SUSTAINABLE ENERGY FOR ALL

GLOBAL TRACKING FRAMEWORK

Progress toward Sustainable Energy

2017

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FOREWORD

THE GLOBAL TRACKING FRAMEWORK A CLARION CALL TO LEADERS

This year's *Global Tracking Framework* (*GTF*) is an urgent call for leaders to take greater, more focused action to deliver sustainable energy for all.

We have just 13 years to meet the Sustainable Development Goals. Doing so will require a rapid increase in energy productivity, a new generation of institutions to manage our energy systems, an integrated approach that embraces centralized and decentralized sources, and a greater share of renewables in the mix. Securing this energy transition will be a critical contribution to the delivery of other Sustainable Development Goals (SDGs). Sustainable energy powers education and health systems, new businesses in previously unserved communities, jobs, manufacturing and industrialization, and water storage and food security.

To meet the Sustainable Development Goal for energy (SDG 7), Sustainable Energy for All and our partners are working to advance progress on three 2030 objectives: ensure universal access to modern energy services; double the share of renewable energy in the global energy mix; and double the global rate of improvement in energy efficiency.

This third edition of the *GTF* provides an evidence-based look at progress at the regional, country, and international level toward meeting these objectives. The report provides an overview of long-term trends since 1990 and focuses on progress achieved in the most recent period, 2012–14.

So how are we doing?

Many countries are taking action, but the world as a whole is not moving fast enough.

However, it's heartening to see that progress on energy efficiency is gaining momentum, bringing us closer to the pace needed to meet the 2030 objectives. The intensity of final energy consumption in industry, agriculture, services, and transport is decreasing. But improvements in the efficiency of thermal power generation and power networks have been relatively slow and the fast-growing residential sector is becoming more energy intensive. Investment in energy efficiency needs to increase by a factor of 3 to 6 from the current $250 billion a year in order to reach the 2030 objective.

On renewable energy, the *GTF* shows that despite advances in technology and falling prices in the electricity sector—particularly for solar and wind—the gains in the energy mix are a fraction of what is needed to meet global objectives. Those countries that have set aggressive targets for renewable energy are seeing rapid progress and need to be joined by others.

On closing the energy access gap, 1.06 billion people still live without electricity, and the number of people who still use traditional, solid fuels to cook rose slightly to 3.04 billion, indicating that efforts to advance clean cooking are not keeping up with population growth. However, the report shows that countries making energy access a policy priority can accelerate rapidly, particularly as new off-grid solar technologies start to come into play.

We hope that you will read the *GTF* alongside another study released in February 2017, which examines the regulatory framework for sustainable energy in 111 countries. RISE (*Regulatory Indicators for Sustainable Energy*) complements the findings in this report by putting the spotlight on the adoption of policies that support more rapid progress.

As global attention increasingly focuses on sustainable energy, providing decision-makers with timely updates of progress is more urgent than ever. Next year, the Sustainable Energy for All Global Tracking Framework will move to an annual rather than a bi-annual cycle. Decision-makers will be able to access the data in a more timely manner and implement changes needed to get us to the finish line.

It's possible to secure sustainable energy for all by 2030. But we are not on track. We must rise to the challenge agreed by the international community.

We must heed the clarion call.

We must all go further, faster—together.

Rachel Kyte
CEO for Sustainable Energy for All and Special Representative of the UN Secretary-General

PARTNERS

The development of the *Global Tracking Framework* was made possible by exceptional collaboration within a specially constituted Steering Group led jointly by the World Bank, Energy Sector Management Assistance Program, and the International Energy Agency. The membership of the Steering Group was as follows.

- Food and Agricultural Organization (FAO)
- Global Alliance for Clean Cookstoves ("the Alliance")
- Global Water Partnership (GWP)
- International Energy Agency (IEA)
- International Institute for Applied Systems Analysis (IIASA)
- International Network on Gender and Sustainable Energy (ENERGIA)
- International Partnership for Energy Efficiency Cooperation (IPEEC)
- International Renewable Energy Agency (IRENA)
- Practical Action
- Renewable Energy Policy Network for the 21st Century (REN21)
- Stockholm International Water Institute (SIWI)
- Sustainable Energy for All (SEforALL)
- United Nations Department of Economics and Social Affairs (UNDESA)
- United Nations Development Programme (UNDP)
- United Nations Economic Commission for Africa (UNECA)
- United Nations Economic Commission for Europe (UNECE)
- United Nations Economic Commission for Latin America and the Caribbean (ECLAC)
- United Nations Economic and Social Commission for Asia and the Pacific (ESCAP)
- United Nations Economic and Social Commission for Western Asia (ESCWA)
- United Nations Environment Programme (UNEP)
- Copenhagen Centre on Energy Efficiency
- UN Energy
- United Nations Foundation (UNF)
- United Nations Industrial Development Organization (UNIDO)
- UN Statistics
- UN Women
- World Bank (WB)
- World Energy Council
- World Health Organization (WHO)

The Steering Group's collaboration was made possible by agreement among the senior management of the member agencies. Riccardo Puliti (World Bank) and Fatih Birol (IEA), with Rohit Khanna (ESMAP), oversaw the development of the Global Tracking Framework in collaboration with Jane Olga Ebinger (SEforALL) and Minoru Takada (UNDP) and Ivan Vera (UNDESA). The technical team was managed by Vivien Foster (World Bank) and Dan Dorner and Hannah Daly (IEA). Alejandro Moreno (World Bank) coordinated inputs from multi-agency working groups and led the preparation of the report.

This work was largely funded by the participating agencies themselves. Financial support from ESMAP, to fund tasks managed by the World Bank, and from SEforALL, to fund tasks managed by the UN Regional Economic Commissions, is gratefully acknowledged.

A detailed list of all contributors can be found in the Acknowledgments section at the end of the report.

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SUMMARY

GLOBAL SCORECARD 2014

WHERE DO WE STAND ON SUSTAINABLE ENERGY FOR ALL OBJECTIVES?

Energy has been described as "the golden thread" connecting economic growth, social equity, and environmental sustainability. With this in mind, the United Nations General Assembly in 2012 embraced the Sustainable Energy for All (SEforALL) objectives for 2030, aiming to achieve universal access to modern energy, double the historic rate of improvement of energy efficiency, and double the share of renewable energy in the global energy mix. In 2015, Sustainable Development Goal 7 was adopted for 2030, to "ensure access to affordable, reliable, sustainable, and modern energy for all," building further on the three SEforALL objectives. Later in 2015, at the historic Paris Climate Conference (COP21), countries from around the world committed to Nationally Determined Contributions, many calling for progress on the sustainable energy agenda.

Preparation of this third edition of the SEforALL *Global Tracking Framework* has again been co-led by the World Bank/Energy Sector Management Assistance Program and the International Energy Agency (IEA), with valuable inputs from more than 20 organizations around the world—some longstanding partners and some joining for the first time. As in previous editions, this SEforALL *Global Tracking Framework* aims to provide the international community with a global dashboard to register progress on the three pillars of sustainable energy: energy access, energy efficiency, and renewable energy. This edition covers progress in 2012–14, collating and harmonizing official national data and providing regional and global analysis.

The findings clearly portray that the pace of progress on sustainable energy during 2012–14 fell short of what is needed to meet the global objectives by 2030. Of the three pillars of SEforALL, energy efficiency is advancing at the closest to the pace of change required to meet the 2030 objective.

Global electrification reached 85.3% in 2014, a modest improvement since 2012 and a slowdown from preceding years (figure 1). Access to clean fuels and technologies for cooking—here "clean cooking"—reached 57.4% globally in 2014, with barely any increase since 2012 (figure 2). Progress in reducing the energy intensity[1] of the global economy continued to accelerate, improving by a 2.1% compound average annual growth rate in 2012–14, compared with a SEforALL objective of –2.6%, and bringing global energy intensity to 5.5 MJ/2011 PPP $ (megajoules per 2011 purchasing power parity dollar) (figure 3). In 2014, the share of renewable energy in total final energy consumption climbed to 18.3%, continuing the slight acceleration of trends evident since 2010 (figure 4). Even so, progress is nowhere near fast enough to double its share to 36% in 2010–30 as envisaged by the SEforALL objective.

Results of recent global energy modeling, by the IEA and others, confirm the view that current efforts will not reach the targets set by the international community for 2030, even after taking into account new policy commitments made under COP21 and favorable technology trends like the steep reduction in the costs of solar PV (photovoltaic).

The IEA's New Policies Scenario, reflecting the latest policy pledges, estimates that by 2030 access rates will stand at 91% for electricity (figure 1) and 72% for clean cooking (figure 2).[2] Improvements in energy intensity will fall short of the 2030 objective, and the share of renewable energy in total final energy consumption will reach 21% (figure 4). This coincides with recent country work by the International Renewable Energy Agency (IRENA), which finds that without substantially exceeding current commitments, the world is likely to reach a renewable energy share of just 21% by 2030.

Looking at each of the dimensions of sustainable energy more closely helps in understanding why the world is not yet on track to meet its goals and what kinds of targeted efforts in which places offer the best prospects for accelerating global progress in coming years.

1. Primary energy intensity is a measurable proxy for energy efficiency that looks at the amount of energy needed to produce a dollar of economic output. Technically, energy intensity is defined as the ratio of total primary energy supply to gross domestic product (GDP, measured at purchasing power parity in 2011 U.S. dollars).
2. IEA Z-modeling excludes the use of coal and kerosene for cooking, which World Health Organization databases include.

FIGURE 1 **Access to electricity**

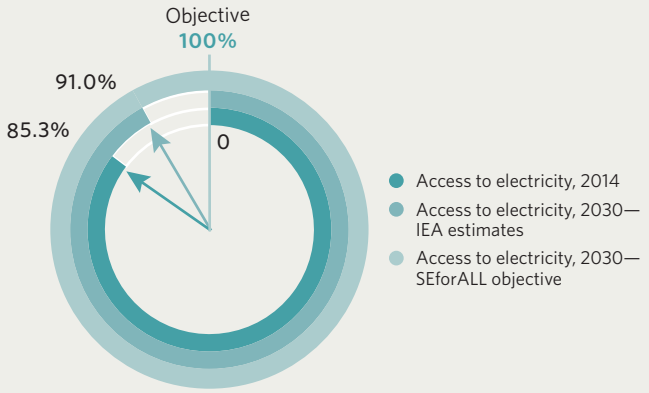


FIGURE 2 **Access to clean fuels and technologies for cooking**

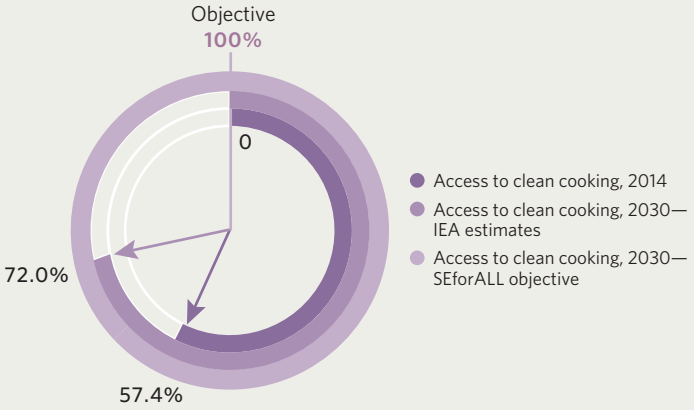


FIGURE 3 **Energy efficiency**

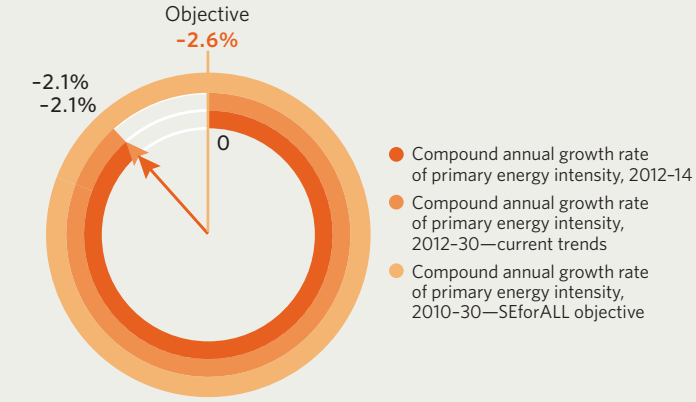
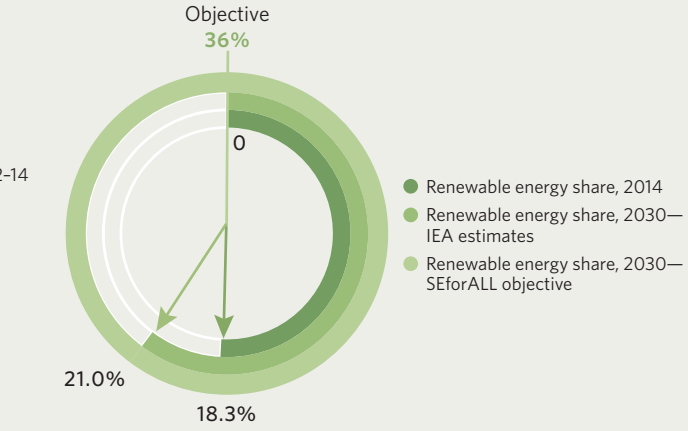


FIGURE 4 **Renewable energy**



ELECTRIFICATION WHERE DID WE STAND ON ELECTRIFICATION IN 2014?

Access to electricity improves lives. Lighting a single room allows a child to read or do homework at night, while charging a single telephone can bring business to a small entrepreneur. Continuous access can keep food or vaccines cold, or power a sewing machine or a school computer.

Electrification, which stands globally at 85.3%, varies widely across continents (figure 5). In Europe, North America, and Central Asia, universal access has long been a reality, and Latin America is not far behind. Both Asia-Pacific and the Arab Region are also doing well, with access rates around 90% in 2014. Yet even advanced regions have lagging countries, such as Haiti (38%) in Latin America and Sudan (45%) in the Arab Region. By far the most severe challenge is in Africa (excluding North Africa), with access for only 37% of its population in 2014.

It is notable that electrification rates rise very steeply as countries move through the income bracket of $500–1,000 per capita GDP (figure 6).

Access to electricity has progressed steadily since 1990. Urban areas across the world already have close to universal access at 96%, although challenges remain in the rapidly growing cities of Africa and Asia-Pacific (figure 7). Although urban access rates have increased relatively little in the last 25 years, even sustaining those rates represents a major achievement given the rapid urbanization that has added 1.6 billion people to the world's cities during this period. Progress in rural electrification has been more evident since 1990, reaching 73% of the population in 2014, narrowing the gap in access between urban and rural populations to 20 percentage points, from 35 in 1990.

In 2014, 1.06 billion people—about three times the population of the United States of America—still lived without access to electricity, only a very slight improvement over 2012 (figure 8). The vast majority of those without access lived in rural areas—particularly rural Africa—where the race against demographic growth is largely being lost.

This does not reflect a lack of effort by countries: some 86 million people, equivalent to the entire population of Egypt, are newly getting electricity annually. But the global population is expanding at almost the same pace (figure 9).

About 80% of the 1.06 billion people without electricity live in just 20 countries. Their progress toward electrification—or lack thereof—will have the greatest impact on global outcomes. Particularly troubling is that two of these high-impact countries, Angola and the Democratic Republic of Congo, saw their electrification rates fall by about 1 percentage point annually in 2012–14 (figure 10). More encouraging is the rapid progress in 2012–14 of a number of populous low-access countries—such as Kenya, Malawi, Sudan, Uganda, and Zambia—that increased their electrification rates by 2–3 percentage points annually. Results for India are inconclusive because no new household survey data on electrification have been published since 2012.

Until 1990, it was rare for countries to expand electrification faster than 2–3 percentage points annually. However, in 2012–14 one of the strongest performers in Africa—Rwanda—added more than 3 percentage points to its electrification rate annually, reflecting a strong policy commitment. In Asia-Pacific, Afghanistan made extraordinary progress, adding electrification for 10 percentage points of the population annually, thanks largely to off-grid rural electrification based on solar PV. Cambodia expanded by more than 7 percentage points annually through sustained grid electrification complemented by solar home systems in rural areas.

FIGURE 5 **Access to electricity, 2014**

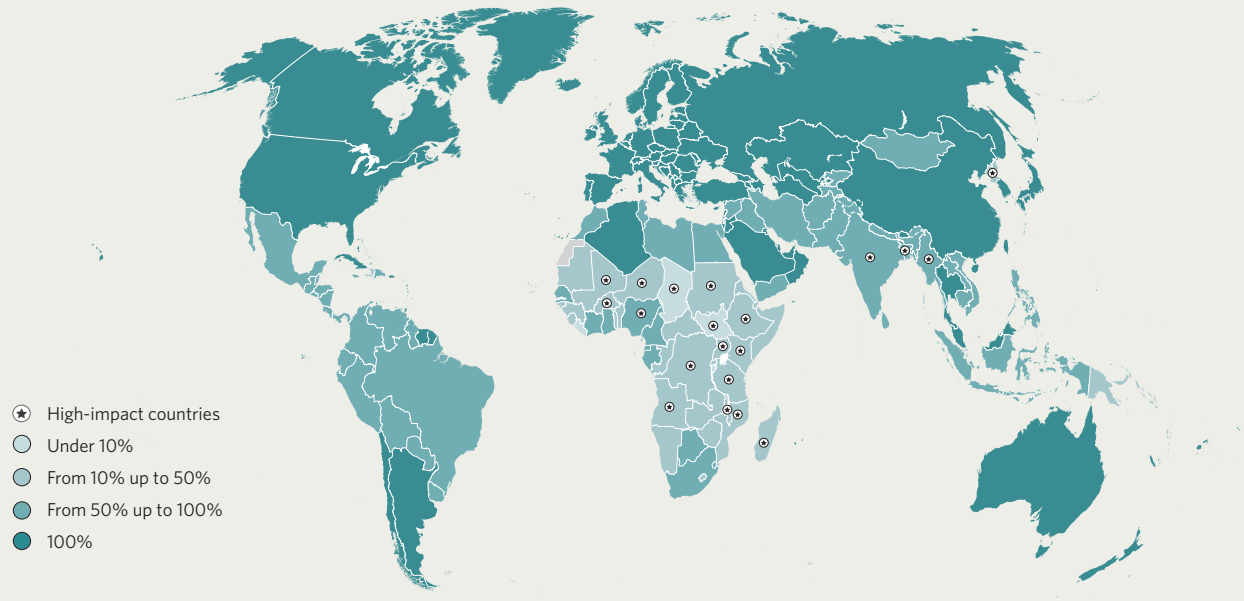


FIGURE 6 Regional differences in access to electricity, 2014

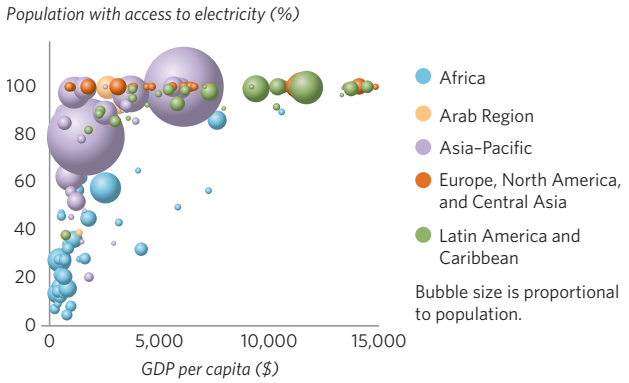


FIGURE 7 Urban–rural differences in access to electricity, 2014

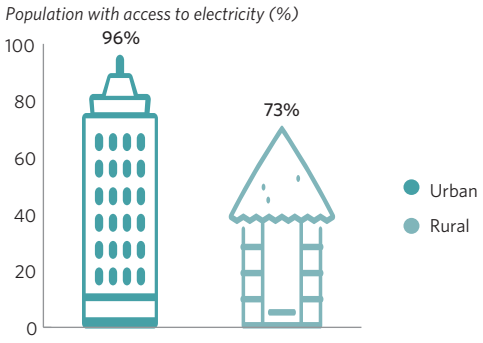


FIGURE 8 Location of the 1.06 billion people living without electricity, 2014

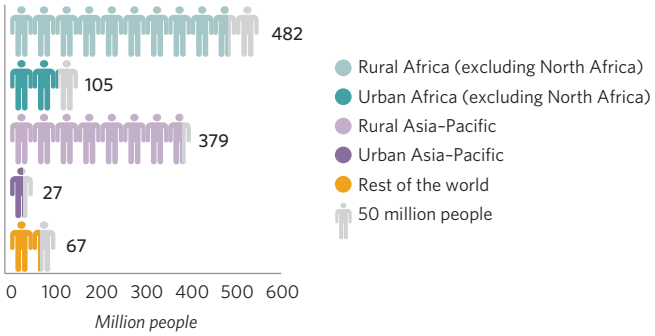


FIGURE 9 Demographic challenges for electrification

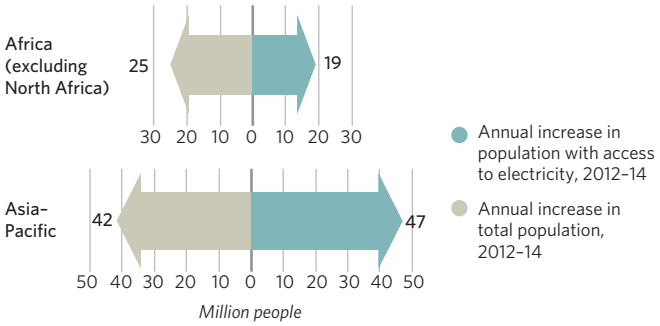
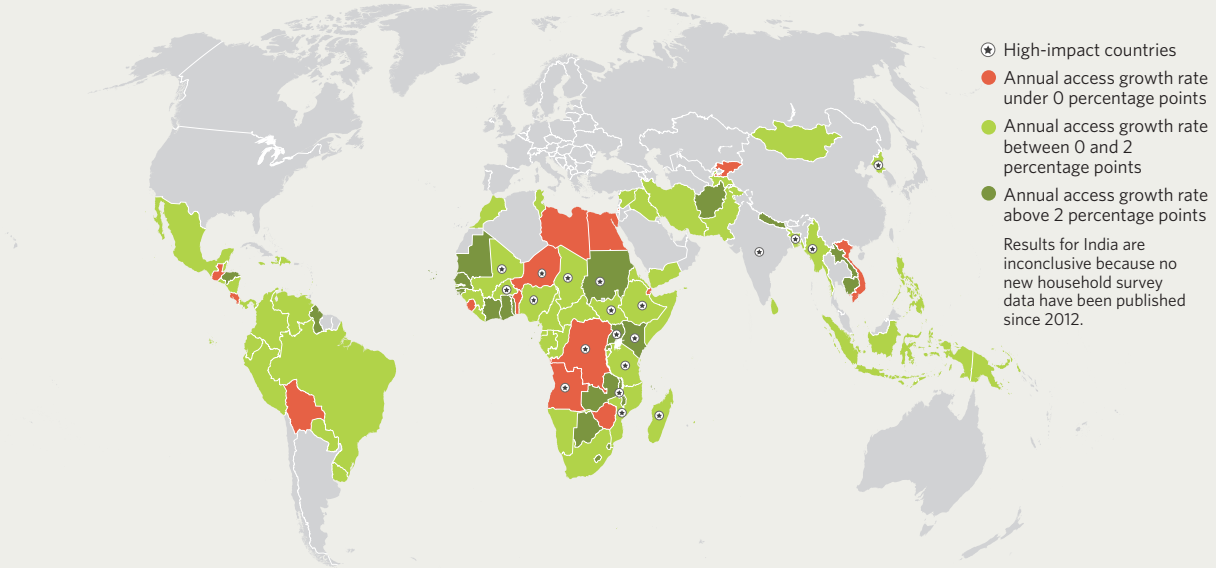


FIGURE 10 Speed of progress toward electrification goal, 2012–14



COOKING WHERE DID WE STAND ON ACCESS TO CLEAN COOKING IN 2014?

The fuels and technologies households use for cooking have become a major global health issue. Some 4 million premature deaths, primarily among women and children, are caused each year by inhaling carbon monoxide and particulate matter from traditional biomass cookstoves. Reducing exposure to these health risks calls for either switching to clean fuels, typically liquefied petroleum gas, or adopting advanced combustion cookstoves that burn biomass more cleanly and efficiently.

Across all continents, access to clean fuels and technologies for cooking—here "clean cooking"—tends to lag behind electrification (figure 11). In regions approaching universal access to clean cooking, such as Europe, North America, and Central Asia, Latin America, and the Arab Region, that gap is just a couple of percentage points, but for Asia-Pacific and Africa it can be very large. In Asia-Pacific, only 51% had access to clean cooking in 2014 compared with 90% for electricity, and in Africa (excluding North Africa) only 12% compared with 37% for electricity. Although many countries experience a rapid scale-up of electrification in the $500–1,000 per capita income bracket, access to clean cooking typically takes much longer, all the way to income levels of $12,000 per capita (figure 12).

Reflecting these dynamics, access to clean cooking has progressed at a consistently slow rate since 1990, edging up just half a percentage point of global population each year, to 57% in 2014. Even in urban areas, only 78% of the population had access (figure 13). This raises a serious concern, given the poor air quality and fire hazards associated with using traditional biomass cookstoves in crowded urban settings. In rural areas, only 22% of the population had access to clean cooking. Biomass is often freely available in the countryside, while distribution channels for modern fuels or advanced cookstoves may be nonexistent. This puts the urban-rural gap for clean cooking at close to 60 percentage points—three times the gap for electricity.

In 2014, 3.04 billion people—about nine times the population of the United States of America—lived without access to clean cooking, a slight increase in the deficit since 2012 (figure 14). This increase is driven by Africa, where population expands by 25 million annually while access to clean cooking increases by only 4 million (figure 15).

Some 85% of the 3.04 billion people without access to clean cooking live in just 20 countries. Their lack of progress toward clean cooking is a large contributor to lackluster global performance (figure 16). Among them, Afghanistan and Nigeria stand out as populous countries whose access to clean cooking fell by about 1 percentage point annually in 2012–14. At the other end of the spectrum, Indonesia made by far the greatest progress, raising its access rate by more than 4 percentage points annually during this period. Other strong performers among the larger countries are Viet Nam, which added almost 2 percentage points annually, and Sudan, which added more than 1. Particularly noteworthy were a handful of smaller countries that raised access to clean cooking by more than 4 percentage points annually, including Angola, Bhutan, Maldives, and Peru.

Overall about 25 countries worldwide expanded access to clean cooking by more than 2 percentage points annually, or at least four times faster than the world. A majority of these—though by no means all—were also natural gas producers, suggesting that the domestic availability of gas can be an advantage. This group's achievement shows that faster progress may be possible in the future, as long as the issue is given a higher priority on the policymaking agenda.

