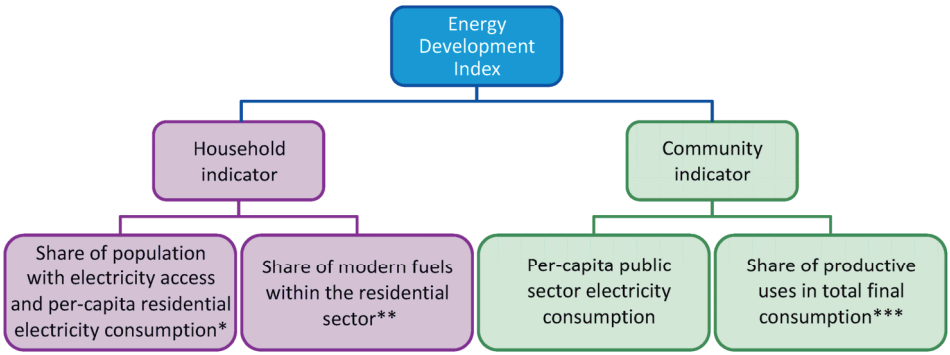


Notes: Household does not distinguish energy use as part of a micro-enterprise conducted within the home (which existing energy access data is often unable to identify). While very different in nature, energy for public services and for economic/productive purposes are grouped here under the community heading.

Focusing on the dimensions of modern energy access set out above makes it possible to identify a number of variables that can and should be monitored as a means of measuring energy development. However, adequate, regular, reliable and robust data are frequently not available. This is because data on many possible variables is typically collected (if at all) only as part of household or business surveys, which are often conducted on an infrequent basis in many countries and with a different prime focus. While this situation persists, some compromises have to be made: variables with some degree of explanatory value have to be used, despite imperfections. The main source is energy balance data from countries. Where possible, we use multiple data sources to cross-check figures. Our assessment of the strengths and weaknesses of the available possible indicators has led us to select those shown in Figure 18.8.[11] Our methodology leaves neutral any judgement on whether individual indicators are more or less important than others, ascribing an equal weighting to each in the calculation of new EDI (Box 18.2).

11. For more information, see our EDI methodology note at *www.worldenergyoutlook.org*.

Figure 18.8 ▷ Composition of the new Energy Development Index



* The geometric mean of the two variables is taken. ** Excludes electricity to avoid double counting. *** Includes industry, agriculture, services, transport and other non-specified energy use.

Notes: All variables are normalised on a fixed scale before calculating the EDI. As the indicators are aggregated to reach the EDI score, they are averaged.

Box 18.2 ▷ Areas for potential further development of the EDI

The standardised definition and measurement of country data would help further improve the EDI. Another desirable improvement would be the inclusion of a stronger indicator for quality of supply or efficiency of energy use. Other factors include the affordability of modern energy (Winkler, *et al.* 2011), how efficiently it is consumed and the level of consumption by small and medium-size enterprises (Kooijman-Van Dijk and Clancy, 2010), given their crucial role in employment and economic growth.

An important issue for some countries or institutions might be the development of a "low carbon" EDI, in which the variables were specifically related to measurement of the role of renewables and low-carbon technologies in the energy system. This might be driven by a concern that energy development that relies on fossil fuels, even to a relatively limited extent, could result in the "lock-in" of these technologies, and their associated emissions, for decades to come. Examining either the level of electricity generated from renewables (or fossil fuels) as a proportion of overall electricity would be one obvious indicator. If this were unavailable, the proportion of renewable energy (or fossil fuels), in a country's energy mix could be a fall-back measure. The number of recorded sales/installations of solar home systems or other types of renewable technologies (or of various energy-efficient technologies) could also be measured. For cooking, it might be appropriate to examine not only the type of fuel used but also the efficiency of stoves that are commonly sold, as this will be an important determinant of fuel demand. In terms of environmental or impact indicators, the level of local pollution linked to burning hydrocarbons could and should be monitored, as well as the number of reported illnesses related to local pollution. In terms of public services, one could measure the number of public health centres and the percentage of schools or training centres that provide their services on the basis of renewable energy technologies.