FIGURE 11 Access to clean cooking, 2014

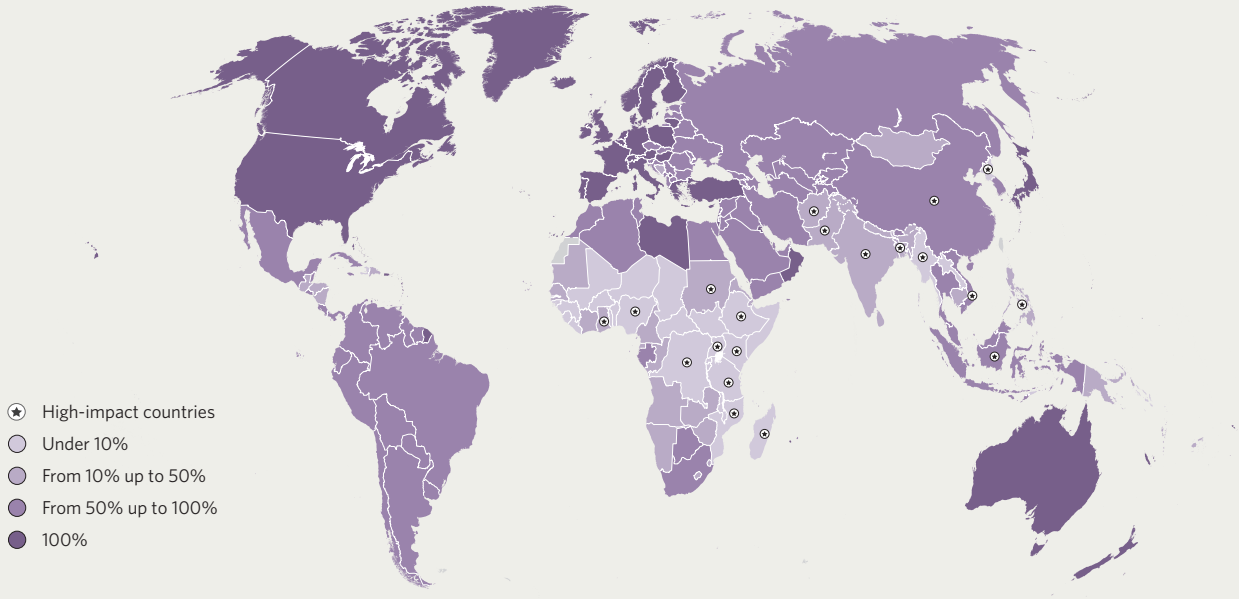


FIGURE 12 Regional differences in access to clean cooking, 2014

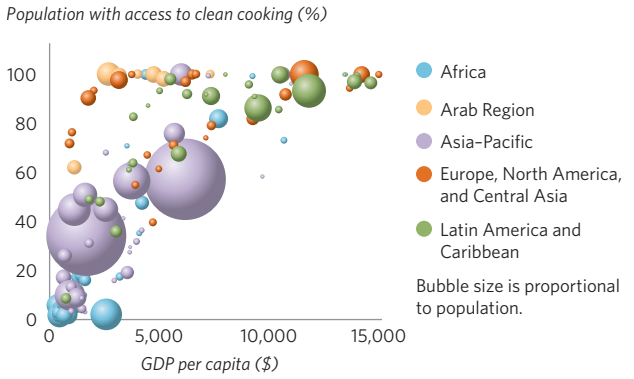


FIGURE 13 Urban–rural differences in access to clean cooking, 2014

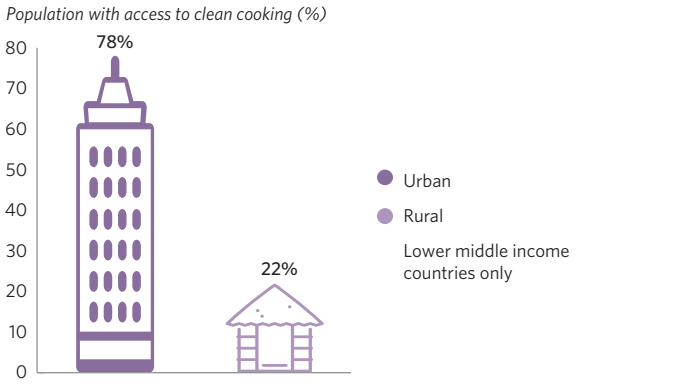


FIGURE 14 Location of the 3.04 billion people living without access to clean cooking, 2014

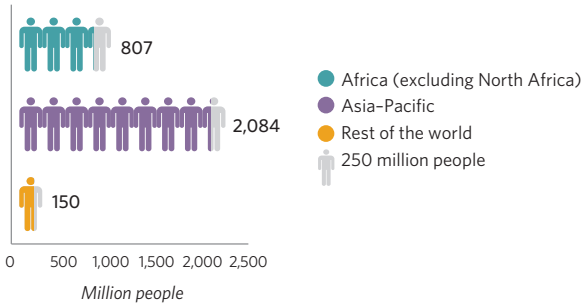


FIGURE 15 Demographic challenges for progress on access to clean cooking

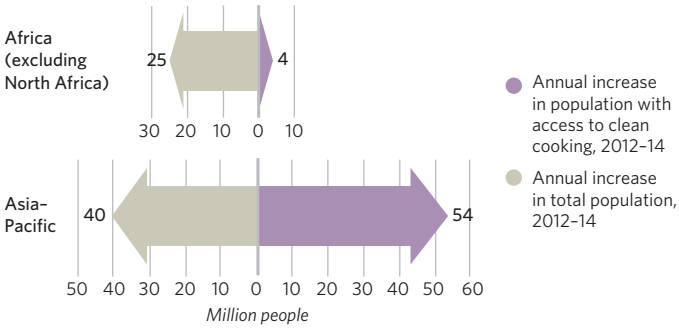
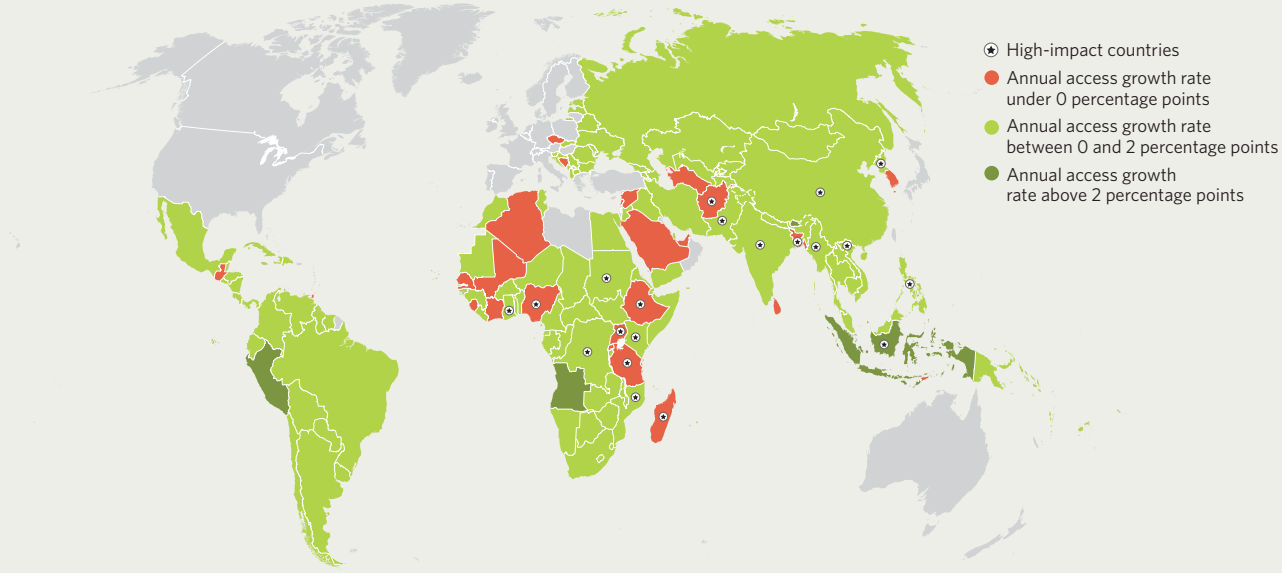


FIGURE 16 Speed of progress toward clean cooking goal, 2012–14



ENERGY EFFICIENCY WHERE DID WE STAND ON ENERGY INTENSITY IN 2014?

Reducing energy intensity—the measurable proxy for increasing energy efficiency—means getting more economic value out of every unit of energy consumed. This helps to dampen demand for energy, reduce the environmental footprint associated with its production, improve the competitiveness of industry, and increase the affordability of energy to households (figure 17). As energy intensity comes down, GDP can grow with much lower growth in energy demand (figure 19). This effect is already evident in much of the developing world except for Latin America and Caribbean and the Arab Region, while in Europe and North America GDP continues to grow while energy demand is flat or falling.

Primary energy intensity has been falling significantly since the beginning of the data series in 1990, and it has been converging across geographic regions toward the current global average of 5.5 MJ/2011 PPP $ in 2014 (figure 18). Low-income countries have by far the highest energy intensity due to reliance on inefficient traditional biomass. By contrast, some high-income countries in Europe—Denmark, Italy, and the United Kingdom of Great Britain and Northern Ireland—are already reporting energy intensities below 3.4 MJ/2011 PPP $, the global energy intensity if the world target for 2030 is met. Globally, recent improvements in energy intensity in 2012–14 really add up, presenting energy savings equivalent to the entire energy consumption of both Brazil and Pakistan in 2014.

Driving progress on energy intensity are actions in key energy-consuming sectors and, to much less extent, in key energy supply sectors. The major energy-consuming sectors are industry, residential, and transport. Industry has contributed much to declining global energy intensity, with an annual reduction of 2.2% in 2012–14, but the residential sector had a small increase in energy intensity (measured in energy consumption per capita) (figure 20). In transport, widespread diffusion of fuel efficiency standards helped accelerate reductions in energy intensity (measured in energy consumption per passenger-km or ton-km), with passenger transport progressing at 2.8% a year, compared with just 1.1% a year for freight transport. The strongest improvements have been in passenger buses (4.8% a year since 2010) and sea freight (3.7%).

The electricity supply industry is itself a major consumer of energy, in part due to losses both in thermal generation and in the transmission and distribution network. The average efficiency of thermal generation has been edging up very slowly since 1990 to reach 39% in 2014. But average efficiency rates of 45% are already being achieved for natural gas electricity plants. Network losses were coming down very slowly, to 9% in 2014, but with wide variation between high-income countries (at 7%) and low-income countries (at 16%) (figure 21).

About three-quarters of the world's energy supply is concentrated in just 20 countries, mainly high-income and upper-middle-income (figure 22). How rapidly these countries reduce their energy intensity has a major impact on the global outcome. Not only did 15 of these high energy consumers reduce their energy intensity in 2012–14, but 7 of them reduced it by more than 2.6% annually: Australia, China, Italy, Mexico, Nigeria, the Russian Federation, and the United Kingdom of Great Britain and Northern Ireland. Even so, 5 countries also saw their energy intensity increase in 2012–14 (Brazil, the Islamic Republic of Iran, Saudi Arabia, South Africa, and Thailand), while 5 still have energy intensities significantly above the global average (Canada, China, the Islamic Republic of Iran, the Russian Federation, and South Africa). And the recent experience of some smaller countries shows that it is sometimes possible to improve energy intensity by more than 5% annually, at least for short periods.

FIGURE 17 Primary energy intensity, 2014

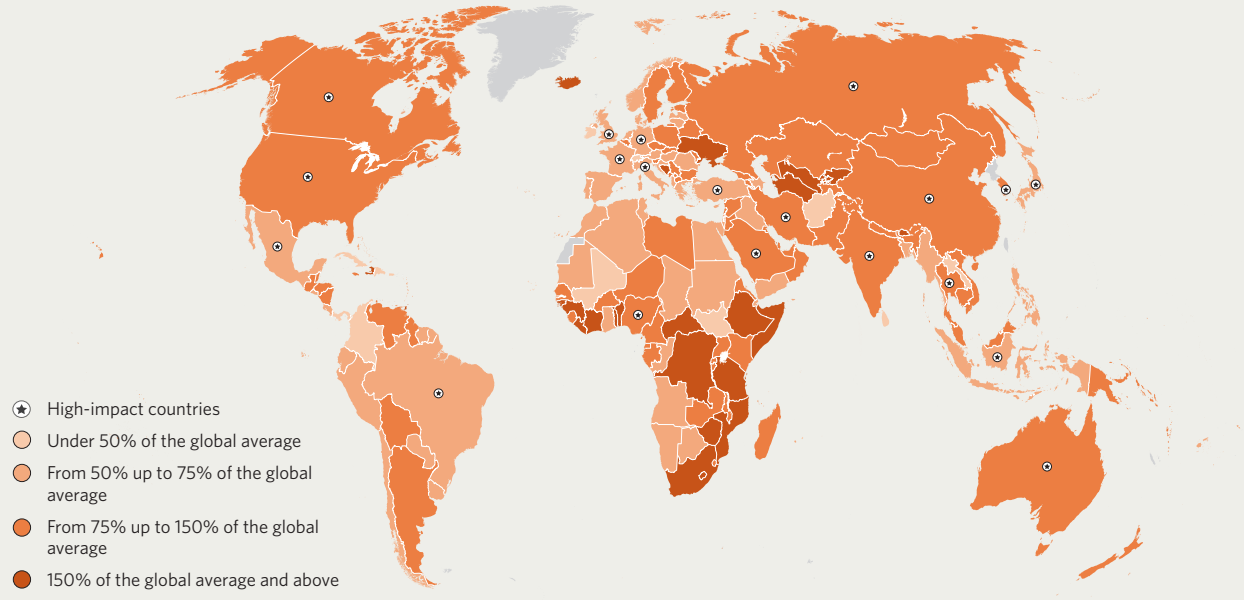


FIGURE 18 Regional differences in primary energy intensity, 2014

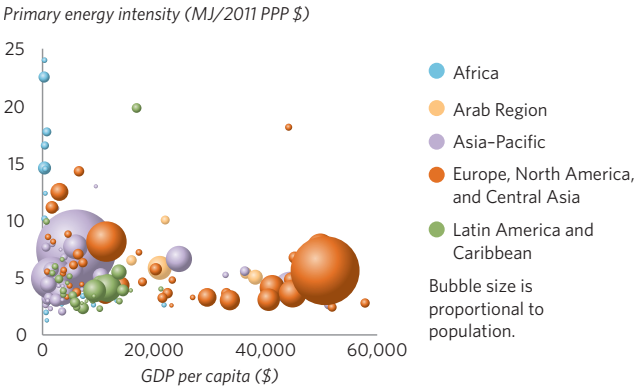


FIGURE 19 Relative growth of GDP and energy supply, 1990–2014

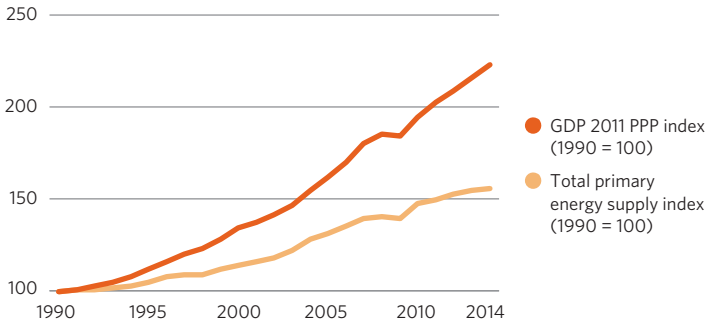


FIGURE 20 Relative improvement in final energy intensity by end-use sectors, 2012–14

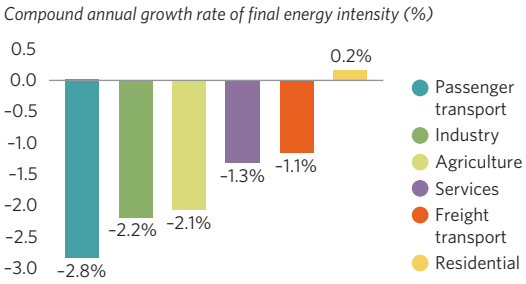


FIGURE 21 Income group differences in supply-side efficiency, 2014

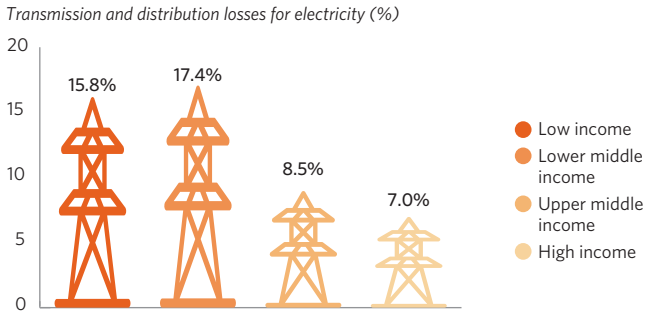
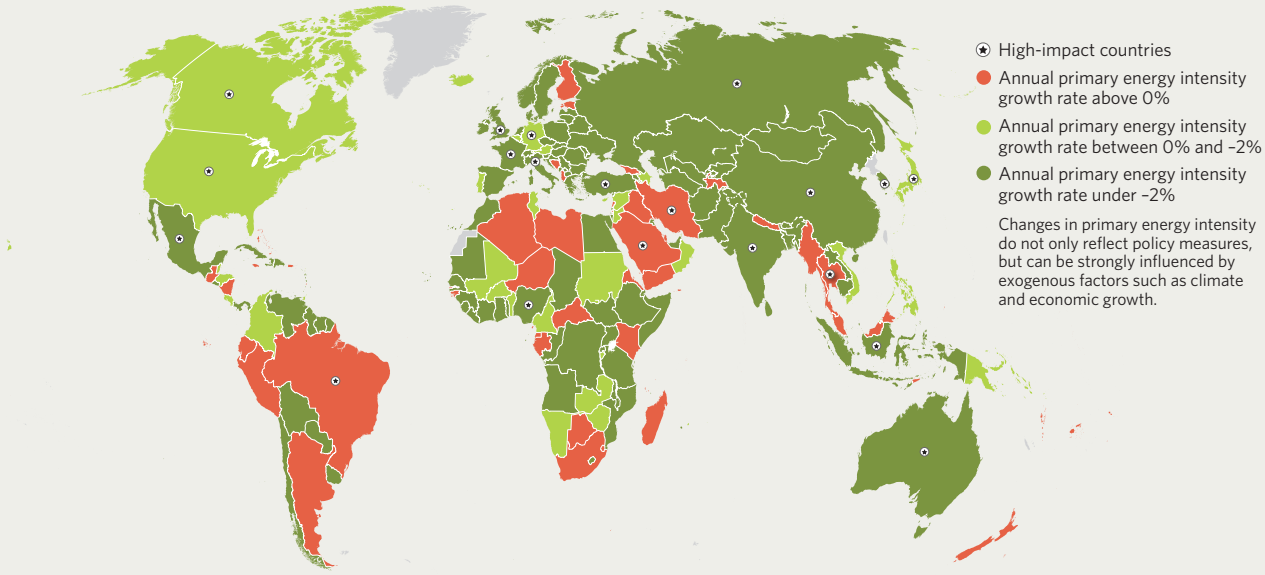


FIGURE 22 Speed of progress toward goal of reducing primary energy intensity, 2012–14



RENEWABLE ENERGY WHERE DID WE STAND ON RENEWABLE ENERGY IN 2014?

Renewable energy shares vary widely around the world (figures 23 and 24). Despite significant growth in renewable energy consumption, continued rapid growth in total final energy consumption has meant that the overall share of renewable energy has been moving more slowly (figure 25).

The narrative for renewable energy is complex because it interweaves two distinct stories. The first relates to the traditional uses of biomass—minimally processed wood, charcoal, dung, or agricultural waste—which is still in widespread use for cooking and heating across the developing world. While biomass is technically renewable, its traditional uses are responsible for serious health effects and, sometimes, deforestation. So reduced dependence on traditional biomass is considered desirable even though it reduces the share of renewable energy overall.

Developing regions, due to their continuing reliance on traditional uses of biomass, show particularly high renewable energy shares, most notably in Africa (excluding North Africa) at 70%, and South-East Asia and South and South-West Asia at around 30%. But these shares are steadily falling as incomes rise, economies modernize, and households and small enterprises switch to modern fuels (figure 24).

The second story relates to modern renewable energy, which includes processed wood fuels, biofuels for transportation, and renewable power generation technologies (figure 27). In Latin America and Caribbean, the share of modern renewable energy has long been high at 23%, reflecting early use of abundant biomass and hydropower resources. In 1990, all other regions were achieving only 5% of their total final energy consumption through modern renewable energy sources. But Asia-Pacific, Europe, and North America have seen strong growth, reaching around the 10% mark in 2014 (figure 24). The major exceptions are the Arab Region and Eastern Europe, Caucasus, and Central Asia. Uptake has been largely policy-driven as more and more countries, particularly at higher incomes, adopt renewable energy targets and incentives.

The story of the advance of renewable energy differs greatly for the three main end-use sectors: electricity, transport, and heat. Electricity and transport represented relatively small shares of total renewable energy consumption in 2012, at 23% and 4% respectively (figure 26). But the penetration of renewable energy in these applications has been growing relatively rapidly. Electricity contributed 49% of the progress in renewable energy in 2012–14 thanks to the steep growth of wind and solar power, while transport contributed 9% of progress in 2012–14 thanks to continued uptake of biofuels. More problematic is the heat sector, which accounted for the bulk of renewable energy consumption, 73% in 2012, but contributed only 42% of progress in 2012–14, reflecting less policy focus as well as greater technological challenges in applying renewable energy to high temperature industrial processes.

How rapidly the world's 20 largest energy consumers are able to meet demand with modern renewables will have a major impact on global outcomes. Just 13 of the large consumers succeeded in increasing their modern renewable energy share in 2012–14 (figure 28). In fact, three of these large consumers saw a significant decline in their modern renewable energy share: particularly Nigeria, and to a lesser extent Brazil and Turkey, where hydropower production suffered due to low rainfall. Worldwide, only a handful of smaller countries managed to grow their renewable energy share by more than 2 percentage points, indicating the challenging nature of this target.

FIGURE 23 Share of renewable energy in total final energy consumption, 2014

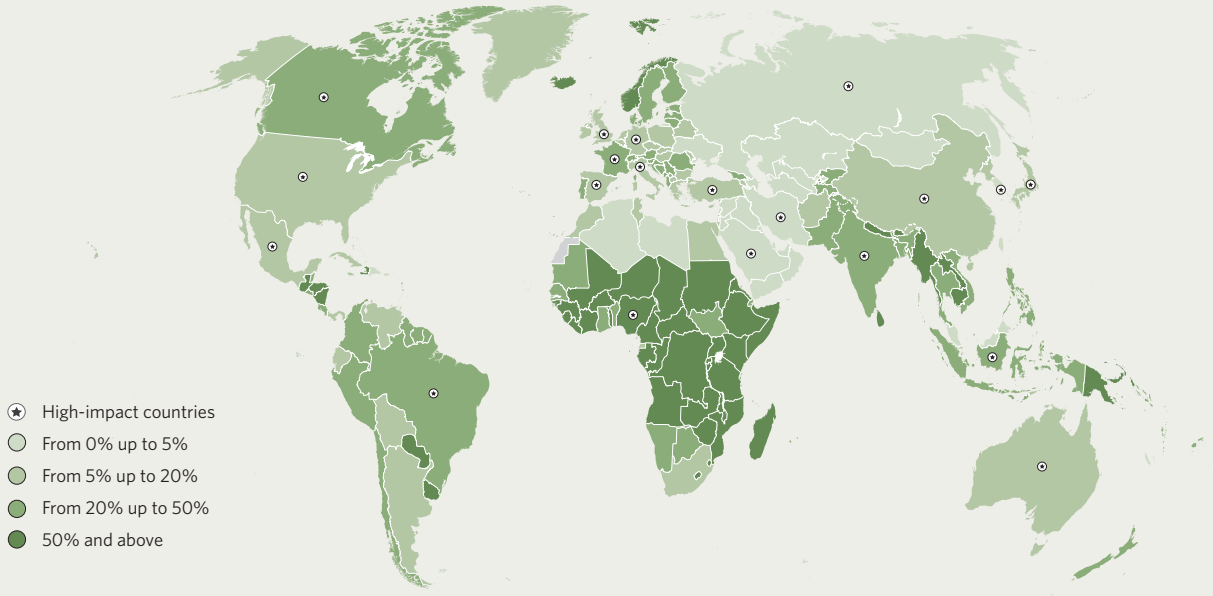


FIGURE 24 Regional differences in renewable energy share, 2014

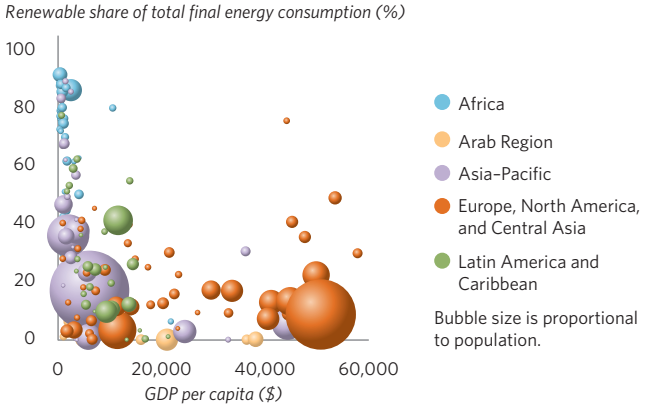


FIGURE 25 Relative growth of renewable and total energy consumption, 1990–2014

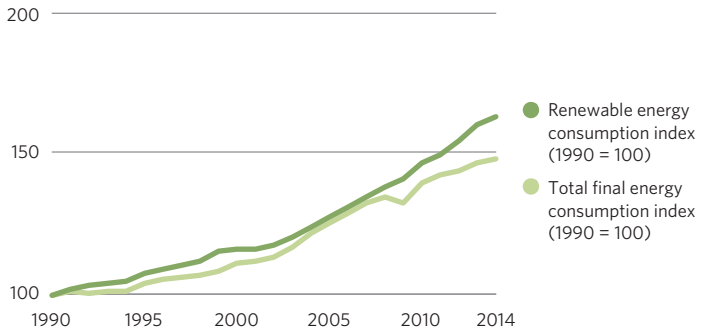


FIGURE 26 Sectoral contribution to renewable energy growth, 2012–14

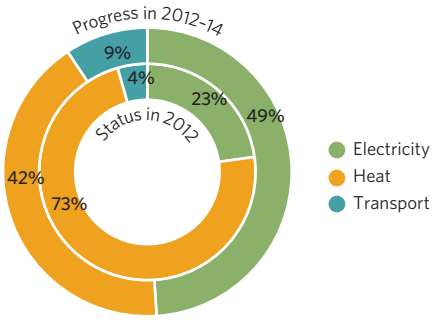


FIGURE 27 Technology differences in renewable energy share, 2014

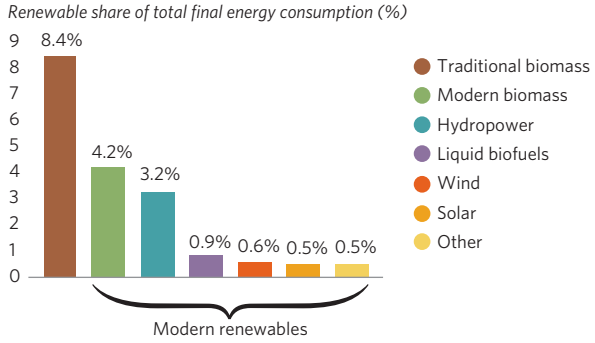
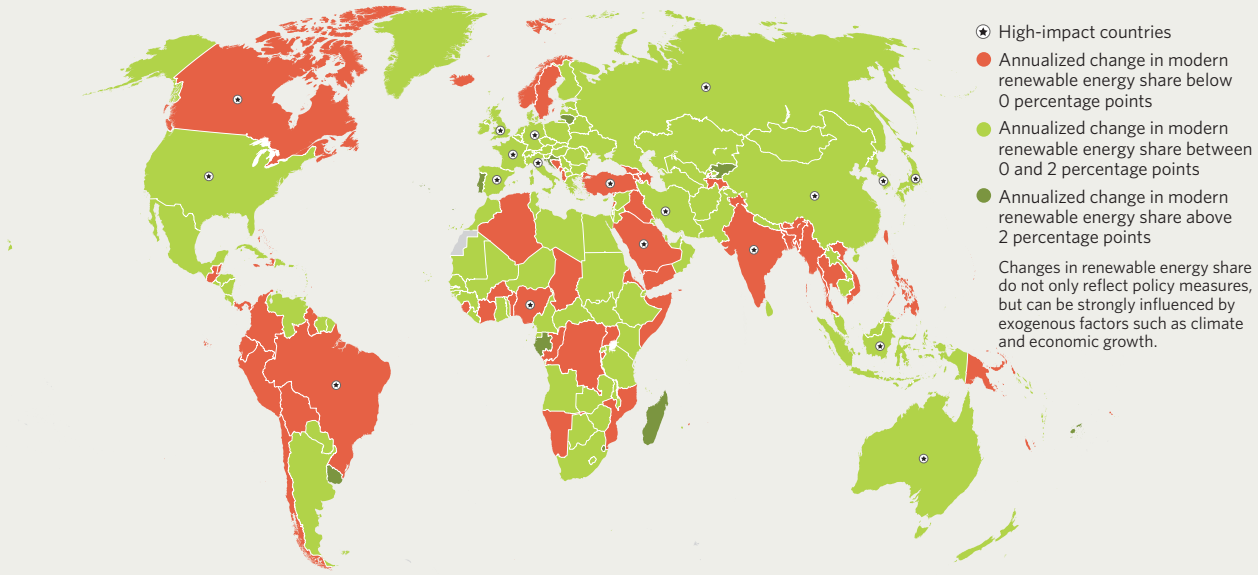


FIGURE 28 Speed of progress toward renewable energy goal, 2012–14



CONCLUSION

The overall progress toward sustainable energy in 2012–14 was not commensurate with the SEforALL goals. Modeling projections indicate that the 2030 objectives are unlikely to be met on current trends or even on the basis of recently enhanced policy commitments.

Much more encouraging than the global trends, however, are the experiences of individual countries demonstrating the feasibility of moving faster toward sustainable energy objectives. In just about every area of sustainable energy, significant numbers of countries are outperforming the world. Equally useful, the findings point to countries and sectors that are not doing so well, where greater policy attention could produce significant payoffs.

On electrification, while Africa is not expanding access as rapidly as its population is growing, Kenya, Malawi, Sudan, Uganda, Zambia, and particularly Rwanda are accelerating at a pace that looks rapid relative to the pace observed around the world since 1990. Moreover, the recent experience of some Asian countries such as Afghanistan and Cambodia making more determined use of off-grid solar energy provides an early indication that new technologies may make it possible to expand electrification much faster than was previously thought.

A particular focus on electrification is needed in low-access countries where growth in population outstrips progress in electrification, so that electrification rates actually decline. Benin and Zimbabwe stand out in the 2012–14 assessment.

On clean cooking, some 20 countries were able to progress at four times the modest pace of the world. Indonesia stands out as by far the fastest moving country, with Angola, Bhutan, Maldives, and Peru also advancing rapidly. The main concern about clean cooking is that it often seems to be given lower priority than other parts of the energy agenda. In particular, Afghanistan and Nigeria stand out in the 2012–14 assessment as two populous countries where access to clean cooking is in decline.

On energy efficiency, the strong improvement in industrial energy intensity is particularly encouraging, as are improvements in the fuel efficiency of passenger road transport and aviation and a trend toward larger freight ships. Moreover, some of the largest energy consumers that already have low energy intensities, such as Italy and the United Kingdom of Great Britain and Northern Ireland, continue to make further progress.

A key area of focus for energy efficiency is the residential sector, a large and fast-growing segment of energy consumption, especially in developing countries. Another challenge is the electricity supply industry, where improvements in the efficiency of thermal power generation and power networks have been relatively slow. Among countries, some of the largest energy consumers remain very energy intensive, and a couple of them—the Islamic Republic of Iran and South Africa—even saw their intensities increase in 2012–14.

On renewable energy, the rapid expansion of wind and solar generation for electricity is a well-known positive story. The problem is that electricity represents only 20% of energy consumption. Without an equivalent breakthrough for renewable heat technologies and a continuing acceleration of progress in renewable transport, it will be difficult to accelerate the ramp-up of renewable energy as a whole.

What is striking about renewable energy, compared with other dimensions of sustainable energy, is the relatively small number of countries managing to progress as rapidly as the world as a whole would need to move to meet its target for 2030. Only two of the large energy consumers—again, Italy and the United Kingdom of Great Britain and Northern Ireland—increased their renewable energy share by more than 1 percentage point annually in 2012–14.

Further improvement on these steady, but still inadequate, levels of progress in the years to 2030 will require greater financing flows and bolder policy commitments, as well as the willingness to embrace new technologies on a much wider scale. Investments in renewable energy and energy efficiency globally have each climbed to an estimated $250 billion a year. But to meet the SEforALL objectives, renewable energy investment would need to increase by a factor of 2 to 3, and energy efficiency investment by a factor of 3 to 6. Investments in energy access are less well understood, but estimates suggest that a fivefold increase would be needed to reach universal access by 2030.

On the policy environment, the 2016 publication of *Regulatory Indicators for Sustainable Energy* maps out the adoption of good practice policies for energy access, energy efficiency, and renewable energy around the world. That report helps to identify where good policies have already been adopted and points to helpful measures that may have been neglected. For example, it shows that many low-access African countries have yet to create a supportive policy environment for energy access, particularly for off-grid solar home systems. More broadly, energy efficiency policies are being systematically neglected by policymakers, who have not yet taken many simple regulatory measures. While targets and incentives for renewable electricity have swept across the globe, major challenges remain in regulating the full integration of renewable resources into the grid.

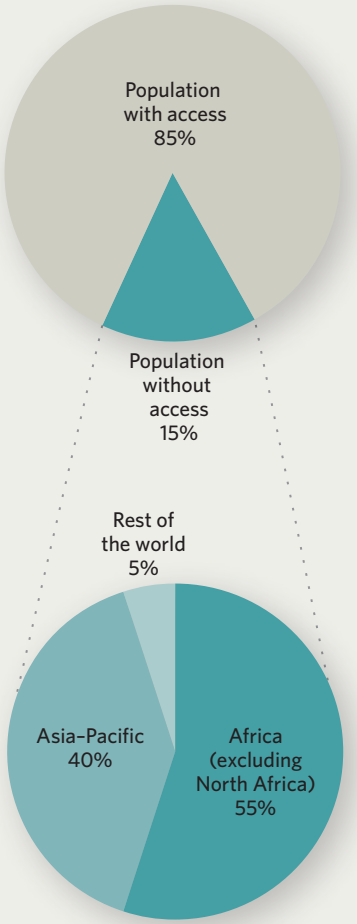
Last, understanding and learning from the evolution and implementation of sustainable energy policies globally requires improved data. All the indicators presented here have conceptual shortcomings, and many are prejudiced by infrequent or incomplete data collection. Capacity building for improved data collection and curation remains a pressing need in many developing countries. Work to develop improved indicators is also critical—to capture the affordability and reliability of energy access, provide a more accurate understanding of traditional uses of biomass, and drill down into the energy efficiency of key economic sectors. Some efforts are already under way, but more needs to be done.

PROGRESS AT A GLANCE

REGIONAL FOCUS

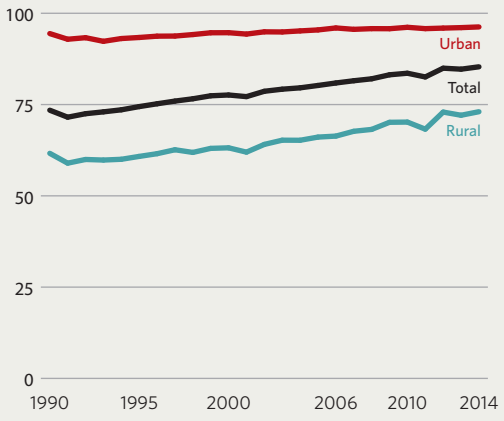
ELECTRICITY ACCESS PROGRESS AT A GLANCE

The electricity access deficit of 1.06 billion people in 2014 was divided as follows:

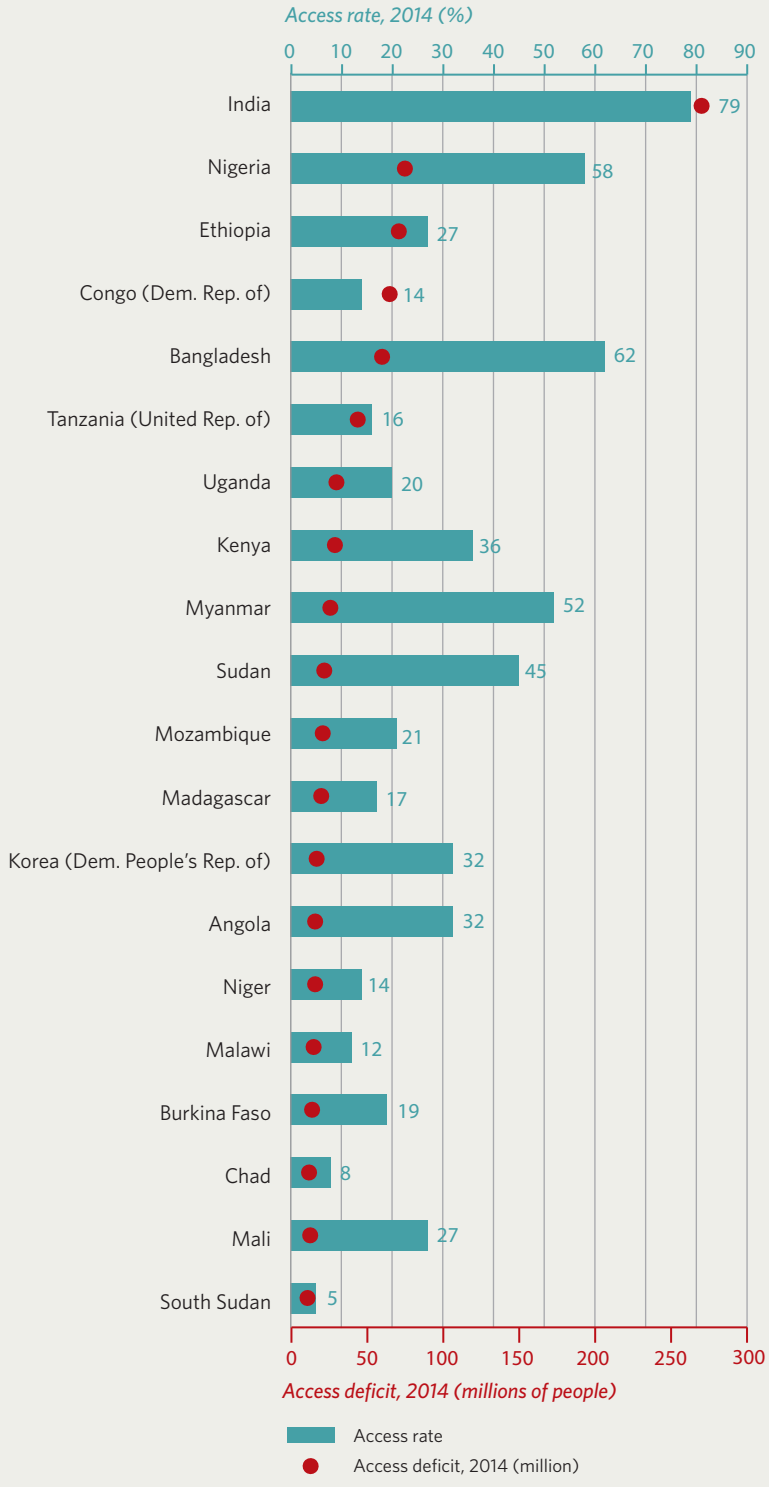


Population without access to electricity, by region, 2014

Total, urban, and rural access rates to electricity, 1990–2014 (%)



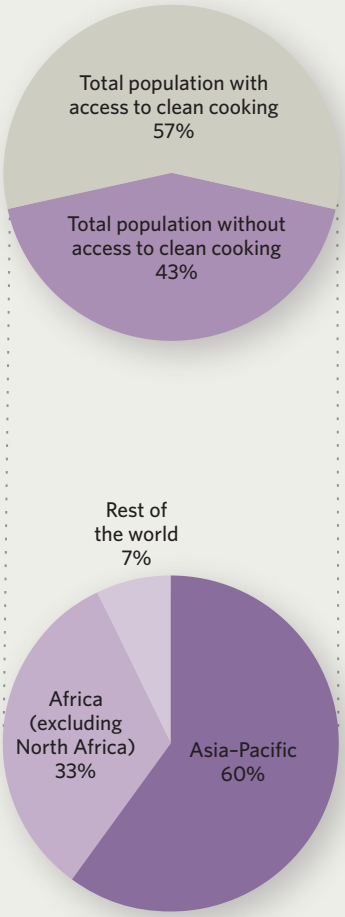
Access rate and electrification deficit in 2014 in the 20 countries with the highest access deficit



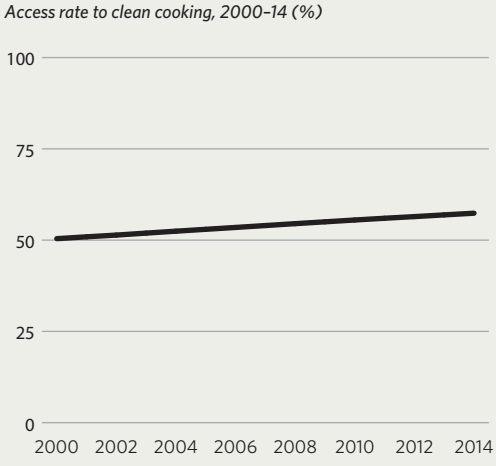
Note: Countries appear in the order of access deficit, from largest to smallest.

ACCESS TO CLEAN FUELS AND TECHNOLOGIES FOR COOKING PROGRESS AT A GLANCE

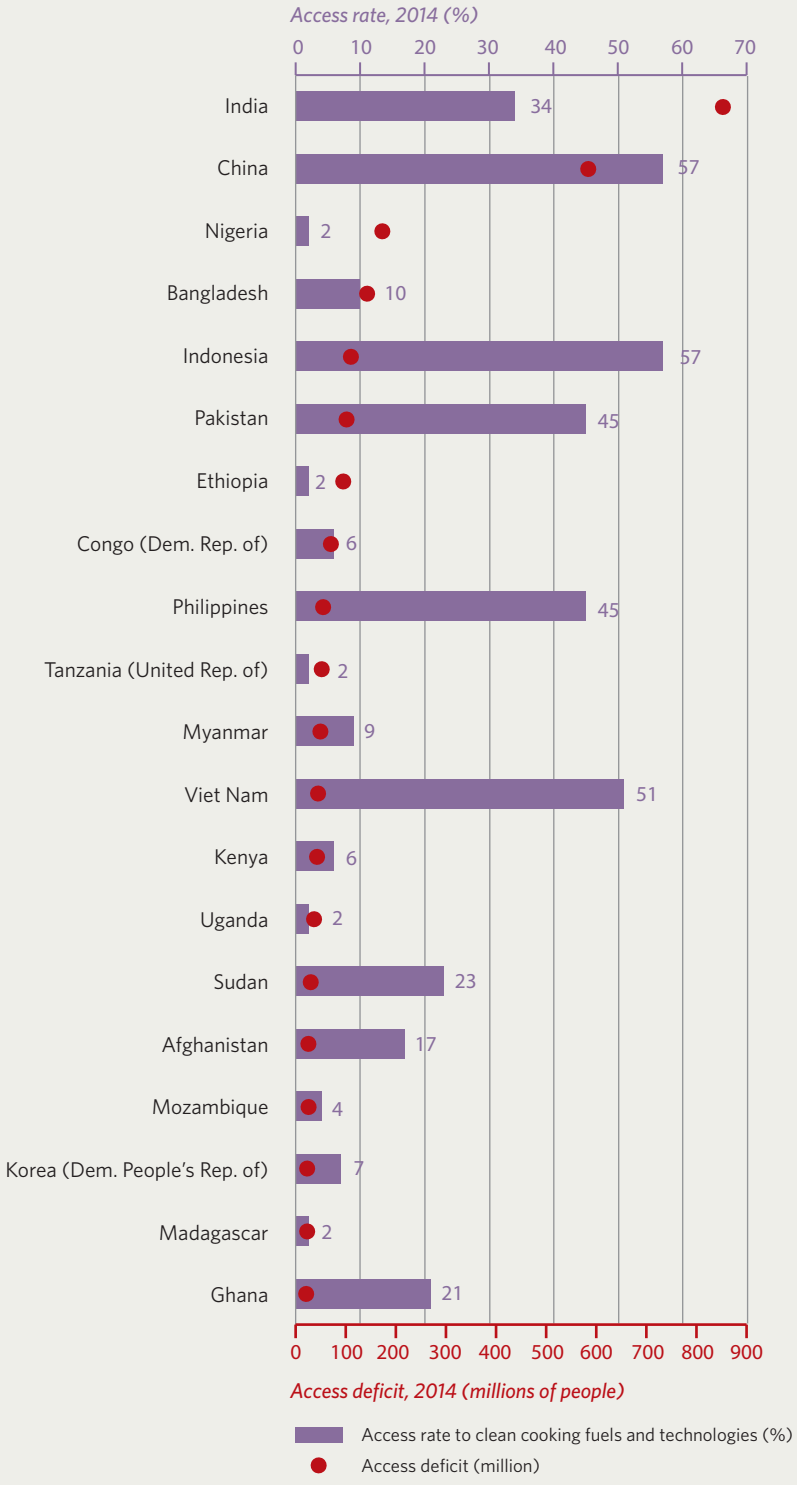
The clean cooking access deficit was 3.04 billion in 2014, divided as follows:



Population without access to clean fuels and technologies for cooking, by region, 2014



Access to clean cooking and cooking access deficit in 2014 in the 20 countries with the highest access deficit

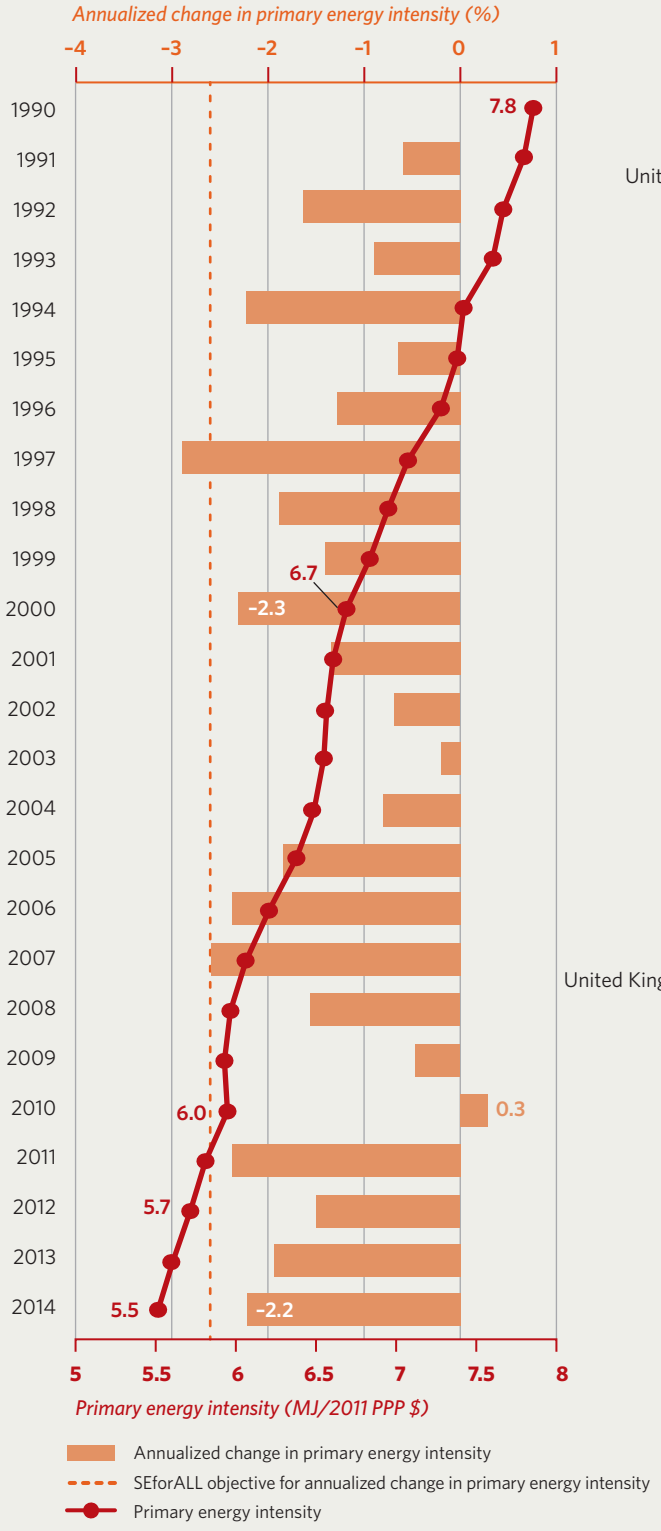


Note: Countries appear in the order of access deficit, from largest to smallest.

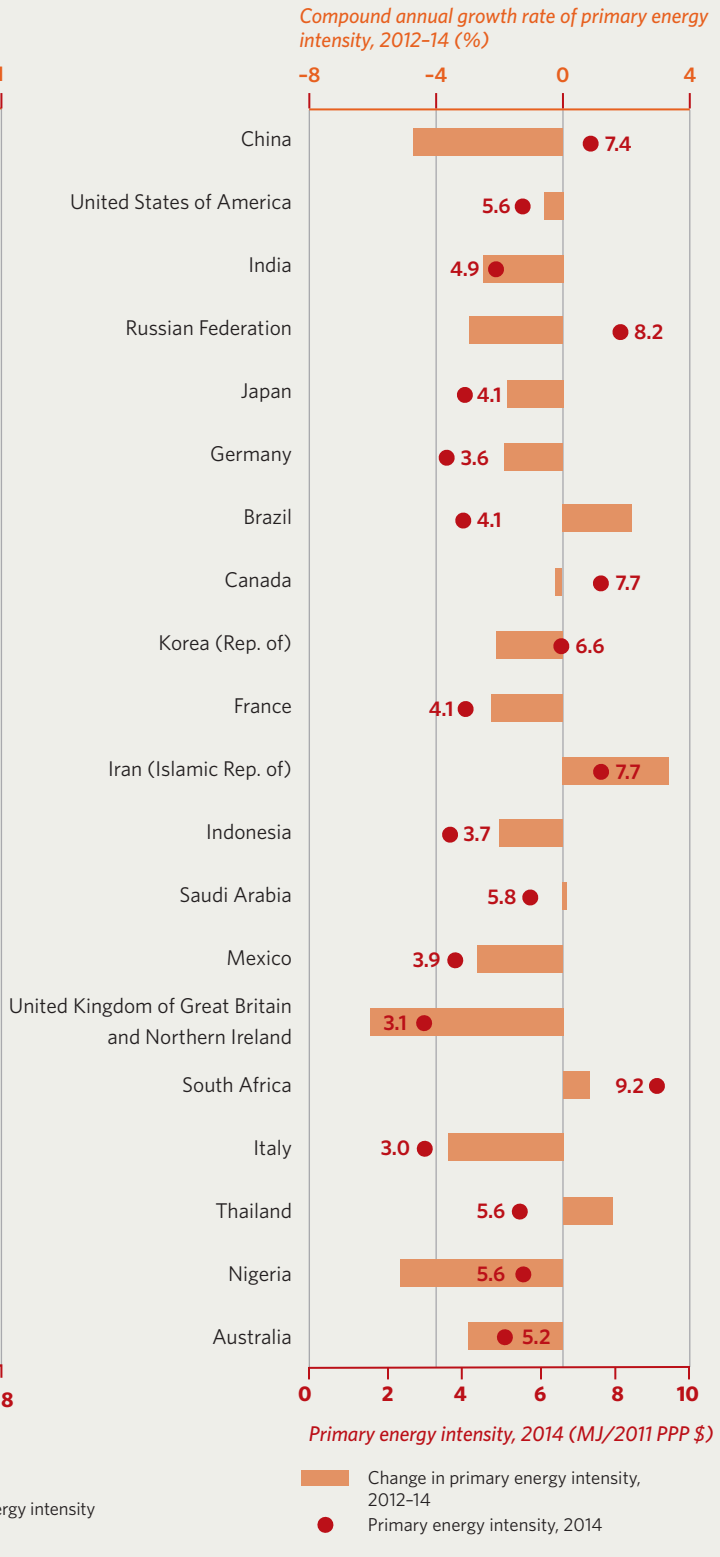
ENERGY EFFICIENCY PROGRESS AT A GLANCE

GTF

Global primary energy intensity and annualized change, 1990–2014



Primary energy intensity in 2014 and compound annual growth rate of energy intensity in 2012–14 for the top 20 primary energy-consuming countries

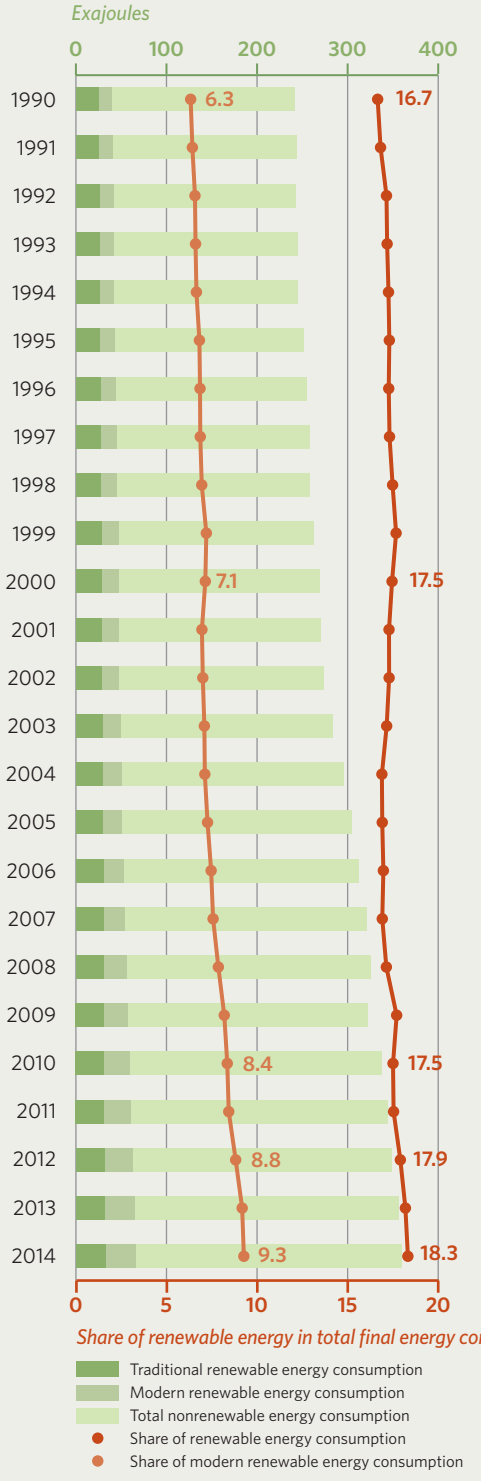


Note: Countries appear in order of primary energy supply, from largest to smallest.