Results from the Energy Development Index

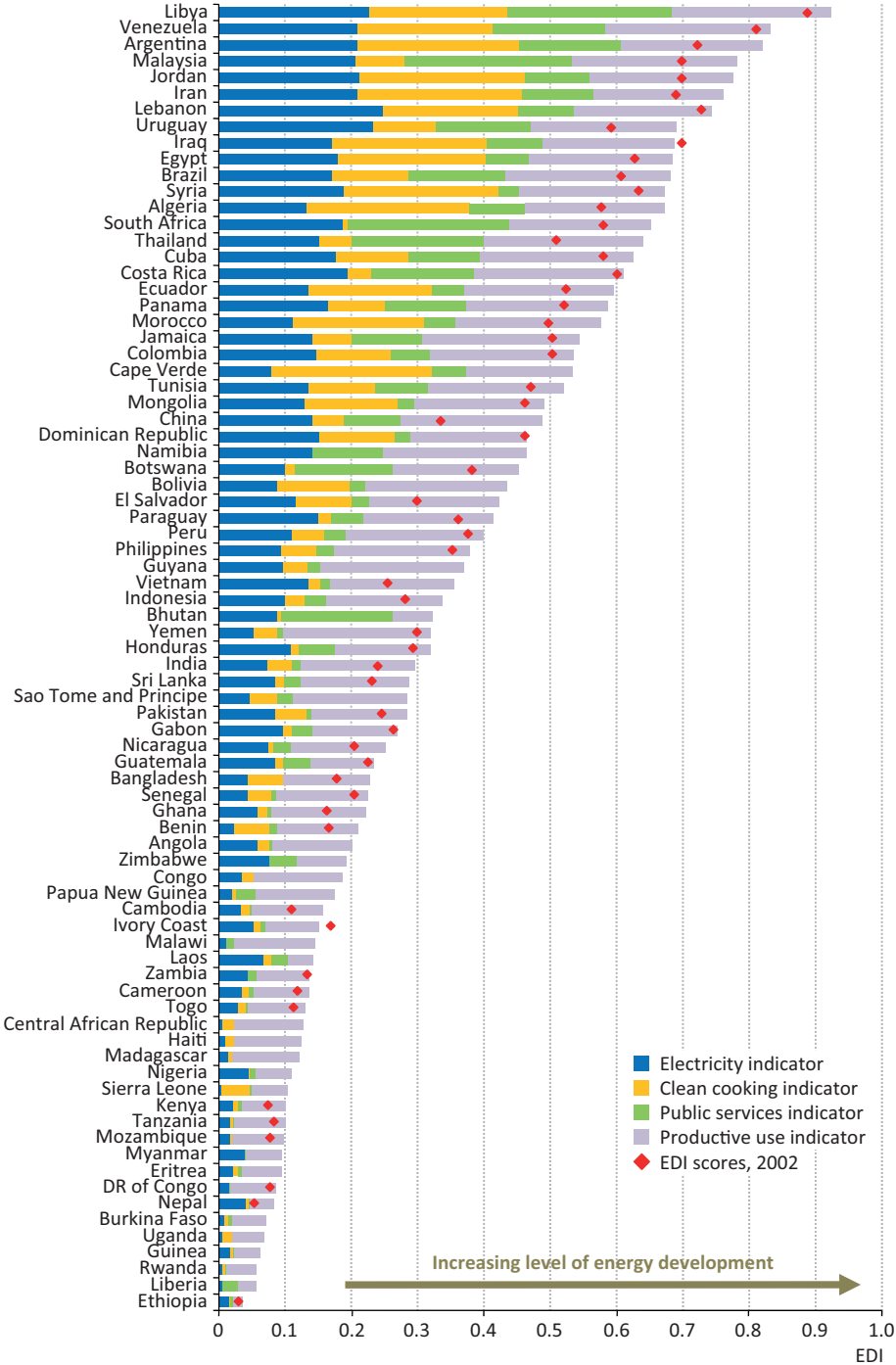
Figure 18.9 ranks 80 countries according to their overall EDI score. It also shows the relative contribution of each of the constituent indicators discussed above and, where available, shows a country's EDI score in 2002 for comparison. Many of the countries with the highest EDI score are in the Middle East, North Africa or Latin America. Countries in sub-Saharan Africa represent a significant share of those in the lower half of our EDI country scores. Rankings for countries in developing Asia are more varied, with Malaysia and Thailand scoring particularly well, while Nepal and Myanmar score relatively poorly. Oil exporters typically score well, although Nigeria is a notable exception. Those countries with a low overall EDI ranking tend to have a low result on the clean cooking and public services indicators. The countries with a higher ranking generally have a more balanced contribution from all the indicators, although there are exceptions, such as the small contribution made by the clean cooking indicator to the overall score for South Africa and Thailand.