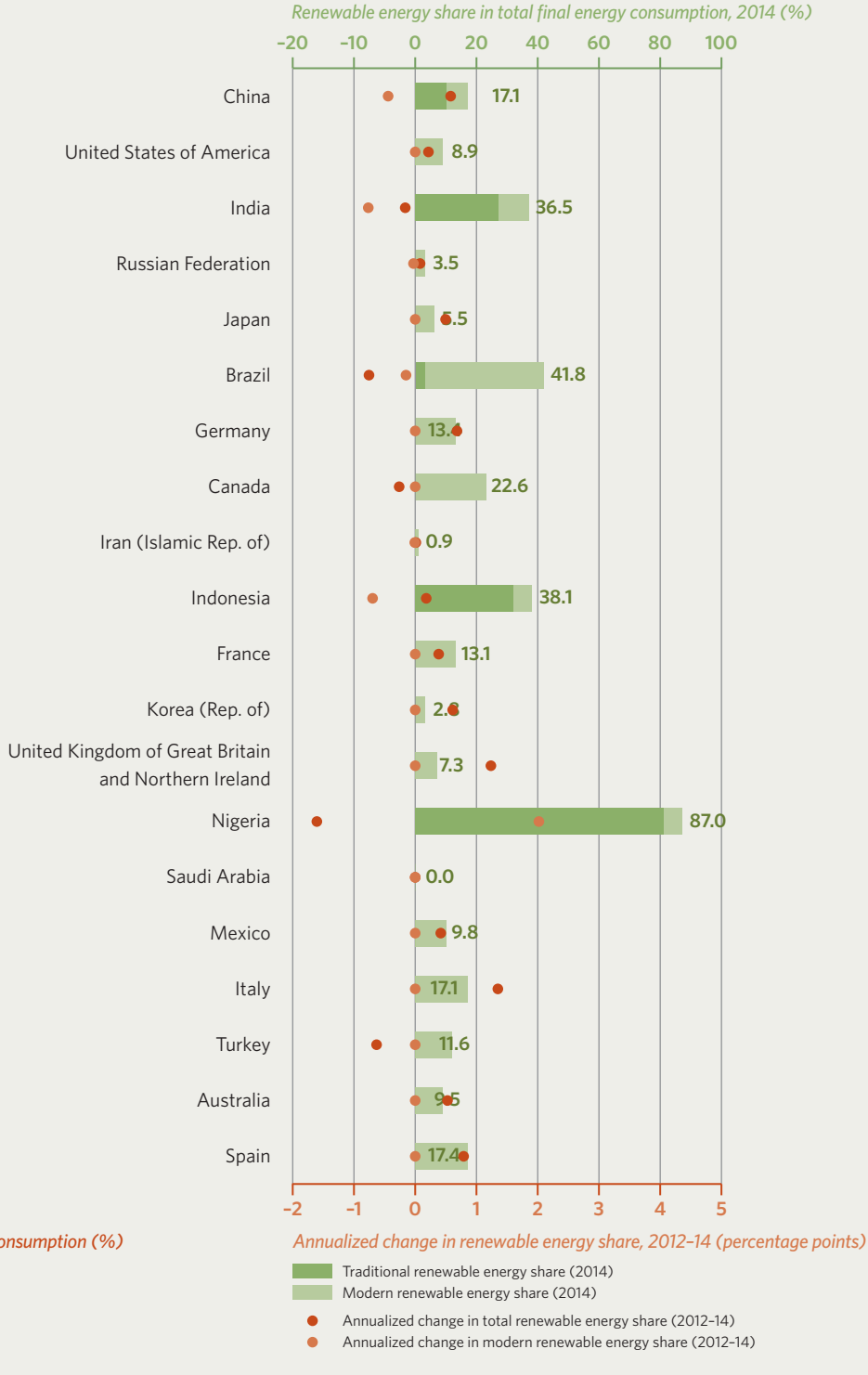
RENEWABLE ENERGY PROGRESS AT A GLANCE

GTF

Renewable energy share in total final energy consumption, 1990–2014



Renewable energy share in 2014 and annualized change in renewable energy share, 2012–14 in the 20 largest energy-consuming countries



Note: Countries appear in order of total final energy consumption, from largest to smallest.

REGIONAL FOCUS **AFRICA**

FIGURE 1 Share of population with access to electricity in urban and rural areas, 1990–2014

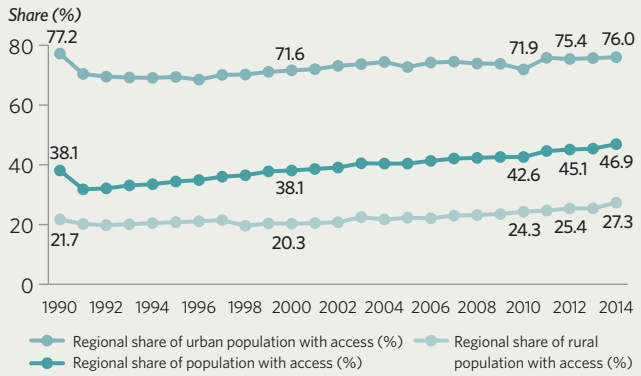


FIGURE 2 Share of population with access to clean fuels and technologies for cooking, 2000–14

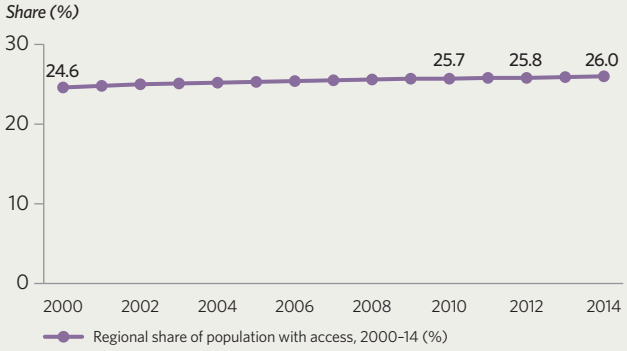


FIGURE 3 Primary energy intensity and annualized change, 1990–2014

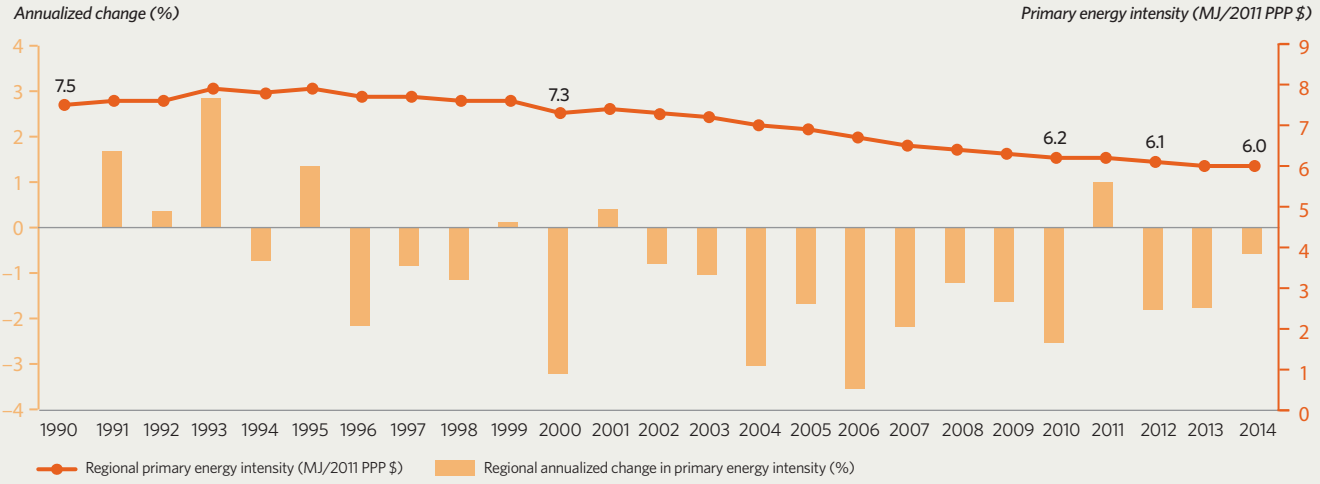


FIGURE 4 Share of renewable energy consumption in total final energy consumption, 1990–2014

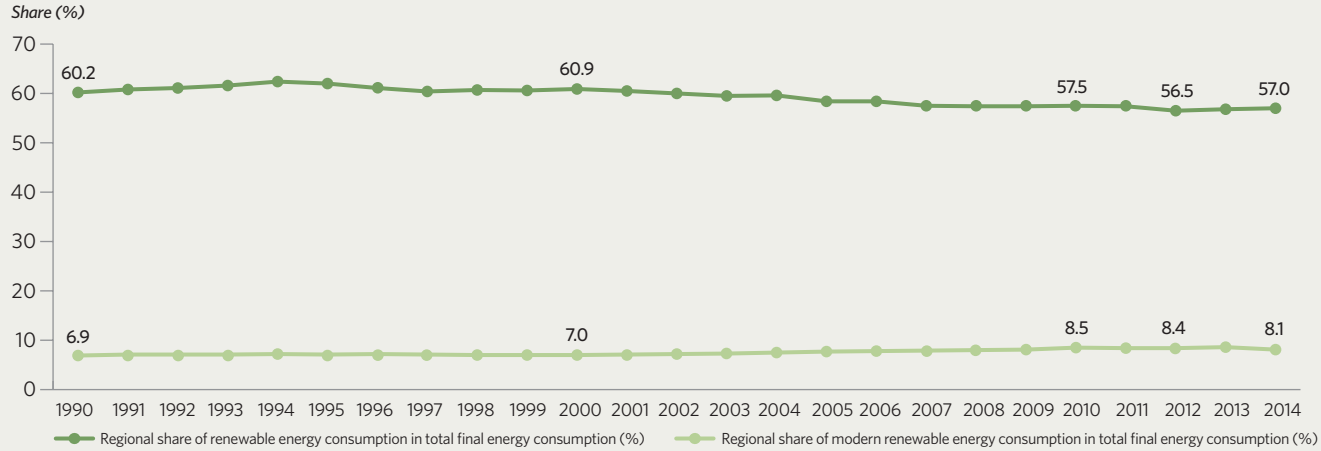


FIGURE 5 Share of population with access to electricity and population without access in 2014

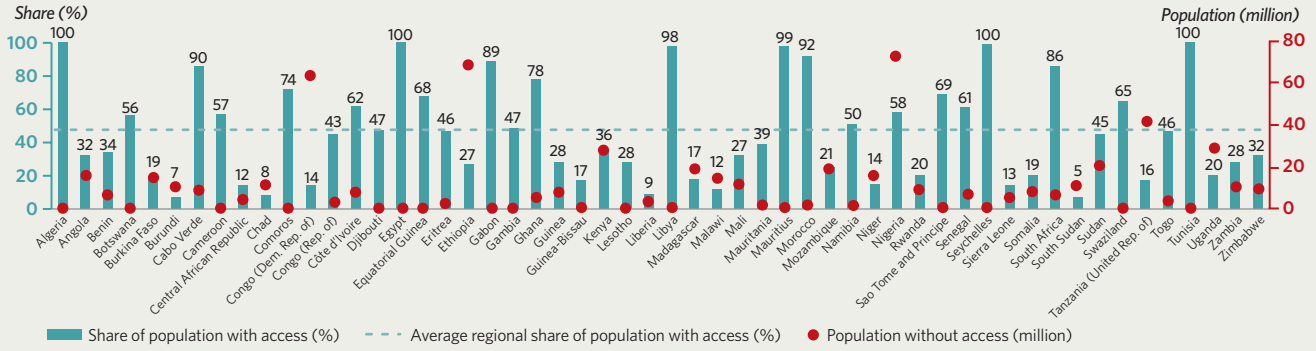


FIGURE 6 Share of population with access to clean fuels and technologies for cooking and population without access in 2014

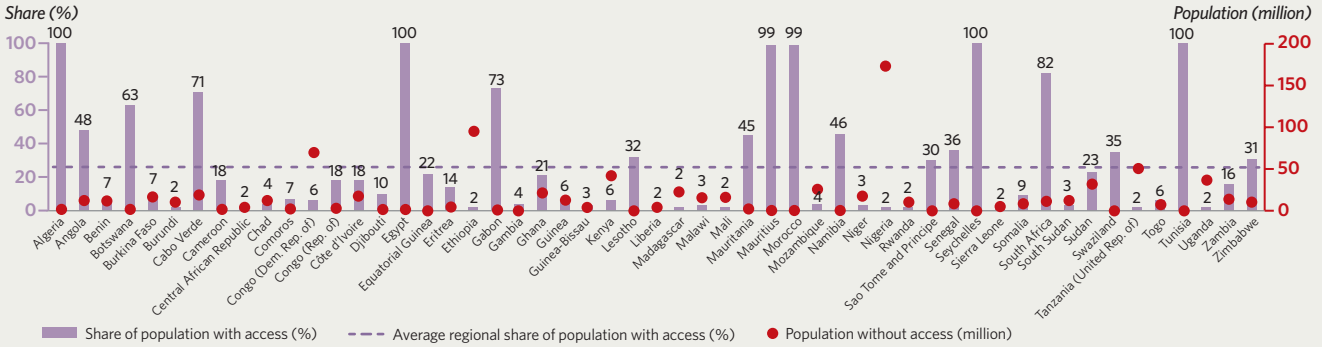


FIGURE 7 Primary energy intensity in 2014 and annualized change in 2012–14

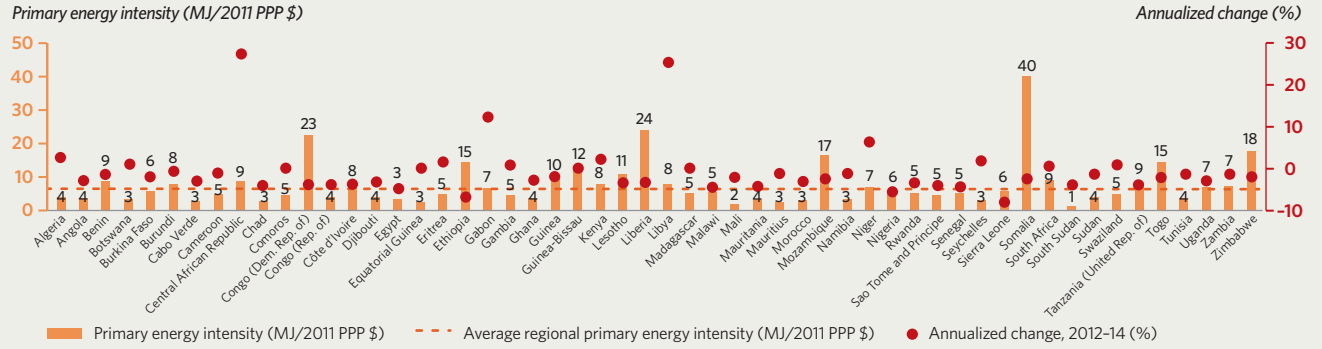
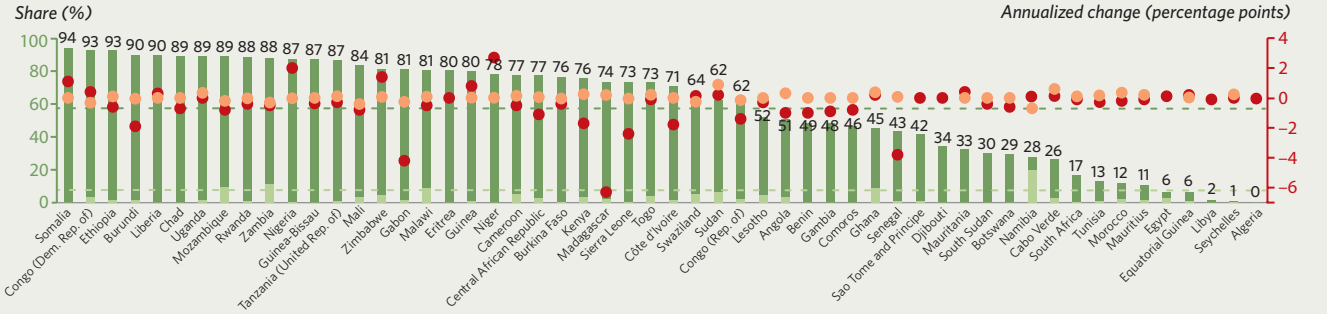


FIGURE 8 Share of renewable energy consumption in total final energy consumption in 2014 and annualized change in share in 2012–14



Note: Renewable energy is the sum of traditional and modern renewable energy consumption.

REGIONAL FOCUS **ARAB REGION**

FIGURE 1 Share of population with access to electricity in urban and rural areas, 1990–2014

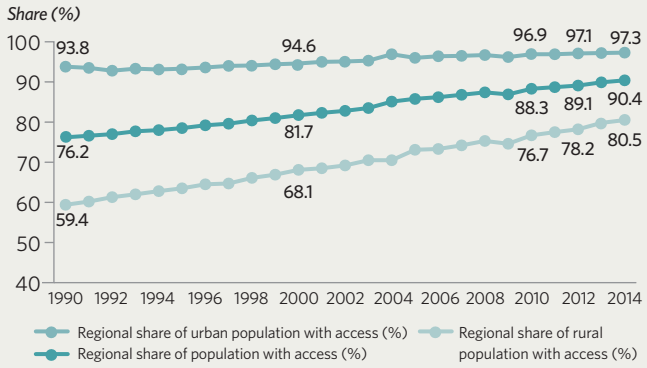


FIGURE 2 Share of population with access to clean fuels and technologies for cooking, 2000–14

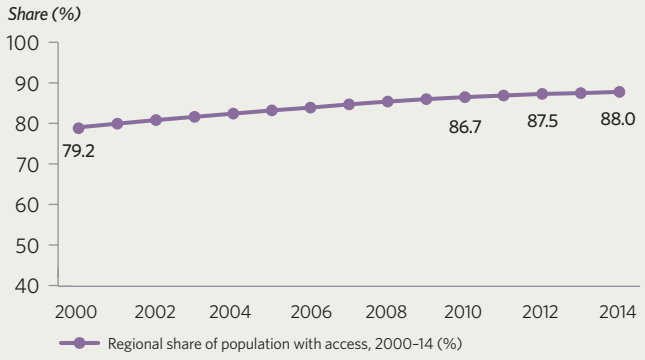


FIGURE 3 Primary energy intensity and annualized change, 1990–2014

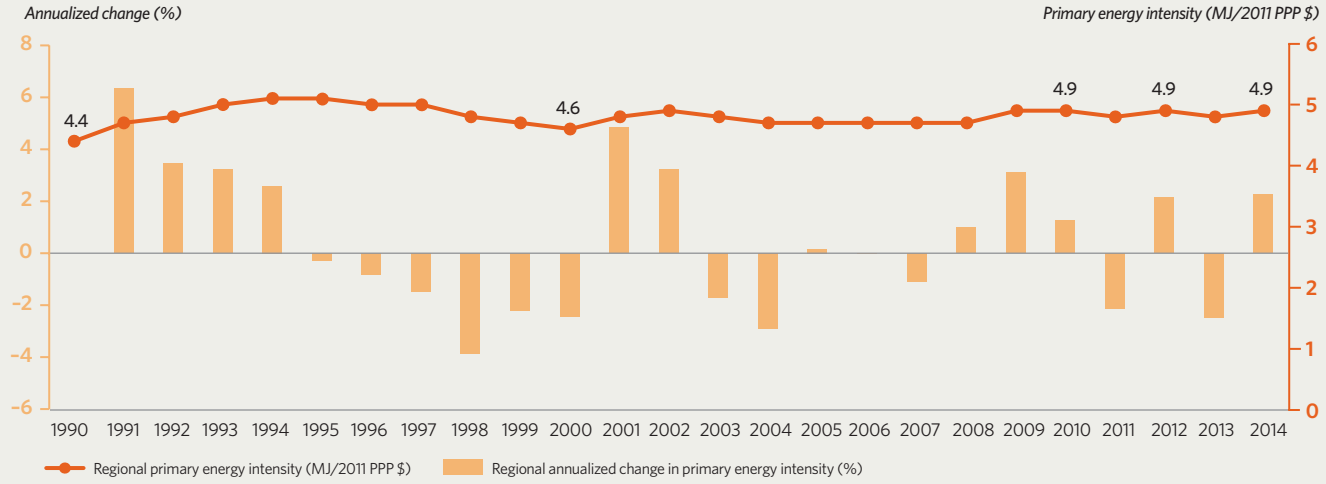


FIGURE 4 Share of renewable energy consumption in total final energy consumption, 1990–2014

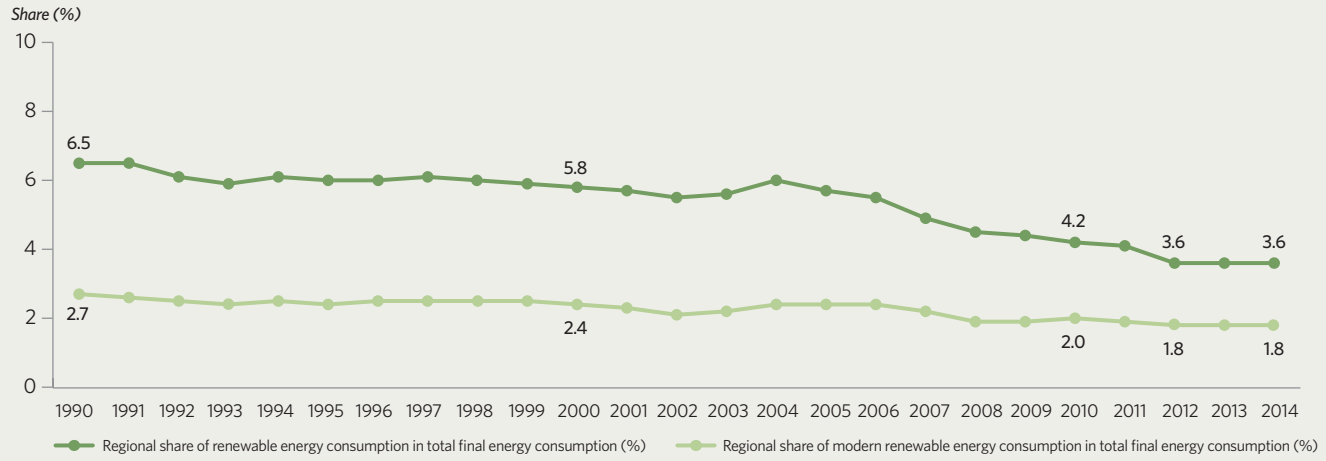


FIGURE 5 Share of population with access to electricity and population without access in 2014

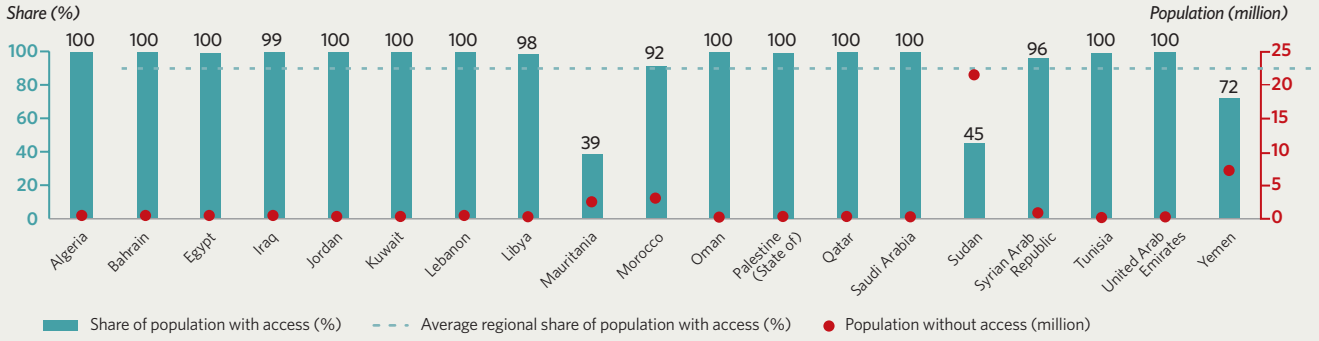


FIGURE 6 Share of population with access to clean fuels and technologies for cooking and population without access in 2014

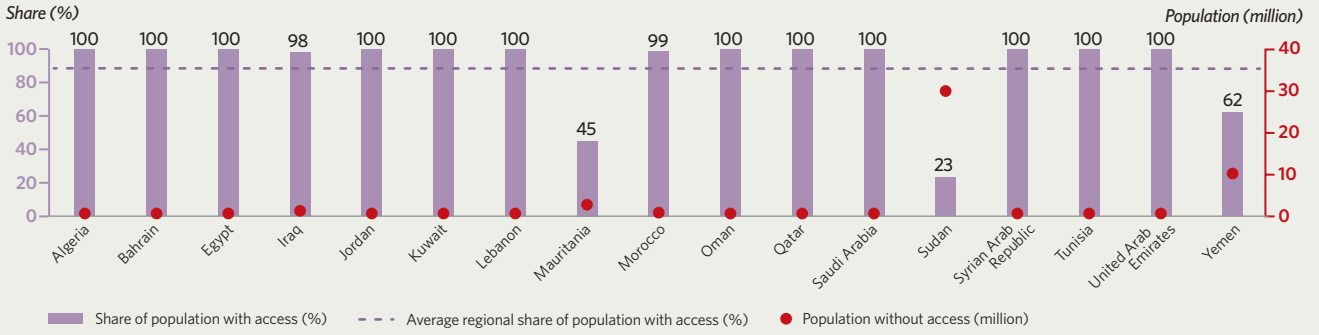


FIGURE 7 Primary energy intensity in 2014 and annualized change in 2012–14

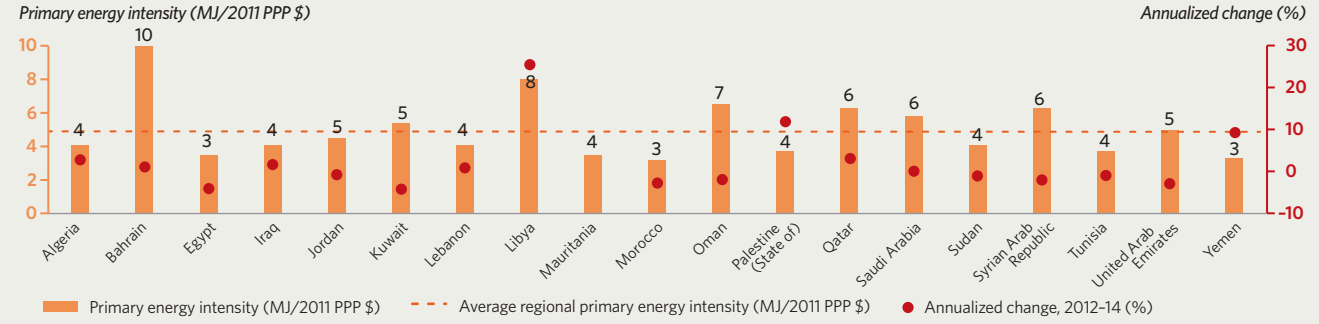
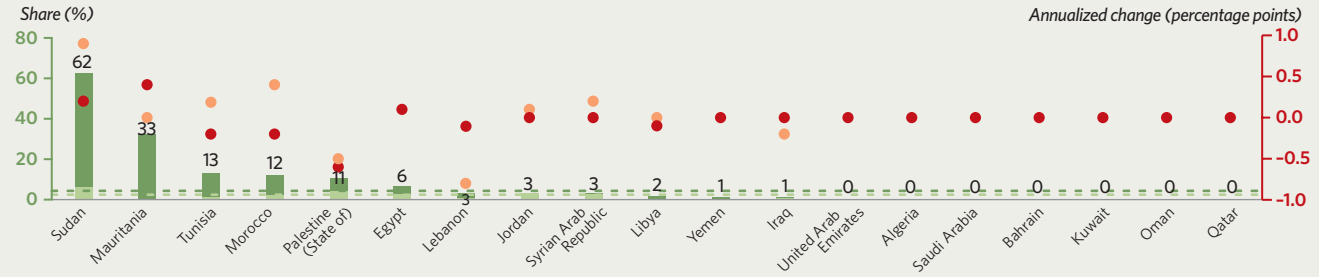


FIGURE 8 Share of renewable energy consumption in total final energy consumption in 2014 and annualized change in share in 2012–14



Share of traditional renewable energy consumption in total final energy consumption, 2014 (%)
Average regional share of renewable energy consumption in total final energy consumption, 2014 (%)
Share of modern renewable energy consumption in total final energy consumption, 2014 (%)
Average regional share of modern renewable energy consumption in total final energy consumption, 2014 (%)
Annualized change in share of traditional renewable energy, 2012–14 (percentage points)
Annualized change in share of modern renewable energy consumption, 2012–14 (percentage points)

Note: Renewable energy is the sum of traditional and modern renewable energy consumption.

REGIONAL FOCUS **ASIA-PACIFIC**

FIGURE 1 Share of population with access to electricity in urban and rural areas, 1990–2014

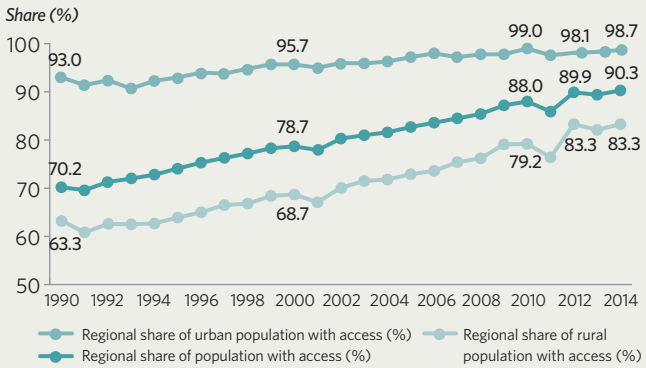


FIGURE 2 Share of population with access to clean fuels and technologies for cooking, 2000–14

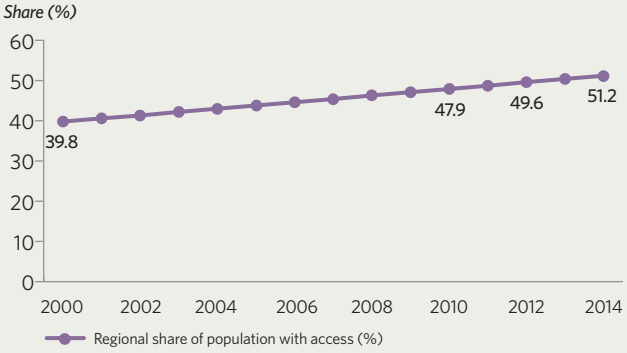


FIGURE 3 Primary energy intensity and annualized change, 1990–2014

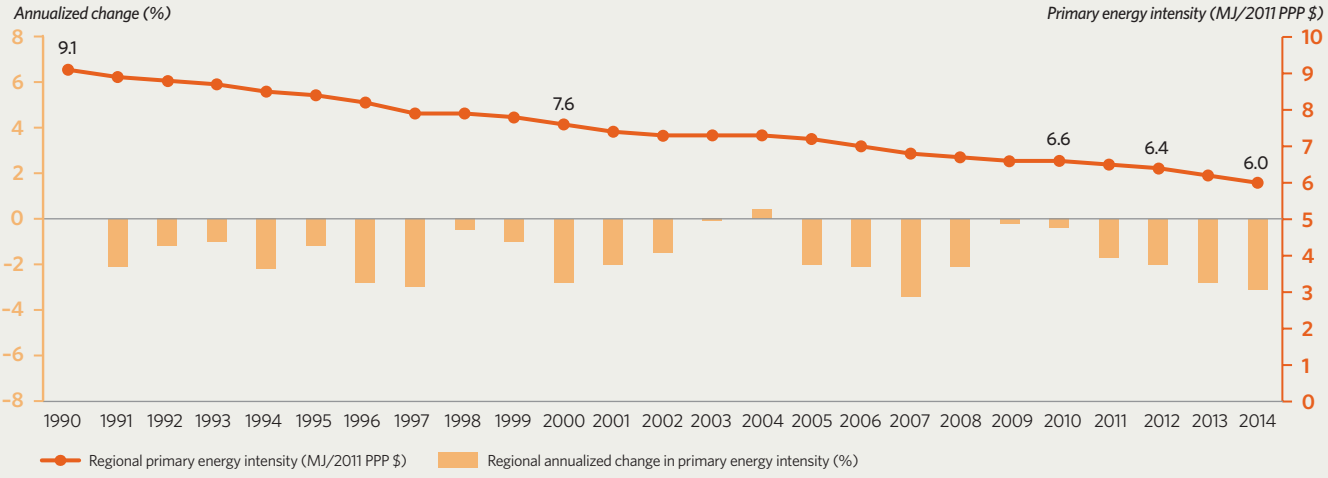


FIGURE 4 Share of renewable energy consumption in total final energy consumption, 1990–2014

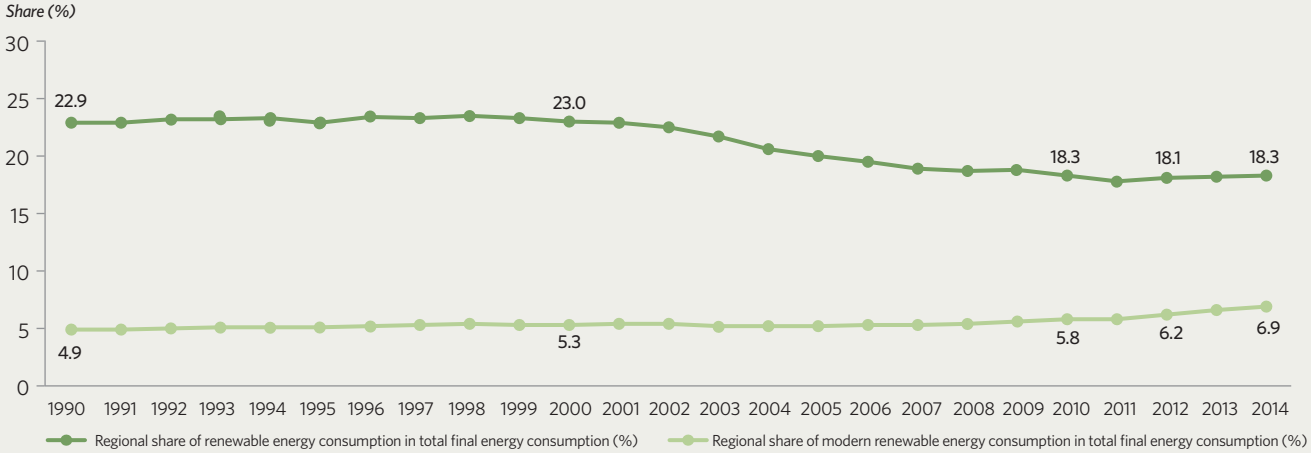


FIGURE 5 Share of population with access to electricity and population without access in 2014

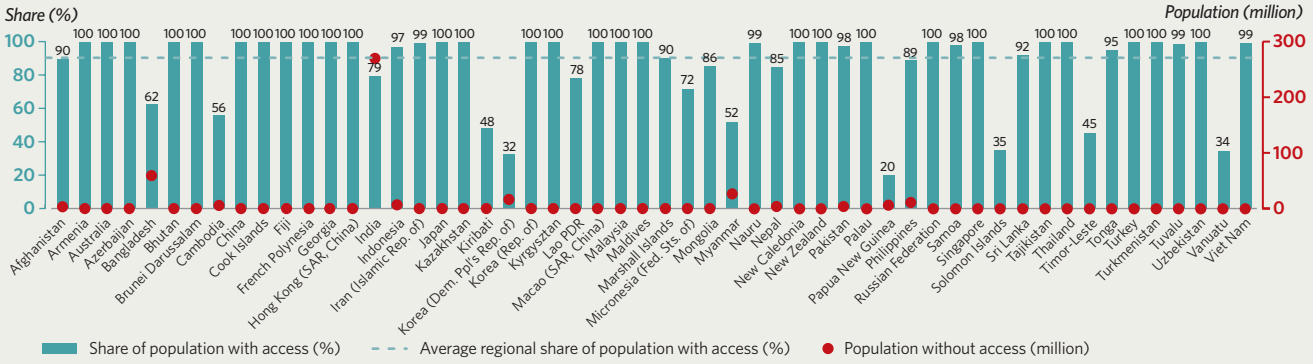


FIGURE 6 Share of population with access to clean fuels and technologies for cooking and population without access in 2014

FIGURE 7 Primary energy intensity in 2014 and annualized change in 2012–14

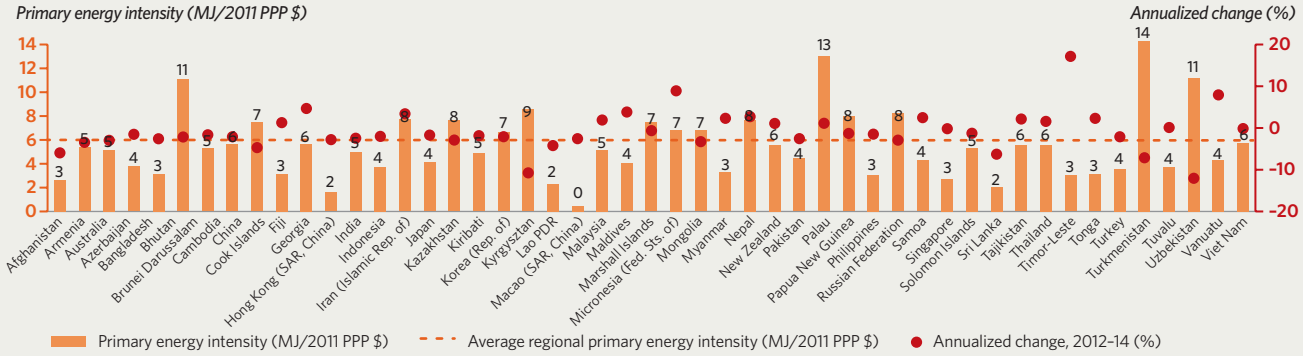
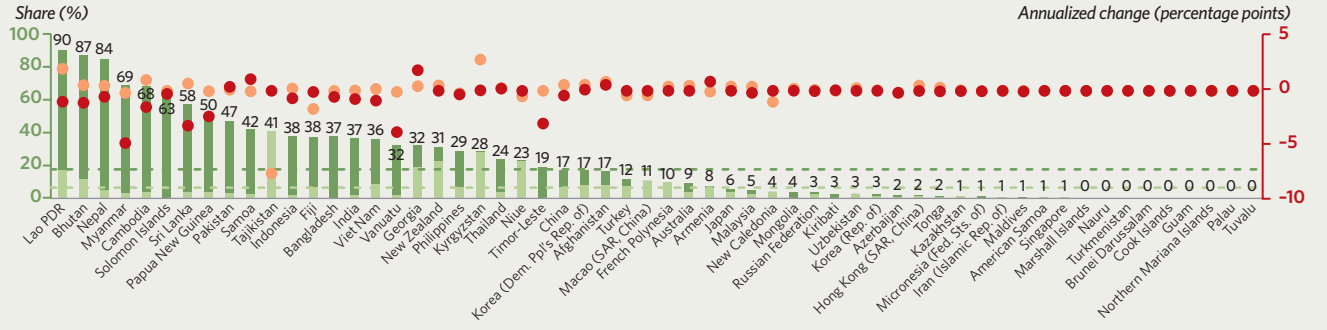


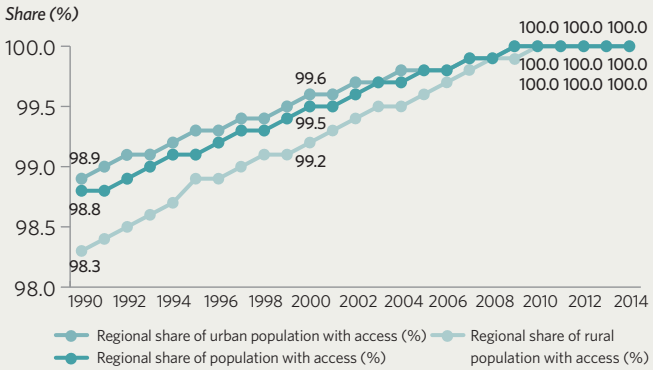
FIGURE 8 Share of renewable energy consumption in total final energy consumption in 2014 and annualized change in share in 2012–14



Note: Renewable energy is the sum of traditional and modern renewable energy consumption.

REGIONAL FOCUS
EUROPE, NORTH AMERICA, AND CENTRAL ASIA

FIGURE 1 Share of population with access to electricity in urban and rural areas, 1990–2014



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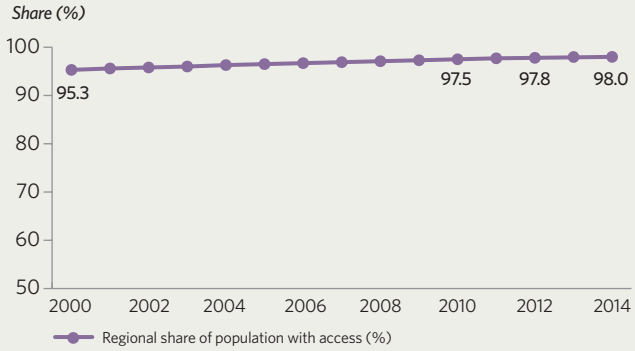

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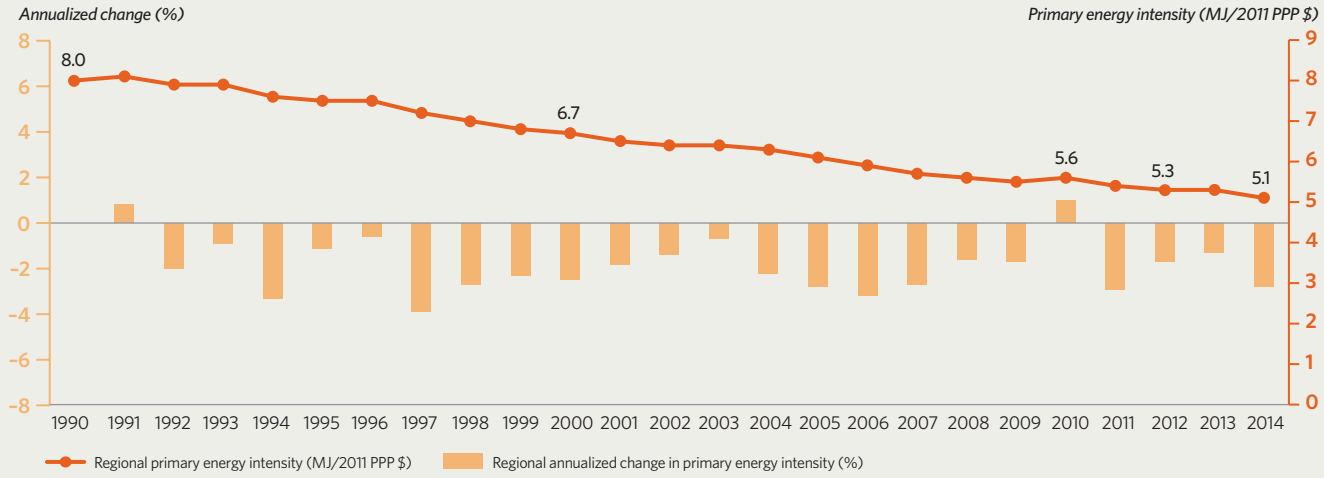


FIGURE 4 Share of renewable energy consumption in total final energy consumption, 1990–2014

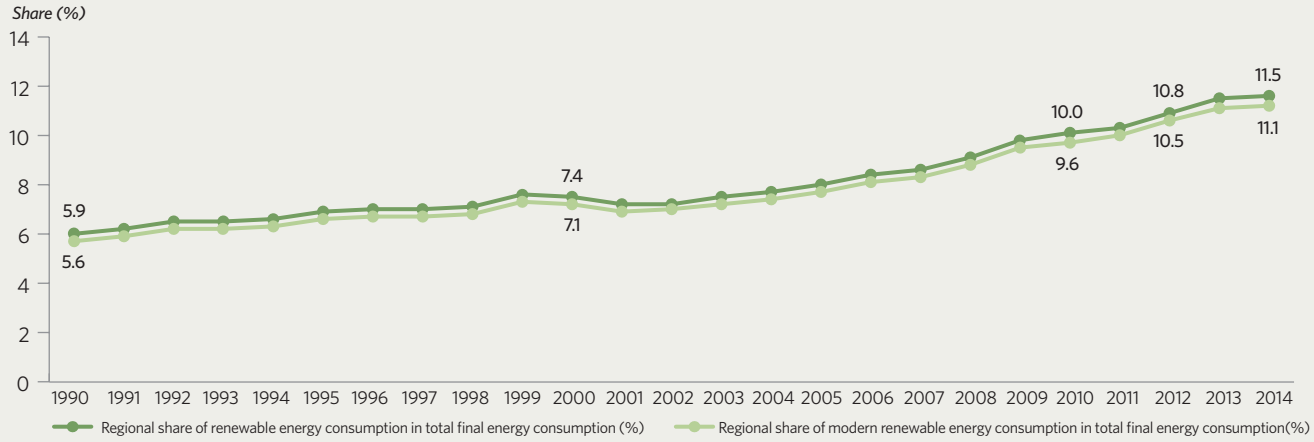
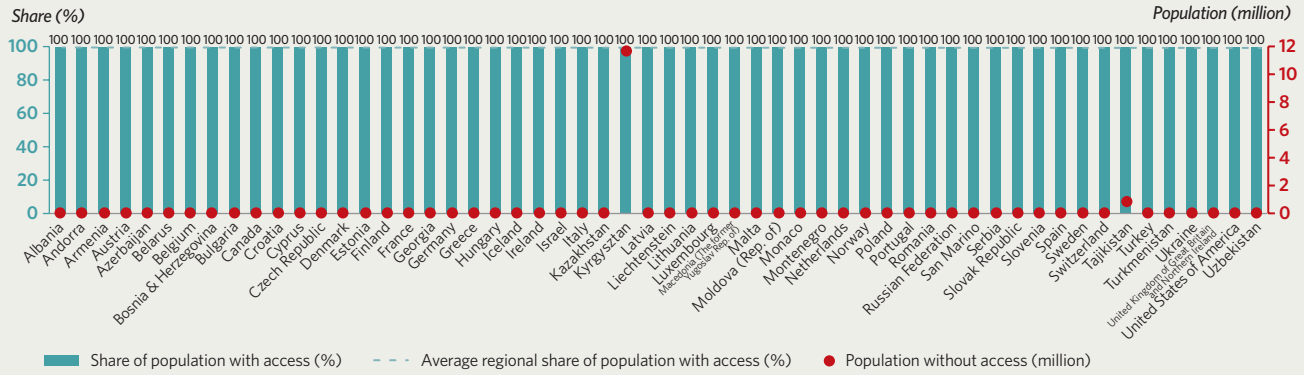


FIGURE 5 Share of population with access to electricity and population without access in 2014



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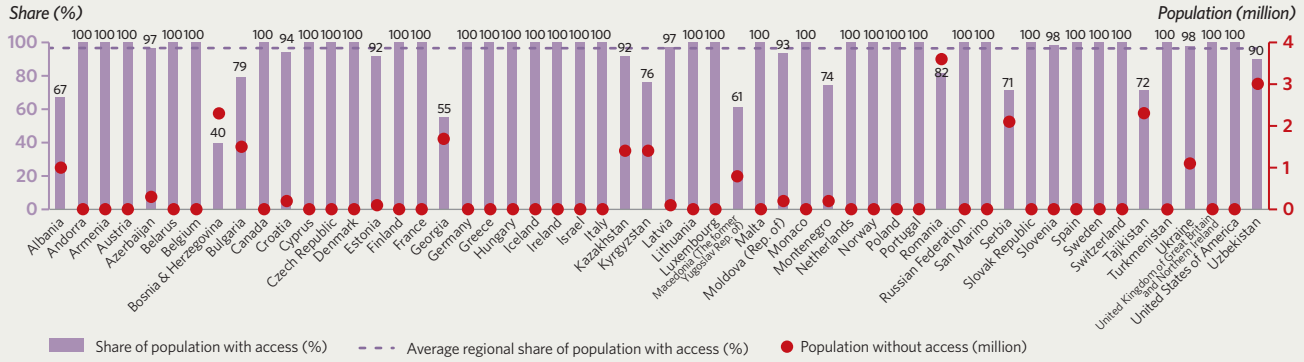


FIGURE 7 Primary energy intensity in 2014 and annualized change in 2012–14

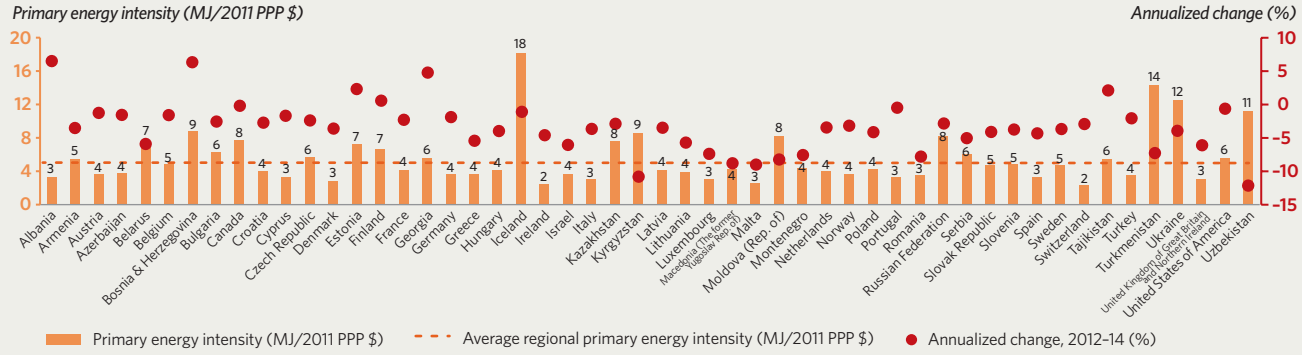
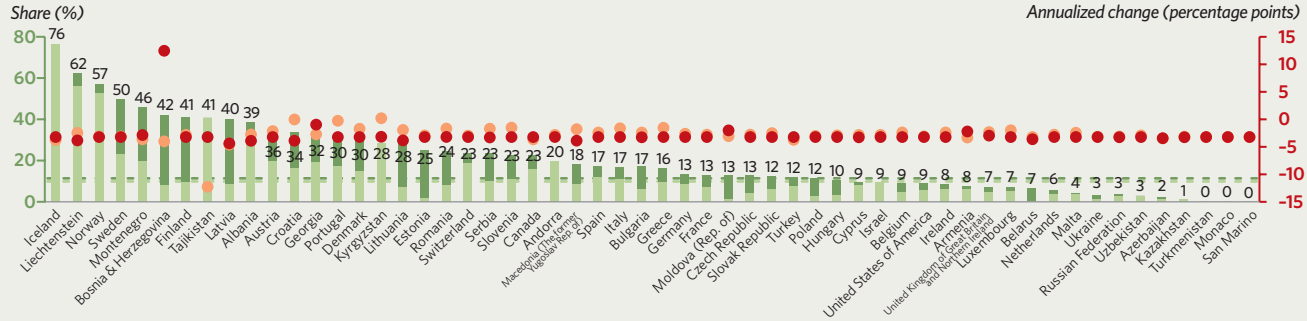


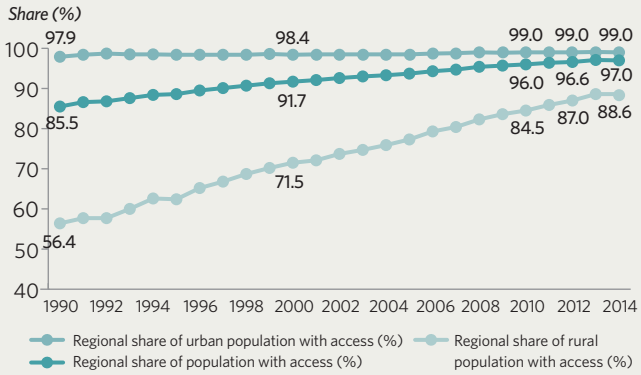
FIGURE 8 Share of renewable energy consumption in total final energy consumption in 2014 and annualized change in share in 2012–14



Note: Renewable energy is the sum of traditional and modern renewable energy consumption.