For the countries for which we have both 2002 and 2010 data (56 in total) a general improvement over time is observed (only two countries do not improve). The average score increases from 0.39 to 0.43 (on the overall index) and the median score from 0.36 to 0.42. Of the ten countries reporting the largest improvement in their EDI score, four are in developing Asia (China, Thailand, Vietnam and Malaysia), three are in Latin America (El Salvador, Argentina, Uruguay), one is in the Middle East (Jordan) and two are in North Africa (Algeria, Morocco). Looking across regions as a whole does suggest that, on average, the biggest improvements have taken place in East Asia and North Africa.

China shows one of the largest increases in EDI score over time, driven by improvements in electricity access, public services and productive uses. In the area of clean cooking, China also sees a moderate improvement reflecting, in part, the successful installation of an estimated 40 million biogas plants by the end of 2010 (SNV, 2011). In the case of Thailand, much of the improvement is attributable to a much higher score in the public services indicator. Vietnam also reports a strong increase in its EDI score over time, with the largest share being attributable to the improvement in the household electricity access indicator. While its efforts go back decades, Vietnam's rural electrification programme has been central to it achieving a national electrification rate of 98% in 2010. Important factors in realising its impressive gains, included harnessing its natural abundance of hydropower, recognising the key role of infrastructure and the importance of multiple funding sources, and sustaining strong public and political support for efforts to improve electrification (Asian Development Bank, 2011). South Africa's Integrated National Electrification Programme can clearly be seen to have helped its improved electricity indicator score. Several countries in Latin America have registered strong improvements in their EDI, including El Salvador, Argentina, Uruguay, Brazil and Ecuador.

Despite the general improvement, many of the countries with the lowest EDI ranking, based on 2010 data, are the same as those with the lowest ranking based on 2002 data. Ethiopia continues to have the lowest EDI in our ranking, although it has improved by nearly 30% compared to 2002. Ethiopia has signed up as a partner in the Norwegian-led

Figure 18.9 ▷ Energy Development Index country results, 2010 (and 2002)



Energy+ Initiative, under which Ethiopia is to receive around $85 million[12] performance-based financing to support energy development, including increased distribution of clean cookstoves in rural areas. Kenya, which also has a relatively low EDI ranking, is to receive around $43 million under the same initiative, with the particular objectives of replacing paraffin lamps by lighting from solar power and increased adoption of clean cookstoves.

Nigeria, a country rich in hydrocarbon resources, continues to receive a low score in our EDI ranking. Despite large oil and gas export revenues, its EDI score reflects low modern fuel use for cooking and little electricity use for public services (Box 18.3). In the case of Ghana, whose electricity indicator has improved over time, the country has set itself the target of achieving universal access to electricity by 2020, in line with its National Energy Strategy of 2010, and has seen the electrification rate increase steadily. It fares less well on clean cooking, where a 2010 energy use survey, conducted by the Energy Commission, estimated that, despite improvement, around 40% of households still use firewood for cooking (Ghana Energy Commission, 2012), suggesting a need for increased focus.

Box 18.3 ▷ Africa: resource rich but modern energy poor

Africa is a continent full of energy resources, but it harvests only a little of these for its domestic use. North and West Africa have substantial oil and gas resources, while new exploration efforts have found significant resources also in East Africa (see Chapter 4); and South Africa is one of the world's largest suppliers of coal. Renewable energy resources are also abundant, with large hydropower potential in Central and East Africa, large geothermal energy potential in East Africa and favourable conditions for wind energy in North Africa, the Horn of Africa and South Africa. Solar energy potential is large across the continent and modern forms of biomass could also play a greater role in some areas. Despite this wealth of resources, Africa consumed less than one-quarter of the global average in modern energy per capita in 2011 while, at the same time, exporting more than half of the fossil fuels that it produced.