REGIONAL FOCUS LATIN AMERICA AND CARIBBEAN

FIGURE 1 Share of population with access to electricity in urban and rural areas, 1990–2014



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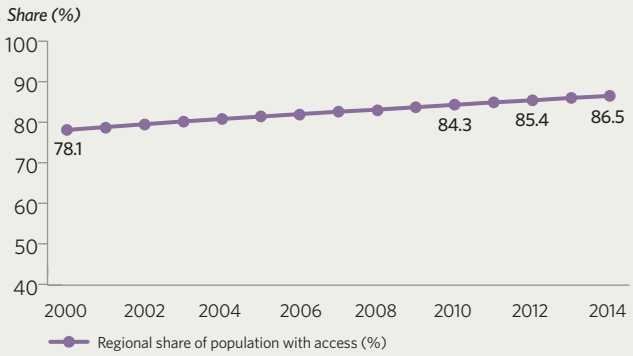


FIGURE 3 Primary energy intensity and annualized change, 1990–2014

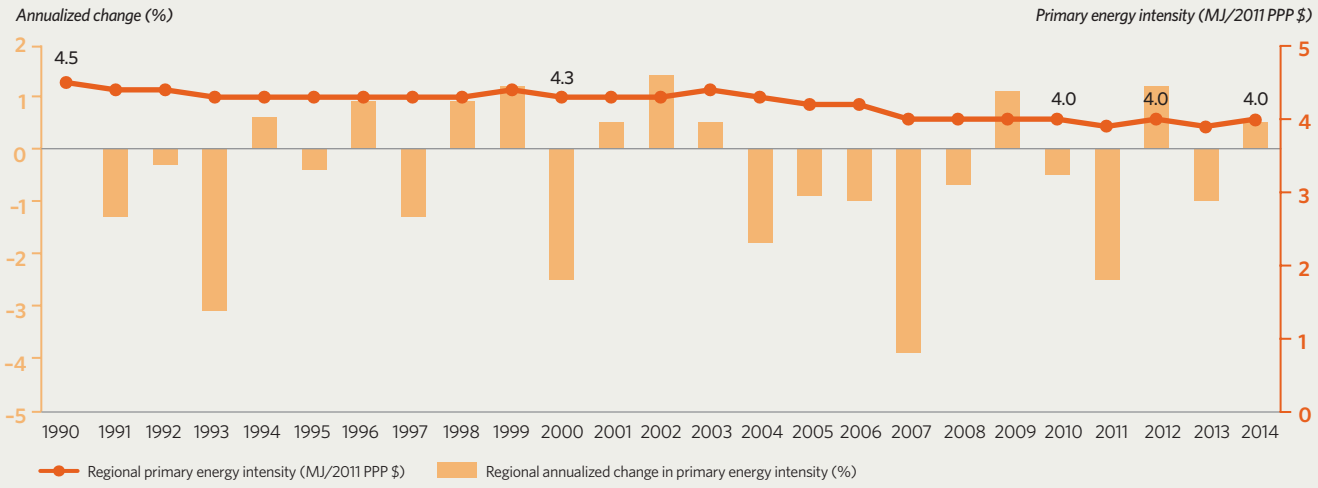


FIGURE 4 Share of renewable energy consumption in total final energy consumption, 1990–2014

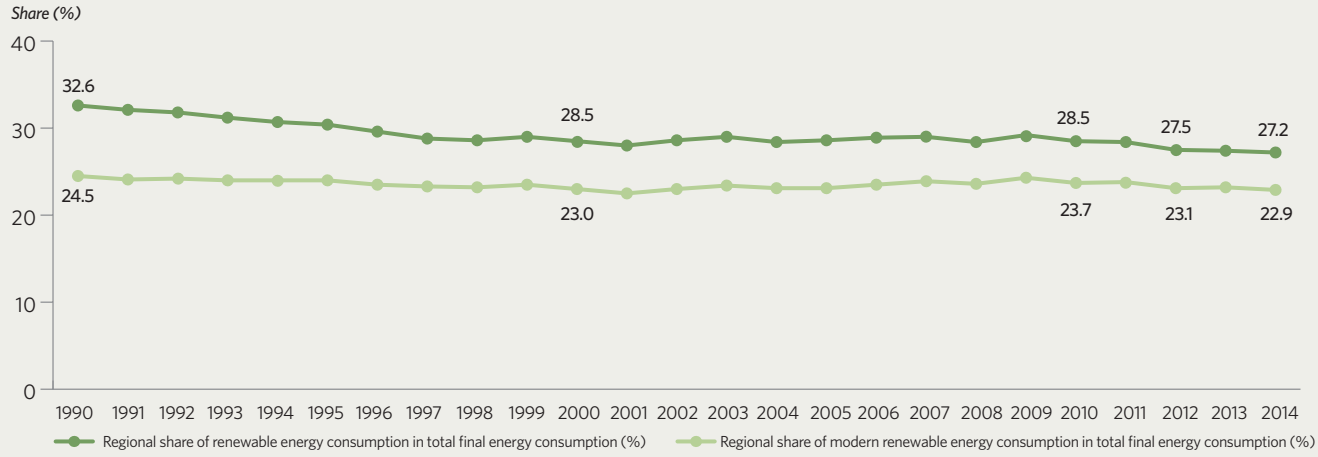


FIGURE 5 Share of population with access to electricity and population without access in 2014

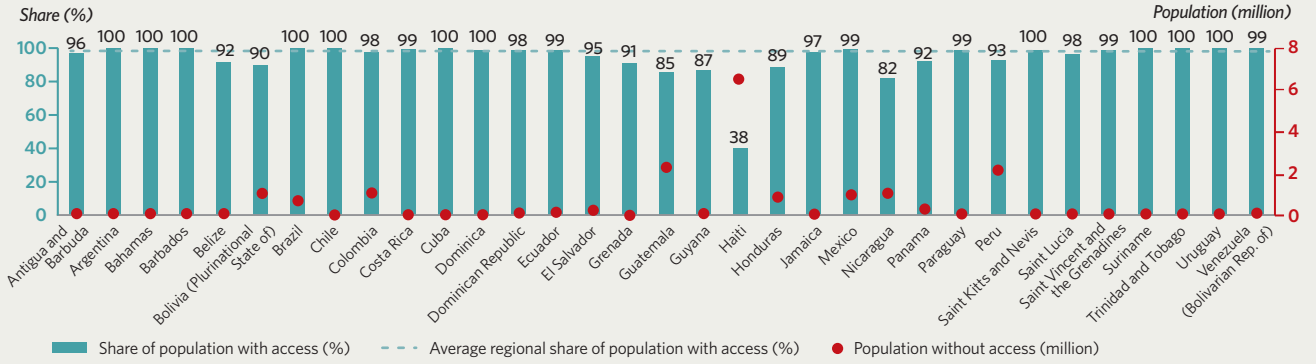


FIGURE 6 Share of population with access to clean fuels and technologies for cooking and population without access in 2014

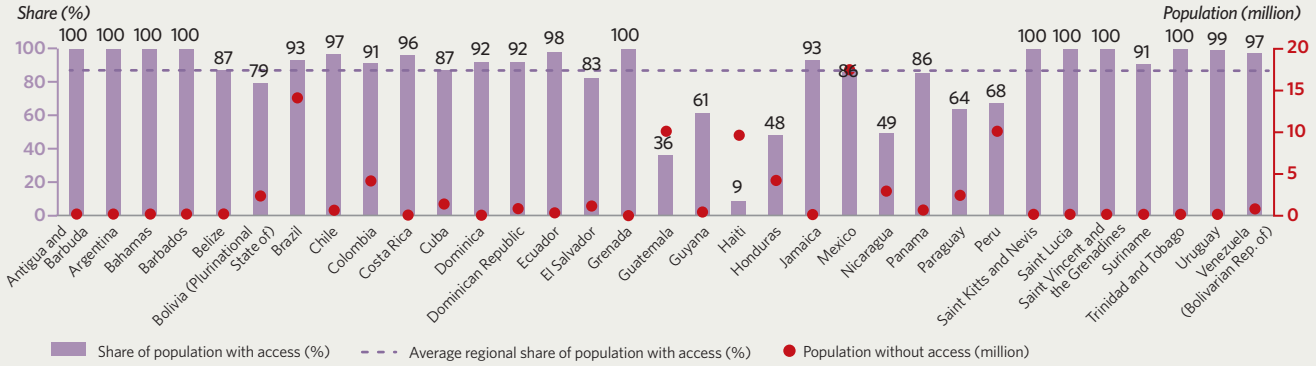


FIGURE 7 Primary energy intensity in 2014 and annualized change in 2012–14

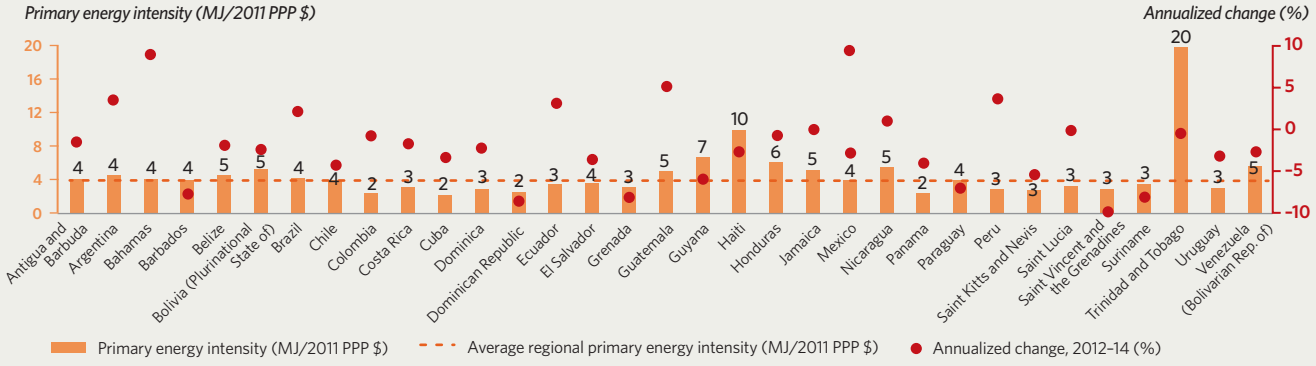
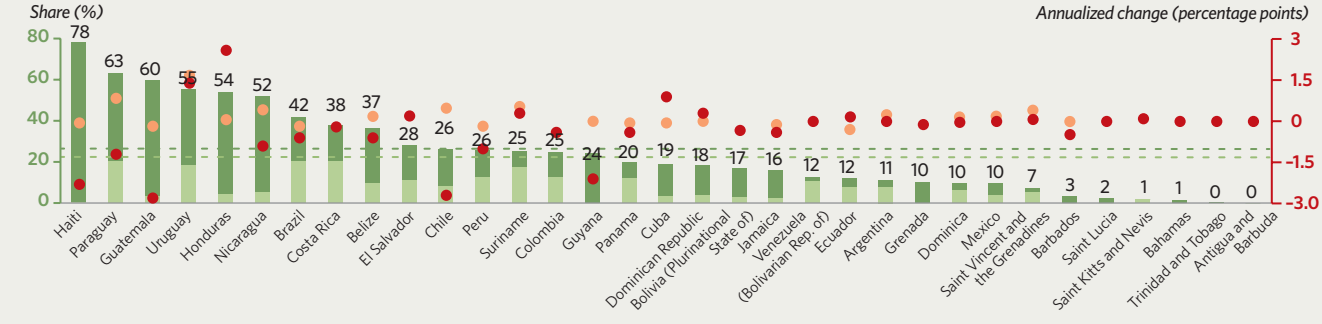
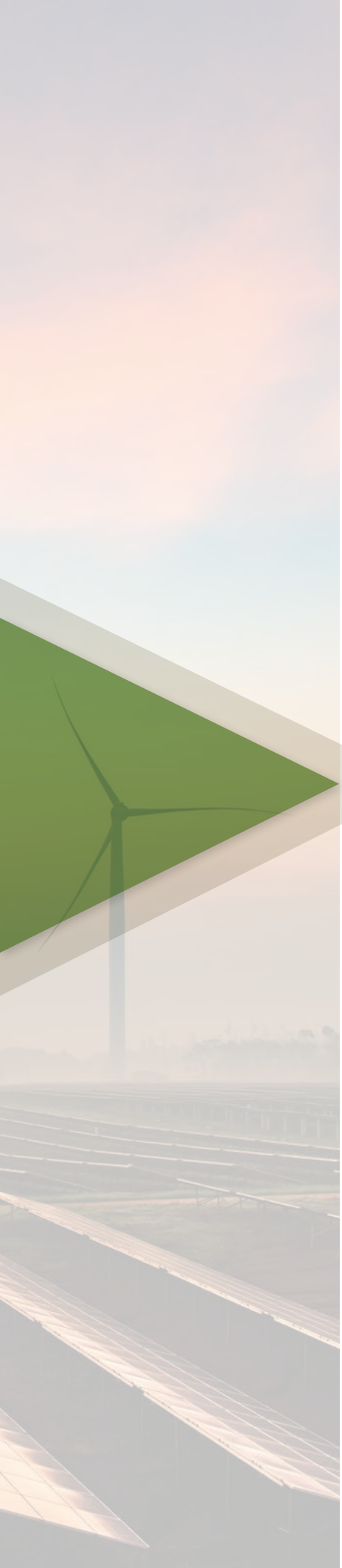


FIGURE 8 Share of renewable energy consumption in total final energy consumption in 2014 and annualized change in share in 2012–14



Note: Renewable energy is the sum of traditional and modern renewable energy consumption.



PART ONE

THE GLOBAL STORY

REMOLQUES
JUCAL S.L.

1

INTRODUCTION

In 2011, United Nations (UN) Secretary-General Ban Ki-Moon launched the Sustainable Energy for All (SEforALL) initiative that articulated three global energy objectives for 2030: ensure universal access to modern energy services, double the global rate of improvement of energy efficiency, and double the share of renewable energy in the global energy mix. That same year, joined by World Bank President Jim Kim as cochair of the SEforALL initiative, he launched a global movement that has engaged numerous countries and hundreds of partners—public, private, and in civil society. Building on this foundation, the UN General Assembly pronounced 2012 the Year of Sustainable Energy for All and later, 2014–24 the Decade of Sustainable Energy for All.

In September 2015, the global community adopted the Sustainable Development Goals (SDGs) for 2030. For the first time, energy occupied a central place in the world's development agenda with SDG 7, which aims to "ensure access to affordable, reliable, sustainable, and modern energy for all." SDG 7 builds on the foundation of SEforALL, adopting targets for energy access, energy efficiency, and renewable energy.

SDG 7 extends the SEforALL framework (table 1.1), in particular by specifying that universal access to energy be affordable and reliable. It also fine-tunes the indicator for access to clean cooking to better align it with the latest scientific evidence on the health effects of different cooking practices.[1] The SDG 7 targets generally mirror the SEforALL objectives, except for the renewable energy share where SDG 7 calls for a vaguer "substantial increase" rather than a "doubling." This report, undertaken for SEforALL, refers to the doubling objective.

Three months after the SDGs were adopted, 195 nations negotiated an historic climate agreement at the 2015 Paris Climate Conference (COP21), one that declared that not only do we need to hold the increase in the global average temperature to "well below 2°C above pre-industrial levels" but also pursue efforts to limit the increase to 1.5°C. Within this framework, each country has adopted its own Nationally Determined Contribution, many of which feature measures on renewable energy, energy efficiency, and energy access, and some on clean cooking. While meeting climate change goals depends on progress in many sectors (industry, agriculture, services, transport, and buildings), there is little doubt that energy plays a major role.

AN EVOLVING REPORT

These landmark political agreements make it more important than ever to track global and national progress on the three sustainable energy pillars of energy access, energy efficiency, and renewable energy. As with the first two reports published in 2013 and 2015, this third edition of the SEforALL *Global Tracking Framework* (*GTF*) has been co-led by the World Bank/Energy Sector Management Assistance Program (ESMAP) and the International Energy Agency, in collaboration with more than 20 organizations around the world. It aims to provide the international community with a global dashboard to register progress on the three pillars.

GTF 2013

Published in 2013 and produced by a wide consortium of global energy agencies, the first *GTF* provided the vehicle for an emerging technical consensus on the best available indicators to capture advances in sustainable energy. It aimed to strike a balance between the search for ideal metrics that accurately capture the state of and progress in sustainable energy, and the practical checks imposed by a need to report data for as many countries in the world as possible. *GTF 2013*, which went through a widespread consultation process before it was released, discussed in detail the pros and cons of indicators and the rationale for the indicators that were adopted.

The final choice of indicators for the historical reference period of 1990–2010 built heavily on earlier efforts to harmonize and consolidate data from an array of international agencies. Access indicators were derived from omnibus household surveys, such as Demographic and Health Surveys and Living Standards Measurement Surveys, which drew on the technical assistance and capacity building carried out over many years as part of efforts to report on the Millennium Development Goals. Energy efficiency and renewable energy indicators were derived from national energy balances, which benefited from decades of effort by the UN Statistical Commission and the International Energy Agency to promote reporting of data using a standardized methodology and to conduct systematic checks for countries' data consistency. Because *GTF 2013* built on these earlier efforts, its findings had several implications for it and for subsequent reports. In particular, *GTF 2013* illustrated that while it is very valuable to have globally harmonized data, there are also some consequences to harmonization that need to be well understood (box 1.1).

TABLE 1.1 SEforALL Objectives and Sustainable Development Goal 7

	SEforALL Objectives	Sustainable Development Goal 7
Year of adoption	2011	2015
Target year	2030	2030
General statement	SEforALL	Ensure access to affordable, reliable, sustainable, and modern energy for all
Energy access	Objective By 2030, ensure universal access to modern energy services	Target 7.1: By 2030, ensure universal access to *affordable, reliable and modern* energy services
	Indicator Percentage of population with access to electricity Percentage of population with access to nonsolid fuels[2]	Indicator Percentage of population with access to electricity Percentage of population with access to *clean fuels and technologies* at the household level
Energy efficiency	Objective By 2030, double the global rate of improvement in energy efficiency	Target 7.3: By 2030, double the global rate of improvement in energy efficiency
	Indicator Compound annual growth rate of energy intensity in terms of total primary energy supply and gross domestic product (GDP) at purchasing power parity (PPP)	Indicator Energy intensity in terms of total primary energy supply and GDP at PPP
Renewable energy	Objective By 2030, double the share of renewable energy in the global energy mix	Target 7.2: By 2030, *increase substantially* the share of renewable energy in the global energy mix
	Indicator Renewable energy share in total final energy consumption	Indicator Renewable energy share in total final energy consumption

Note: Text in italics shows where SDG 7 differs from SEforALL.

Box 1.1

Three implications of moves to harmonize data at the global level

All data reported in the *GTF* are based on official national statistical sources. However, in order to allow international comparisons, some harmonization is needed in order to ensure that the statistics are based on a consistent methodology. Although harmonized data are very valuable, such data also come at a cost, for various reasons identified below.

1. The long time required to standardize international data creates a lag in publishing data for global tracking. It typically takes at least one year for national data to be published, a further year for the data to be collected and harmonized by international agencies, and a further year for the data to be analyzed for the *GTF*, which is why the latest data for the reports are for three years earlier.

2. The results for standardized indicators for countries may differ from those reported domestically owing to divergences between the statistical methodologies. Without this standardization, cross-country comparisons and regional or global aggregation of indicators would not be valid or meaningful. This does not mean that either the national or global data are incorrect; they simply may be measuring related but slightly different concepts.

   For example, a country may report as its national electrification rate the share of population living in villages that have been "connected to the grid," while the global tracking indicator is the share of households that report being "connected to electricity" through a household survey process. These are different ways of measuring electrification. Both are correct to some degree, but are measuring different concepts and so there is no reason why they should coincide.

3. The underlying data series are updated by the originating agencies as new sources of information become available or as previous errors are corrected. The values for the indicators in each *GTF* may therefore differ from those in earlier reports, owing not only to the recently incorporated data but also to minor revisions in the historical series.

The indicators adopted for *GTF 2013* were positively evaluated by the Bureau of the UN Statistical Commission in early 2015.[3] It rated all the indicators, with the partial exception of that for clean cooking, AAA, meaning that they performed well on three main characteristics: feasibility, suitability, and relevance. They were among only 16% of SDG candidate indicators that received the highest "green light" grade overall, meaning that the UN Statistical Commission considered them fit for purpose and ready to use.

In sum, *GTF 2013* created a global data platform with data for over 180 countries since 1990, bringing together all available data on the agreed indicators in the report itself and online through the World Bank's World Development Indicators platform.

GTF 2015

The second *GTF* report, which came out in 2015, updated indicator results to 2011 and 2012 and evaluated progress toward the SEforALL objectives. In common with *GTF 2013*, it included the results of projections from several global energy models to evaluate the feasibility of goals being met during the remaining period to 2030. A special chapter discussed the nexus between sustainable energy and other important aspects of the development agenda, including water, agriculture, health, and gender.[4]

GTF 2017

This latest *GTF* report continues the task of tracking global progress by releasing indicator results for 2013 and 2014, bolstered by five regional profiles that reveal emerging trends in the five global regions: Africa, the Arab Region; Asia–Pacific; Europe, North America, and Central Asia; and Latin America and the Caribbean. Their construction entailed close work with the five UN Regional Commissions—the United Nations Economic Commission for Africa, United Nations Economic Commission for Europe, United Nations Economic Commission for Latin America and the Caribbean, United Nations Economic and Social Commission for Asia and the Pacific, and United Nations Economic and Social Commission for Western Asia—and extensive outreach to national policymakers.

GTF 2017 also sees the launch of a website allowing easier user interaction with the data, including many visualizations and the ability to easily download customized datasheets and country reports (table 1.2). The underlying data can still be downloaded as Excel files through the World Development Indicators portal.

Going forward, the *GTF* will now be published annually to provide the international community with more timely updates on progress on the three pillars.

SOME WEAKNESSES IN DATA AND INDICATORS

The *GTF* process has made considerable gains in building a global data platform, but key shortcomings persist, in the data and in the indicators themselves. The quality, consistency, and completeness of data reported by

TABLE 1.2 Snapshot of SEforALL *Global Tracking Frameworks*

	GTF 2013	*GTF 2015*	*GTF 2017*
New data	1990–2010	2011–12	2013–14
Aim	Define indicators Create global data platform Provide historical reference period	Track progress in 2011–12 Explore nexus between energy and other development areas	Track progress in 2013–14 Give detail on regional progress
URL	http://www.worldbank.org/en/topic/energy/publication/Global-Tracking-Framework-Report	http://gtf.esmap.org	http://gtf.esmap.org

many smaller or lower-income countries—particularly in Africa, the Pacific, and parts of the Arab Region—is still far from ideal. Additional support for building capacity, targeted at energy ministries and national statistical agencies, is required to bridge these gaps.

Similarly, the four SDG 7 indicators, despite receiving a good rating from the UN Statistical Commission, do not fully capture the underlying variables. To take energy access, SDG 7 emphasizes the need for it to be affordable and reliable, yet metrics capture only the presence or absence of an electricity connection in the household. The Multi-Tier Framework[5] is a new system for measuring energy access according to a number of progressive tiers that captures these and other dimensions of service quality and makes it possible to gauge whether access is affordable, reliable, and modern. First results from a large-scale application of this framework are expected in 2018.

Energy intensity, too, is only an imperfect proxy for energy efficiency, and we need to collect higher resolution subsector data on energy end uses, as many countries in the Organisation for Economic Co-operation and Development already do. Finally, the largest component of renewable energy is traditional use of biomass by households in the developing world, but much uncertainty surrounds attempts to measure it,[6] and even more the question of how much of its use is considered sustainable.

STRUCTURE OF *GTF 2017*

The *GTF 2017* has two parts. The rest of the first part contains four chapters on the three pillars, reporting the headline global findings for access to electricity (chapter 2), access to clean cooking (chapter 3), energy efficiency (chapter 4), and renewable energy (chapter 5). Chapter 6 on scenarios and prospects brings together the most recent findings from the global energy modeling literature and uses them to shed light on the current outlook and feasibility of meeting SDG 7 targets by 2030.

The second part begins with a brief introduction that compares performance among regions (chapter 7) and then provides five regional profiles, for Africa (chapter 8), the Arab Region (chapter 9), Asia–Pacific (chapter 10), Europe, North America, and Central Asia (chapter 11), and Latin America and the Caribbean (chapter 12).

NOTES

1. See annex 3.1 in chapter 3.
2. Due to data limitations, the indicator for clean cooking under the original SEforALL *GTF 2013* was defined in terms of access to nonsolid fuels. In advance of the adoption of SDG 7, the World Health Organization put out a new and improved dataset on access to clean fuels and technologies for cooking, which was adopted for SDG 7.
3. See Bureau of the United Nations Statistical Commission, "Technical Report by the Bureau of the United Nations Statistical Commission (UNSC) on the Process of the Development of an Indicator Framework for the Goals and Targets of the Post-2015 Development Agenda" (working draft, March 19, 2015), https://sustainabledevelopment.un.org/index.php?page=view&type=111&nr=6754&menu=35.
4. Contributions for the nexus chapter came from further partner agencies including Energia, the Food and Agriculture Organization of the United Nations, the Global Water Partnership, the Stockholm International Water Institute, UN Women, and the World Health Organization.
5. The Multi-Tier Framework is a new methodology for measuring energy access along a continuum of five different tiers, based on an evaluation of seven dimensions of service quality including affordability and reliability. It is described in the World Bank/ESMAP 2015 report *Beyond Connections: Energy Access Redefined*.
6. See box 5.1 in chapter 5.

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2

ACCESS TO ELECTRICITY

HIGHLIGHTS

- The share of the global population with access to electricity rose from 85.0% in 2012 to 85.3% in 2014, for an annual increase of 0.19 percentage points—much slower than the required rate of 0.92 percentage points a year to meet the universal access to electricity objective in 2030.
- In absolute terms in 2012–14, 86.5 million people a year gained access to electricity, or only slightly above the global population increase of 85.5 million a year. The number of people without electricity worldwide—the global access deficit—therefore fell only slightly, by 1 million a year, from 1.063 billion in 2012 to 1.061 billion in 2014.
- Electricity access advanced faster in urban than rural areas, adding 0.16 percentage points to the urban access rate but only 0.05 percentage points to the rural access rate each year. The urban access rate was 96.3% in 2014, and the rural rate 73.0%.
- Access to electricity in absolute terms is outpacing population growth everywhere but Africa (excluding North Africa), where incremental (absolute) population surpassed incremental access by 4 million people annually.[1] This is a setback from 2010–12, when population growth and access growth had drawn just about equal.
- High-impact countries—the 20 countries with the biggest access deficit—accounted for 80% of the global access deficit in 2014. The majority of these countries made rapid progress on access in 2012–14, electrifying more than 1 percentage point of their population each year.
- As India has by far the largest national access deficit—and nearly one-fourth of the global access deficit—the absence of any new household survey data for the country since 2012 is a major caveat for all estimates of recent global trends.

GLOBAL TRENDS

Progress in electricity access in 2012–14

The world is making slow progress toward universal access to electricity. In 2014, 85.3% of the global population had access to electricity (some 6.18 billion people), an annual increase of 0.19 percentage points from 85.0% in 2012 (figure 2.1). In 2013 and again in 2014, 86.5 million people gained access to electricity, only slightly above the global population growth of 85.5 million a year. So the global access deficit fell only slightly, by 1 million a year, from 1.063 billion in 2012 to 1.062 billion in 2013 and to 1.061 billion in 2014.

These trends are broadly consistent with recent figures reported by the International Energy Agency (IEA), reinforcing the message of slow progress on electrification (IEA 2016). The IEA methodology differs somewhat from the methodology used here, lowering the global access deficit by 125 million people to just under 1 billion (annex 2.1).

A key innovation of this *Global Tracking Framework 2017* (*GTF 2017*) is the adoption of a statistical model that draws on experience in global monitoring for the cooking and water sectors. This model helps present long-term electrification trends by using statistical estimations to fill gaps in the time series data (annex 2.1).[2] But one important caveat for the 2014 global access rate is the lack of any recent household survey data for India, which is by far the most populous country facing an electrification challenge (box 2.1).

Box 2.1

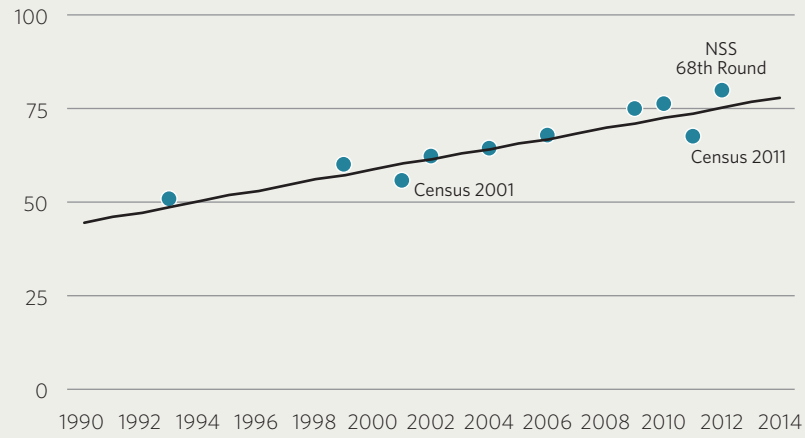
Estimating India's access rate for 2014

With 24% of the global access deficit in 2012, India influences global progress more than any other country. Estimating its progress in 2014 is difficult, however, because the most recent National Sample Survey (NSS) with a question on electricity access was conducted back in 2012. Although a new questionnaire was piloted in 2014, its results have yet to be published. Further, the 2011 census estimate for electricity access is much lower than the 2012 NSS results, at 68% against 80% (box figure 1).

The new statistical model (annex 2.1) indicates an access rate of 79.2% in 2014, marginally lower than the 2012 NSS. So this *GTF* report may slightly underestimate India's progress—and thus the world's. The global access rate excluding India was 86.7% in 2014, against 85.3% with India.

BOX FIGURE 1 Survey data and model estimates for India

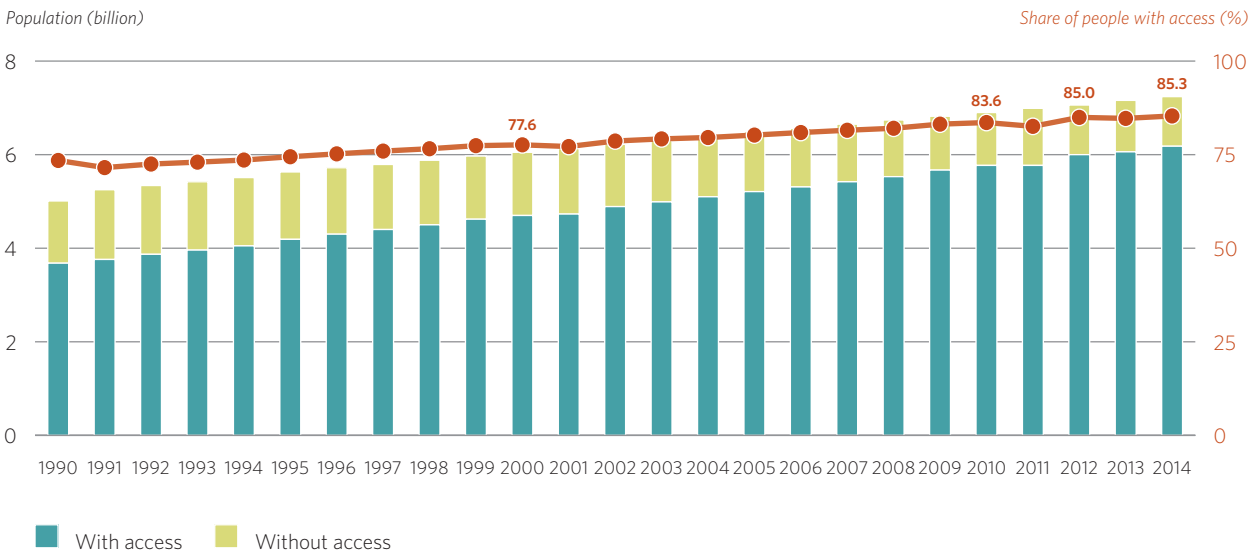
Electricity access rate (%)



Source: GTF.

FIGURE 2.1 The global electricity access rate edged up only marginally in 2012–14

Number and share of population with access to electricity, 1990–2014



Source: GTF and World Development Indicators (WDI) data.

Likely future trends against objectives

Annual progress in access slowed sharply from 0.69 percentage points annually in 2010–12 to 0.19 percentage points in 2012–14. To reach universal access by 2030, the global access rate would have needed to rise by 0.82 percentage points each year from the base year 2010. But because progress has fallen short of this rate since 2010, efforts for 2015–30 need to be stepped up to 0.92 percentage points a year (figure 2.2)—more than four times faster than what actually took place in 2012–14.

The outlook for access to electricity shows that the world is far from being on track to meeting the Sustainable Energy for All (SEforALL) goal of universal access to modern energy by 2030. Under the IEA's latest *World Energy Outlook* New Policies Scenario (its central scenario), around 1.7 billion people gain access to electricity from 2014 to 2030. An expanding centralized electricity grid provides around 60% of electricity generated for additional access in 2030, but decentralized solutions, particularly from renewables, are critical in providing access to remote rural areas in many countries. Despite this significant progress, around 780 million are projected to remain without electricity in 2030 in the central scenario and are increasingly concentrated in Africa (excluding North Africa)—around 80% of the global total at that time. Other scenarios, discussed in detail in chapter 6, also point to the need for additional policy action to achieve universal access to electricity by 2030.

Policy progress

Beyond electricity access, Sustainable Development Goal 7[3] directs the attention of policymakers to ensuring that energy access is affordable and reliable. Boxes 2.2 and 2.3 provide an illustrative overview of how affordability and reliability constrain access to electricity in the developing world.

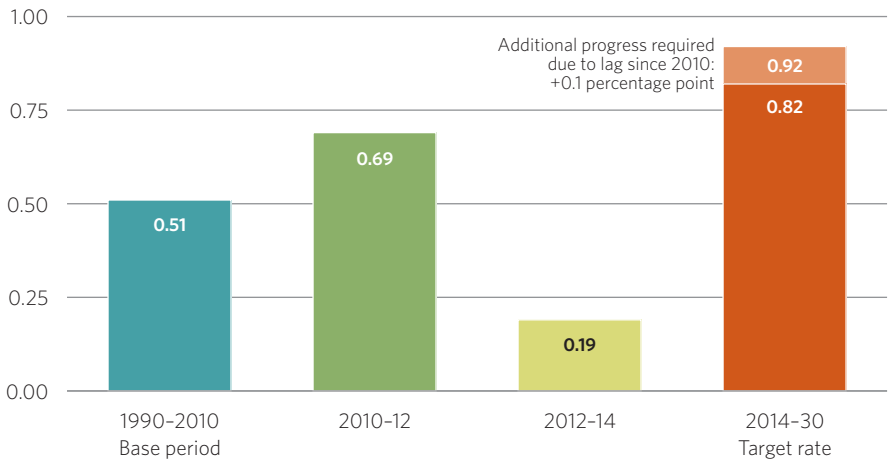
The Multi-Tier Framework developed under the SEforALL initiative provides an improved multidimensional framework for measuring energy access that encompasses capacity, duration (including daily supply and evening supply), reliability, quality, affordability, legality, and health and safety (box 2.4). Access to electricity is measured based on technology-neutral multitier standards where successive thresholds for supply attributes allow increased use of electricity appliances (tier 1 to tier 5). In this framework, affordability is defined as basic energy service costing less than 5% of household income, while reliability is measured as the number and duration of electricity outages.[4]

In a majority of least electrified countries, policy and regulatory progress to support electrification are uneven, but electricity is affordable, if often with high connection charges (box 2.2).[5] The real problem seems to be that tariffs are kept so low that they undermine the creditworthiness of the utility and choke off financing for further network expansion. Most countries perform well on designing and monitoring electrification plans, though these plans often miss important elements such as service level targets, geospatial mapping, off-grid solutions, and inclusion of community and productive uses.[6]

Where many countries appear to lag is on the regulatory framework to support off-grid access through solar home systems and other distributed resources. Regulations that clarify market entry and exit, define minimum quality standards, and target subsidies and duty exemptions should be considered for supporting off-grid solutions and enabling countries to benefit from the plummeting costs of decentralized solutions based on solar photovoltaics.

FIGURE 2.2 Access falls well short of the pace to meet the 2030 objective

Average annual increase in access rate to electricity



Source: GTF.

DRIVERS OF RESULTS AND TRENDS

Incremental access against population growth in 2012–14

Worldwide access to electricity is increasing only slightly faster than the total population in absolute terms—86.5 million in 2010–12 against 85.5 million a year in 2012–14—reducing the number of people without access marginally, from 1.063 billion in 2012 to 1.061 billion in 2014.

This global picture masks two very different trends in Africa and in Asia-Pacific, the world's two largest access-deficit regions with respectively 610 million and 420 million people without access in 2014. In Africa (excluding North Africa), access increased by 19 million a year in 2012–14, but the population grew by 25 million a year—different from 2010–12 when the absolute increases were much closer together. Examples of populous countries with this disparity are the Democratic Republic of Congo, Ethiopia, and the United Republic of Tanzania. Asia-Pacific, by contrast, saw access increase by some 47 million people a year in 2012–14, ahead of the 42 million annual population growth (figure 2.4). China and Pakistan were leading contributors to this outcome.

Urban–rural trends and structural influence

The electricity access rate moved up much faster globally in urban than rural areas in 2012–14: for 95.9% to 96.9% (an annual 0.16 percentage points) against 72.9% to 73.0% (0.05 percentage points). The vast majority of incremental access (92%) was achieved in urban areas, providing an additional 81 million people a year with access (figure 2.5). In contrast, only 6 million people in rural areas gained access annually, a number outpaced by population growth of 7 million.

Box 2.2

Measuring affordability: Some good news

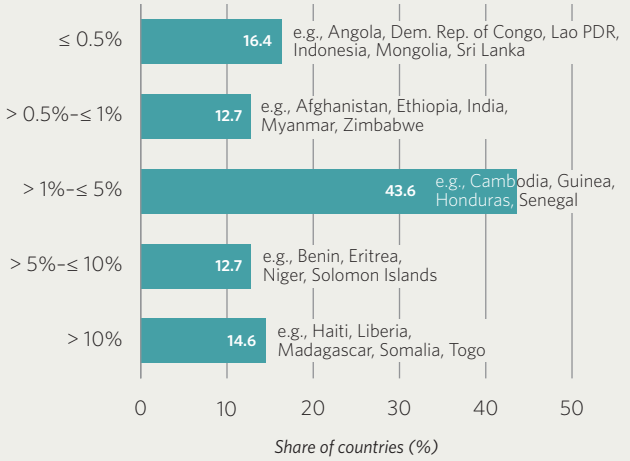
Regulatory Indicators for Sustainable Energy (*RISE*), a recent World Bank report, looked into the affordability of electricity in 55 countries with access deficit.[a] The price of electricity varies hugely from $1 per kilowatt-hour (kWh) in Somalia to $0.10 in Angola, reflecting differences in service costs and national policies.

In the RISE report, electricity is considered affordable if annual expenditure on a basic allowance of 30 kWh per month for residential users at the prevailing retail price is at most 5% of gross national income (GNI) per household in the bottom 20% of the population. Electricity is considered unaffordable if the costs surpass 10%. Despite widespread price concerns, the *RISE* indicator suggests that unaffordability may be less common than feared, with subsistence consumption costing less than 5% of GNI in 73% of surveyed countries in 2015 (box figure 1).

The minority of countries that face genuine affordability issues are typically small and landlocked, small islands, and conflict-affected states that face exceptionally high costs of generating power, and many of them are among the world's least electrified countries. For example, the basic electricity allowance would cost 17% of GNI in Central African Republic, 32% in Liberia, and 300% in Somalia. Similar results hold for small island nations such as Madagascar (16%) and the Solomon Islands (8%).

BOX FIGURE 1 Affordability of electricity is less of a concern than previously feared

Annual bill for 30 kWh a month as a share of GNI per household, in the bottom 20% of population



Source: RISE database, World Bank.

a. With an access rate below 90%, or more than 1 million people without access.

Box 2.3

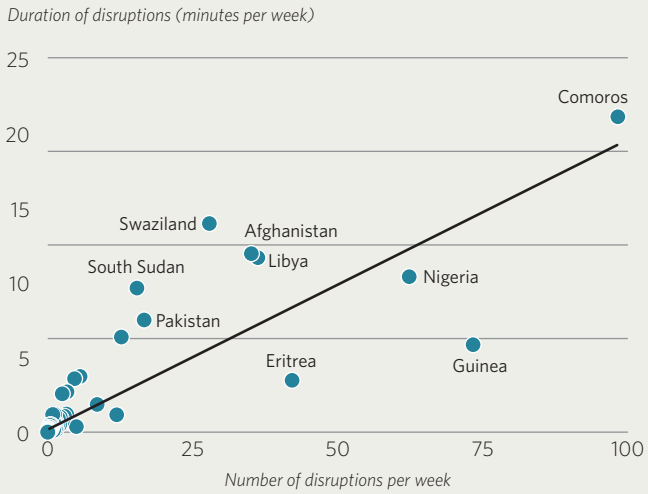
Measuring reliability of access

One way of evaluating the reliability of electricity services is to measure the frequency and length of unpredictable outages, which the World Bank's Doing Business surveys do for 146 countries.

The frequency and average duration of outages often go together. While most high-income countries are clustered at the origin with low frequency and short duration of outages, some developing countries stand out as having a high incidence of outages, notably Comoros, Guinea, and Nigeria, with more than 60 outages a week (box figure 1). In these countries, even households with grid connections cannot be considered as having reliable access.

BOX FIGURE 1 The frequency and duration of disruptions go hand in hand

Average number of disruptions and their duration in countries averaging more than 14 a week



Source: World Bank Doing Business surveys; GTF.

Box 2.4

Multi-Tier Framework results: Tracking more than connections

What is the Multi-Tier Framework for Measuring Energy Access?

The Multi-Tier Framework (MTF) redefines energy access to fill the gaps in the *GTF* binary access measurement. It acknowledges that access is a spectrum of service levels experienced by households. The framework was developed by the World Bank acting in the role of the SEforALL Knowledge Hub, with the support of the Energy Sector Management Assistance Program (ESMAP), in partnership and thorough consultations with multiple SEforALL stakeholders. The need for a multitier approach to improve on the binary measurement was first introduced in the SEforALL *GTF,* published by the World Bank and SEforALL in 2013. The MTF was published in 2015 as *Beyond Connections: Energy Access Redefined* (World Bank 2015).

How are the MTF data collected?

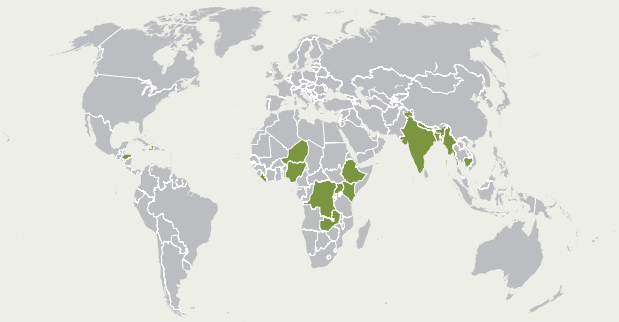
The World Bank/ESMAP is currently carrying out a global baseline survey to collect MTF data in 15 countries in partnership with the Scaling up Renewable Energy Program. The survey, covering household access to electricity and clean cooking, is carried out through a household questionnaire applied to a nationally representative sample of households. The survey is being implemented in 15 access-deficit countries: Bangladesh, Cambodia, Ethiopia, Haiti, Honduras, Kenya, Liberia, Myanmar, Nepal, Niger, Nigeria, Rwanda, Sao Tome and Principe, Uganda, and Zambia. The survey will be extended to cover another 10 to 15 countries in 2018–19.

What does MTF data provide?

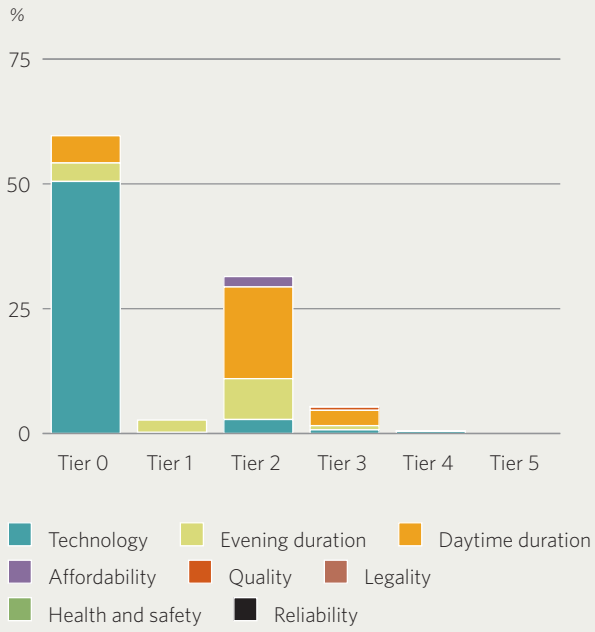
The MTF provides more accurate data on the actual services that households receive. It classifies energy services into tiers—starting from Tier 0 (no service) to Tier 5 (full service)—by capturing the granularity of energy access attributes such as capacity, duration of supply, reliability, quality, affordability, legality, and safety.

The gap analysis presented in box figure 2 can be a powerful tool for targeted policy and investment decisions. Figure 2 captures the energy situation at a disaggregated level and helps identify the key reasons that are holding the country back in terms of energy access tiers. For example, a large number of the households (50%) are held back in Tier 0 as they do not have access to any source of electricity. Duration of service (both daytime and evening) is also a constraint and is holding back households in lower tiers (9% are in Tier 0 because they have less than the minimum electricity duration threshold required, and 26% are in Tier 3 because they have an insufficient electricity duration). Energy access for these households can be increased by providing them with basic sources of energy or by improving service and increasing the number of hours that electricity is available. Hence, this type of information can help target specific energy sector interventions and lead to improved energy access.

BOX FIGURE 1 MTF surveyed countries



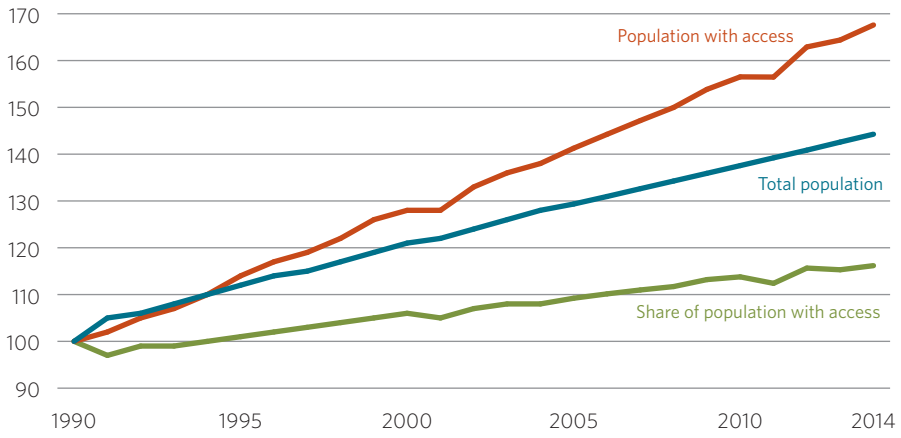
BOX FIGURE 2 Example of gap analysis using MTF survey data



Source: MTF Global Energy Access Survey.

FIGURE 2.3 The population with access to electricity is growing only slightly faster than the population as a whole

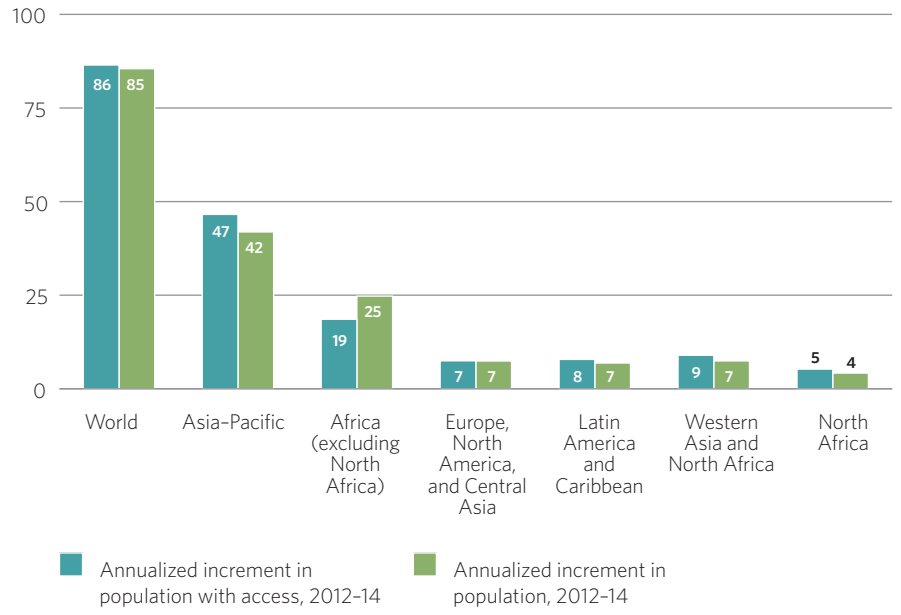
Electricity access and population growth indexed to 1990 level, 1990–2014



Source: GTF.

FIGURE 2.4 Growth in population with access is outpacing population growth everywhere but Africa (excluding North Africa)

Annual increase in total and electrified population, 2012–14



Source: GTF.

Regional urban–rural trends also diverge. New connections in urban areas typically stayed ahead of population growth, except for Africa (excluding North Africa) and Latin America and the Caribbean. Asia–Pacific accounted for more than 65% of the urban increase in access in 2012–14. The share of population in urban areas increased by 0.28 percentage points annually in 2012–14 in both Asia–Pacific and Africa (excluding North Africa). And while the Asia–Pacific rural population is declining slowly, the number of people without access to electricity is declining even faster. In rural areas, Africa (excluding North Africa) remains the only region where absolute population growth is outpacing access to electricity.

Afghanistan, China, and Pakistan all made good progress in electrifying rural areas, at around 2.5 million more people than the annual population increase, with decentralized solar PVs beginning to have an impact in difficult rural settings. To a lesser extent, Africa also has been taking advantage of similar renewable energy sources (box 2.5).

PERFORMANCE BY COUNTRY GROUPS

High-impact countries

The high-impact countries are the 20 countries with the largest absolute access deficit, whose performance on electrification will have a substantial impact on the world as a whole—notably India (figure 2.6, horizontal axis). The unserved population in these 20 countries was 846 million people in 2014, about 80% of the global access deficit. Low-income countries account for 50% of this deficit, and lower-middle-income countries 48%. Three-quarters of these countries are in Africa (excluding North Africa), including Angola, the only upper-middle-income country in this group.

Sixteen of these 20 countries made progress in 2012–14 (figure 2.7). Ten made strong progress (over 1 percentage point a year), and Kenya, Malawi, Sudan, and Uganda performed particularly well (over 2 percentage points a year). Only Angola and the Democratic Republic of Congo saw their access rates fall significantly, each by around 1 percentage point a year. Quite a few countries, including Bangladesh, Kenya, Myanmar, Nigeria, Sudan, and Uganda, electrified faster than their populations grew.

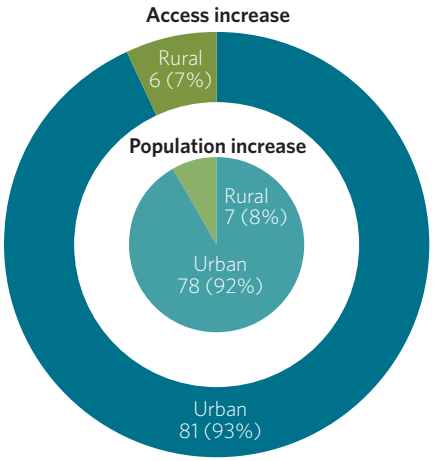
Of the world's least electrified countries—all in Africa (excluding North Africa) except Papua New Guinea—most are small, with access rates below 20% (figure 2.8). Some of course also overlap with the 20 high-impact countries. All (except the Democratic Republic of Congo and Sierra Leone) saw their access rates rise, a fifth of them by more than 2 percentage points a year in 2012–14 (Guinea-Bissau, Malawi, Rwanda, and Uganda).