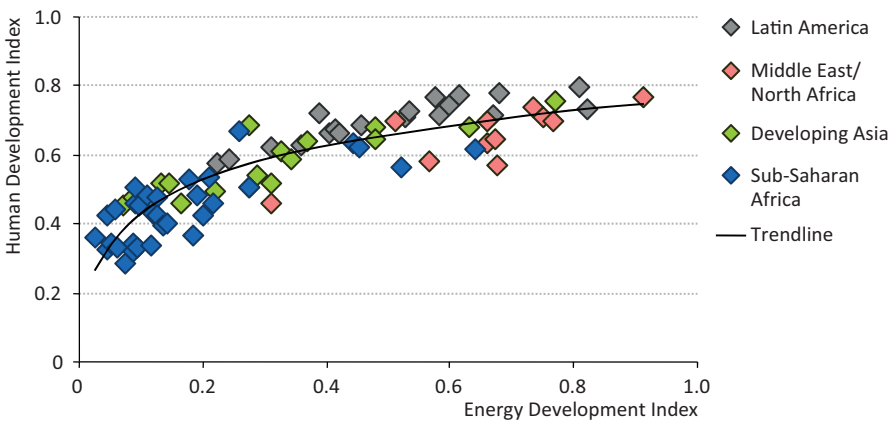
Africa's revenues from net energy exports are projected to increase from almost $280 billion per year to $415 billion in 2030. We estimate that achieving modern energy for all in Africa by 2030 would require investments of around $20 billion per year, or 5.5% of energy export revenues over the period. Over the projection period, Nigeria is projected to generate $105 billion per year in oil and gas revenues on average, while universal access to electricity and clean cooking facilities there would require investment of around $1 billion per year. In the case of Angola, the country would need to invest, on average, only 0.5% of its projected energy-export revenues in modern energy access in order to achieve universal access by 2030. For Mozambique, the story is of future potential, with the exploitation of new natural gas discoveries offering the opportunity to boost significantly efforts to provide modern energy access.

12. Based on NOK 0.17 = $1.

Iraq's EDI ranking serves to highlight the importance of including in a more sophisticated index an indicator capturing quality of supply (see Part C for more on Iraq's energy sector). While its ranking has worsened, when compared with 2002, it remains relatively high, reflecting a high rate of electrification (around 98%), relatively high consumption of electricity in the residential sector, significant use of either LPG or other modern fuels in cooking and relatively high levels of modern energy use in public services and productive sectors. However, what is not captured adequately is the unreliability of the electricity supply, entailing frequent power cuts, and unsatisfied electricity demand, compensated partly by reliance on expensive diesel generators. Were quality of supply factors reflected more directly within the EDI, we would expect Iraq to rank reasonably high, compared to many other countries, though not as high as at present.

The country and regional stories reflected in the EDI are generally confirmed when they are then compared to the scores of the UN Human Development Index (HDI) (Figure 18.10). Countries in sub-Saharan Africa once again tend towards the lower end of the spectrum, while those in the Middle East and North Africa tend to have both stronger EDI and HDI scores. There tends to be a more mixed picture in developing Asia and Latin America.

Figure 18.10 ▷ Comparison between the new Energy Development Index and the Human Development Index in 2010



This EDI, presented by country, but also split by indicator and shown over time, should be a valuable aid to a range of decision makers in tracking progress in important elements of a country's energy development. The EDI will also become more valuable as data quality improves, reinforcing the need for initiatives, such as the UN Sustainable Energy for All initiative, to emphasise and support efforts to strengthen capacity in this area. However, the EDI should still be seen as part of a broader suite of indicators that might also provide coverage at project/programme, sub-national and regional levels. We will continue to update the EDI on a regular basis, reflecting the latest available data, and, whenever possible, seeking to expand our country coverage. We will also continue to review the range of data sets available and, in light of developments, consider if our EDI methodology can be strengthened further, to provide an even better measure of a country's energy development.

Chapter 18: Energy for all

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