Fast-moving countries

Another category of interest is the countries that have increased their access rate the fastest in 2012–14 (figure 2.9). Fourteen of these fast-moving countries are in Africa (excluding North Africa) and five are in Asia. Honduras is the only Latin American country in this group.

FIGURE 2.5 Urban areas are making progress in access to electricity while rural areas have population growth outpacing the growth in access

Annual increase in access and population, urban and rural, 2012–14 (million)



Source: GTF.

Box 2.5

The contribution of renewables to off-grid electricity access in Africa

Renewable energy is an attractive option for off-grid electricity supply as it does not require regular fuel deliveries and is cost-competitive with diesel generators. It can also provide electricity at different scales, from solar lights and small home solar systems to mini-grids powered by solar photovoltaics (PVs), wind turbines, biomass plants, or small hydropower plants.

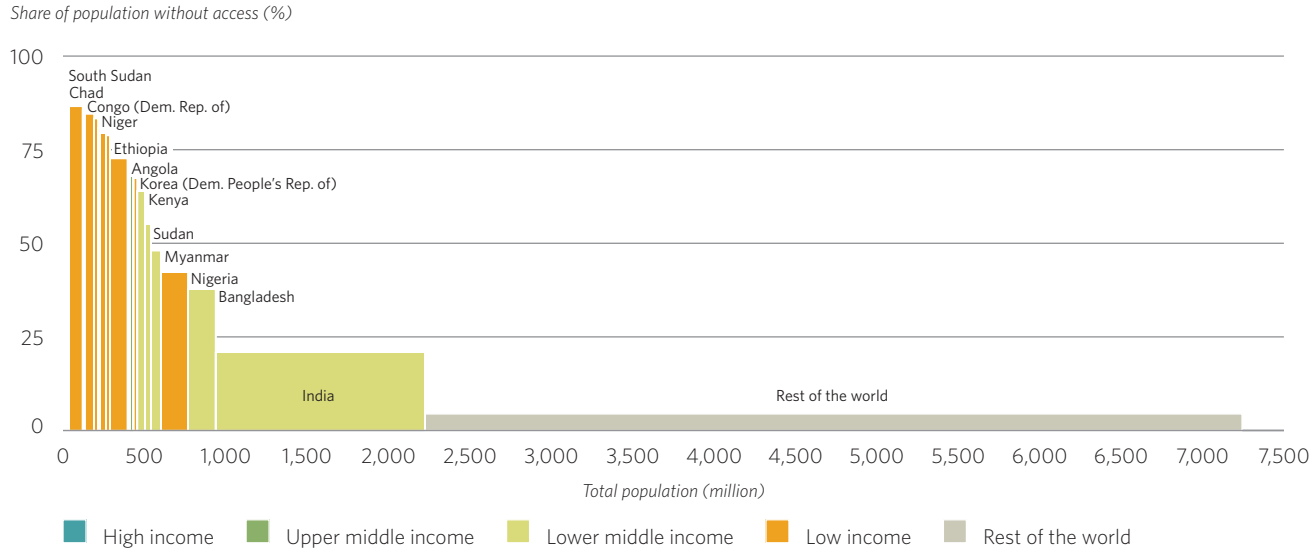
Statistics collected by the International Renewable Energy Agency (IRENA) show that off-grid renewable capacity in Africa reached 717 megawatts (MW) in 2015. Solar PVs accounted for most of this (630 MW), with another 67 MW of small hydropower and 21 MW of wind energy. The trend in capacity also showed strong growth, with a tenfold increase in off-grid renewable capacity since 2005 and a 65% increase in 2015 alone.

IRENA estimates the number of people supplied by off-grid renewables from the population of towns and villages connected to renewable-powered mini-grids and the number of solar devices (lamps, lighting kits, and home systems) sold in recent years. From these figures, it estimates that off-grid renewable energy provides electricity access to about 60 million people in Africa, or 10% of Africa's off-grid population, with 36.5 million using small solar lights, 13.5 million using lighting kits or solar home systems, and 10 million connected to mini-grids or standalone systems with a higher power rating.

Source: IRENA 2016.

FIGURE 2.6 The 20 high-impact countries account for 80% of the global access deficit

Share of population without access and total population, 2014



Source: GTF and WDI data.

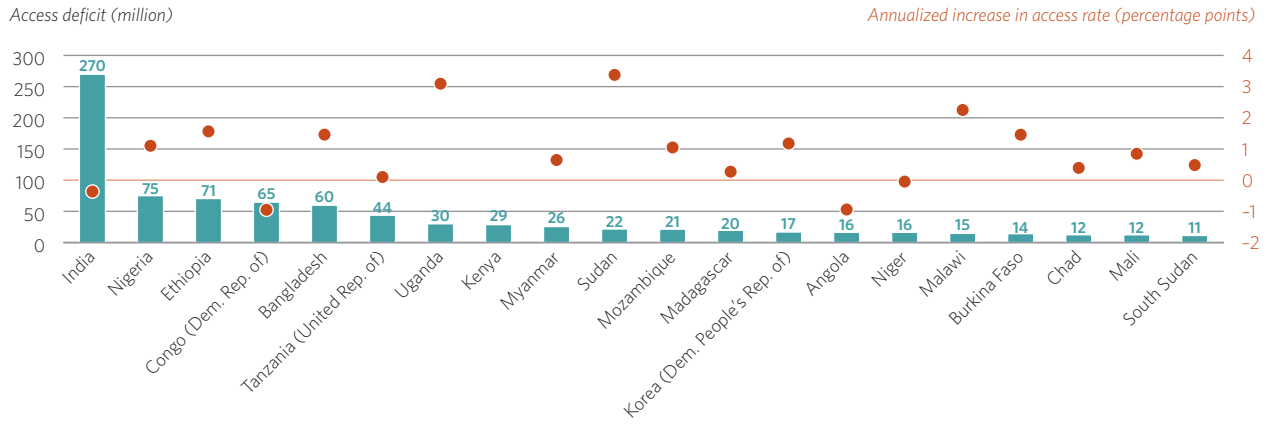
Note: Country income classification corresponds to that in effect in 2014.

Afghanistan stands out with an increase of 10.2 percentage points a year in 2012–14, followed by Cambodia (7.6 percentage points). Afghanistan's gains were driven largely by rural access, particularly off-grid solutions. In 2014, 11% of the rural population received electricity from the grid, but notably, 58% relied on solar through solar-home systems, which typically provide only enough power for one or two bulbs and perhaps a fan.

Country trajectories can be very different (box 2.6). And while electrification is typically analyzed at national level, the increasing number of displaced persons in 2012–14 shows how refugee camps are presenting access challenges in countries that otherwise have high access rates (box 2.7).

FIGURE 2.7 The vast majority of high-impact countries made progress in 2012–14

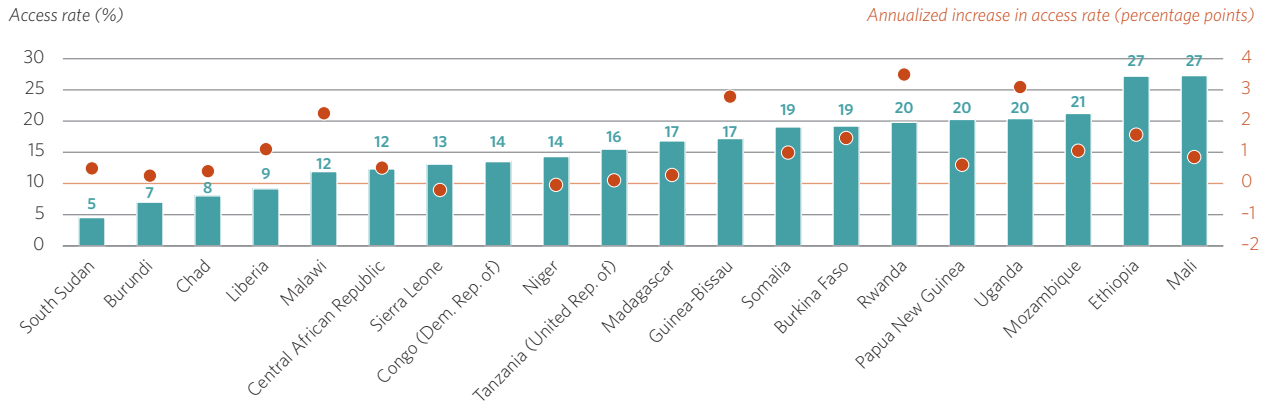
Access deficit in 2014 (million) and annualized increase in access rate in 2012–14 (percentage points)



Source: GTF.

FIGURE 2.8 Eighteen of the 20 least electrified countries boosted access rates in 2012–14

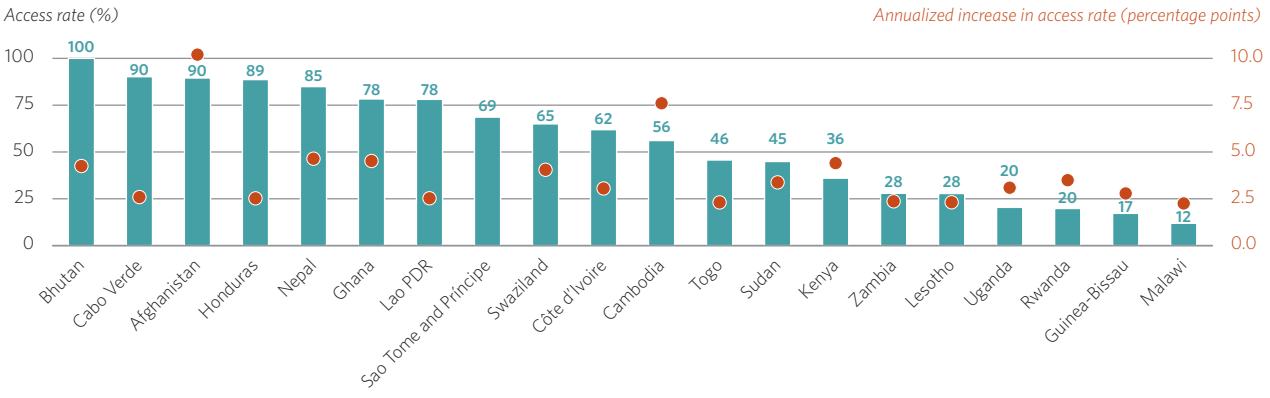
Access rate in 2014 (%) and annualized increase in access rate in 2012–14 (percentage points)



Source: GTF.

FIGURE 2.9 Among fast-moving countries, Afghanistan stands out

Access rate in 2014 (%) and annualized increase in electricity access in 2012–14 (percentage points)



Source: GTF.

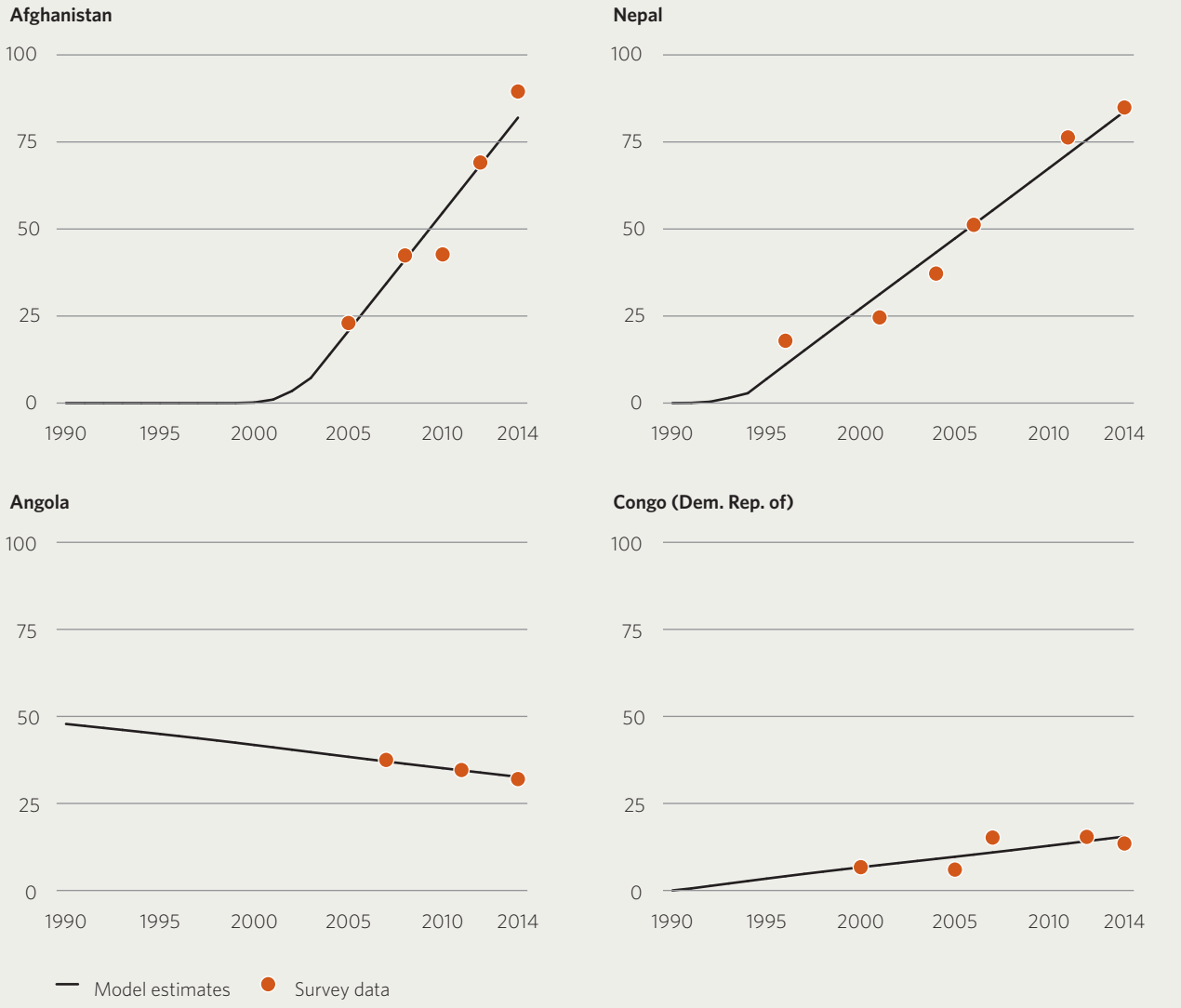
Box 2.6

Zooming in on individual country trajectories

The World Bank's Global Electrification Database reveals a variety of country trajectories and the progress in electrification that can be achieved over 10 or 20 years. Afghanistan and Nepal came from almost nowhere in 2000 to more than 80% in 2014. By contrast, Angola and the Democratic Republic of Congo barely increased their rates, or even saw access fall.

BOX FIGURE 1 Four contrasting country trajectories

Electricity access rate (%)



Source: GTF.

Box 2.7

Displaced people and energy

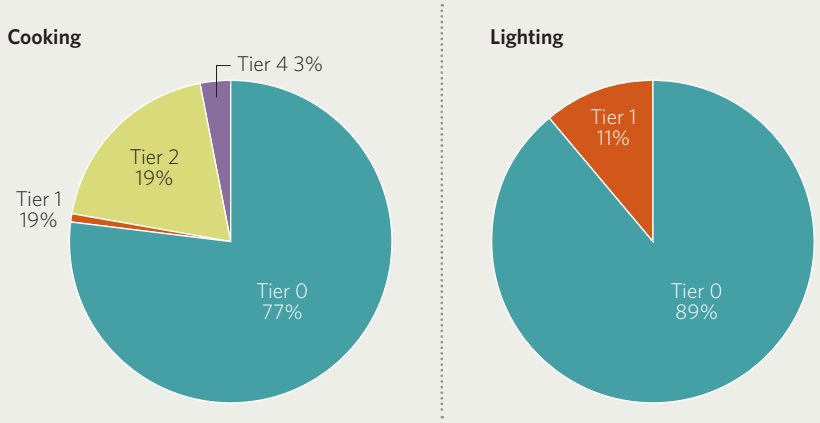
More than 65 million people were displaced from their homes by conflict in 2015. More than 80% of them took refuge in developing countries, facing poverty and energy insecurity. In several countries, displaced people make up a significant part of the population, and their energy access challenges are intertwined with those of the host country.

Data on energy use among displaced people in camps and host communities are scarce, but new research by the Moving Energy Initiative reveals some challenges.[a] Matters are particularly severe for the 8.7 million people in camps, where 80% have tier 0 access to cooking energy and electricity.[b] Although camps generally provide food, people usually have to find most of their own firewood and to cook on extremely inefficient stoves. Only 11% have any access to reliable lighting, with most living with only firelight at night. Women and children risk their safety visiting communal toilets in darkness.

New partnerships are emerging to link humanitarian, development, and private actors to achieve better access with safer, cleaner energy solutions such as the Moving Energy Initiative and the SAFE Humanitarian Working Group.[c] If governments and the international community are serious about "leaving no one behind," they need to do more to include the needs of displaced people in energy access debates.

See box 3.5 in chapter 3 for a discussion of the specific cooking fuel needs of displaced people.

BOX FIGURE 1 Tier energy access level for cooking and lightning (displaced population in camps)



Source: Practical Action; UNHCR 2016; Lahn and Grafham 2015; Vianello 2015.

a. The Moving Energy Initiative seeks to change the way energy is managed in the humanitarian sector and to improve the access, safety, and sustainability of energy services reaching displaced people. It began in 2015 as a partnership between Energy for Impact, Practical Action, Chatham House, the Department for International Development (UK), UNHCR, and the Norwegian Refugee Council.

b. For a detailed definition of tiers of access to cooking and electricity, see World Bank (2015).

c. The SAFE Humanitarian Working Group is a consortium of humanitarian agencies and nongovernmental organizations whose mission is to facilitate a more coordinated, predictable, timely, and effective response to the fuel and energy needs of crisis-affected populations.

ANNEX 2.1 METHODOLOGY FOR ACCESS TO ELECTRICITY

The methodology for tracking access to electricity has been updated in the *Global Tracking Framework 2017* (*GTF 2017*) to harmonize the estimation methodologies for clean fuels and technologies, and electricity. Key differences from past *GTF* editions include:

- Using of a new statistical model to estimate missing data.
- In-filling the data series from only four snapshots in time to the full 1990–2014 time series.
- Using a different method to calculate the annual access rate increase.

Data sources

Survey data from the World Bank's Global Electrification Database (GED) were used for electrification, which compiles some 500 nationally representative household survey data, and occasionally census data, from sources going back as far as 1990 (table A2.1). The database also incorporates data from the Socio-Economic Database for Latin America and the Caribbean (SEDLAC) and the Europe and Central Asia Poverty Database (ECAPOV), which are based on similar surveys: 28% (221 data points) of the GED, spanning 26 countries. At the time of analysis, the GED contained 767 surveys from 144 countries, excluding high-income countries classified as developed by the United Nations (UN), for 1990–2014 (table A2.1).

Despite being nationally representative, the survey estimates can differ based on their natural sampling error and their methodology. Some surveys measure whether a household has access to electricity for any purpose, while others ask whether electricity is the main source of lighting. The GED includes grid connections as well as off-grid sources such as generators and solar home systems, but sources of electricity are not always specified. So data may or may not include off-grid solutions, depending on the conventions in each country.

Population data from the World Bank's World Development Indicators (WDI) were used for all countries except the Cook Islands and Anguilla (not in that database), so UN Population Division data were used. WDI does not include 2013–14 data for Eritrea, 1992–94 data for Kuwait, or 1990–97 data for Sint Maarten, so the 2011, 1991, and 1998 populations were used as proxies.

The International Energy Agency (IEA) has maintained a database on household

TABLE A2.1 Overview of data sources for electricity

		Electricity		
Name	Entity	Number of countries	Number of surveys	Question
Census	National statistical agencies	62	100 (13%)	Is the household connected to an electricity supply? Or does the household have electricity?
Demographic and Health Survey	USAID funded, ICF International implemented	82	221 (29%)	Does your household have electricity?
Living Standards Measurement Survey, income expenditure survey, or other national surveys	National statistical agencies, supported by the World Bank	77	177 (23%)	Is the house connected to an electricity supply? Or what is your primary source of lighting?
Multi-indicator cluster survey	UNICEF	23	27 (4%)	Does your household have electricity?
World Health Survey	World Health Organization	8	8 (1%)	
Other		13	13 (2%)	

electrification since 2000 based largely on utility connection data.[7] For the majority of countries access rates are similar, but not in large countries including Indonesia, Nigeria, and Pakistan. The IEA's methodology offers a supply-side perspective on electrification.

There are pros and cons of relying on official estimates that draw on utility connections (IEA) or on household surveys (World Bank). Utility data focus on what is happening in utility service areas that are often smaller than the national territory and fail to capture decentralized forms of electrification in rural areas and illegal access to electricity in urban areas. By contrast, surveys allow households to report directly—based on their experience—whether they have access to electricity. But the data are affected by sampling errors and the potential unreliability of responses. Both types of data offer valid and complementary perspectives, but they should not be mixed, because they are based on different methodologies.

Estimating missing values

Relatively few countries conduct surveys annually. A more typical frequency is every three years, though for some countries and regions surveys can be irregular in timing and much less frequent. This irregularity results in a significant number of data gaps for a significant share of countries in any particular year. A multilevel nonparametric modeling approach, which was developed by the World Health Organization for estimating clean fuel use[8] and has already been widely used to evaluate access to cooking, was adapted to electricity access and used to fill in the missing data points for 1990–2014. Similar approaches are already in widespread use, such as that by the Joint Monitoring Program for water and sanitation and those to estimate poverty rates and other human development outcomes.

In this approach, time series comprise survey data and estimates. Bangladesh, for example, had 10 surveys in 1994–2014 comprising Demographic and Health Surveys, multi-indicator cluster surveys, and other national surveys; the remaining 15 years are filled in with estimates (figure A2.1).

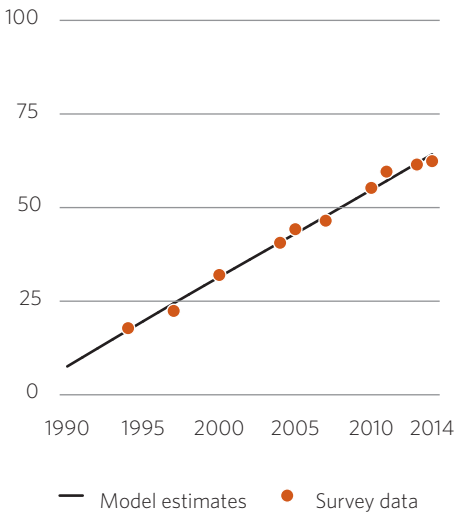
Multilevel nonparametric modeling takes into account the hierarchical structure of the data: survey points are correlated within countries, which are then clustered within regions. Time is the only explanatory variable; no covariates are used. Regional groupings are based on UN regions, with Africa (excluding North Africa) further divided into Eastern Africa, Central Africa, Southern Africa, and Western Africa.

The model is applied for all countries with at least one data point. But to use as much real data as possible, results based on real survey data are reported in their original form for all years available. The statistical model is used only to fill in data for years where they are missing. The difference between real data points and estimated values is clearly identified in the database.

Countries considered "developed" by the UN are assumed to have an electrification rate of 100%, since such data are not typically collected or reported for these countries. These include countries in northern America and Europe, Japan in Asia, and Australia and New Zealand in Oceania. Countries classified as high income (HICs) are also assumed to have an electrification rate of 100% from the time the country first became a HIC, unless survey data were collected. For the years before a country became a HIC and for non-HICs without data, no data are approximated. Countries are population-weighted to obtain regional aggregates. Countries with no data are excluded from this aggregation; no regional averages are used.

FIGURE A2.1 Survey data and model estimates for Bangladesh

Electricity access rate (%)



Source: GTF.

This methodology differs from the approach applied in *GTF 2015*, when survey data ranging around the reference years 1990, 2000, 2010, and 2012 were used to establish a simple time series with four data points, so a survey for a given reference year was not necessarily taken in that year. Further, missing data in this earlier series were estimated using a simpler linear model. The new approach was chosen to improve precision and allow for more comprehensive annual tracking. However, the values reported in *GTF 2015* and the estimation using the new model yield similar results (table A2.2).

TABLE A2.2 Comparison of *GTF 2015* and *GTF 2017* results

Access rates (%)		1990	2000	2010	2012	2014
Total	*GTF 2015*	75.6	79.3	83.2	84.7	
	GTF 2017	73.5	77.6	83.6	85.0	85.3
Urban	*GTF 2015*	94.2	95.2	94.9	96.1	
	GTF 2017	94.4	94.7	96.2	95.9	96.3
Rural	*GTF 2015*	60.8	64.2	70.3	71.8	
	GTF 2017	61.6	63.1	70.2	72.9	73.0

An important implication of the new approach is that all estimated values will change slightly when the model is re-run each year with the new data points released for that year. The reason is that the new data points affect the overall trend line.

Calculating the annual change in access rate

In *GTF 2015*, a normalized annual growth rate was calculated by using the absolute net increase of population with access as a numerator, with the population at the end of the period as the denominator. The total was divided by the total years in the period to annualize the growth. *GTF 2017* uses a simpler, more intuitive indicator for the change in access: The annual change in access rate is calculated as the difference between the access rate in year 2 and the rate in year 1, divided by the number of years in order to annualize the value:

(Access Rate Year 2 – Access Rate Year 1) / (Year 2 – Year 1)

This approach takes population growth into account by working with the final national access rates.

NOTES

1. See chapter 8 for a list of countries for the Africa Region.
2. All the analysis in this chapter uses the new data produced by this methodology.
3. Sustainable Development Goal 7: Ensure access to affordable, reliable, sustainable, and modern energy for all.
4. The income threshold is a standard consumption package of 365 kWh a year at the current country tariff.
5. See the World Bank's RISE database (2017).
6. The term "off grid" is broad and refers to not using or depending on electricity provided through main grids and generated by main power infrastructure. "Off-grid systems" cover both mini-grids and standalone systems for individual appliances and/or users, and they can be used for residential or commercial purposes (IRENA 2015).
7. See the IEA *World Energy Outlook 2016*.
8. The model is described in depth in Bonjour et al. (2013).

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3

ACCESS TO CLEAN COOKING

HIGHLIGHTS

- The indicator for tracking use of clean cooking fuels and technologies has been redefined by the World Health Organization (WHO) to measure "the proportion of population primarily using clean cooking fuels and technologies for cooking" —shortened here to "access to clean cooking." Ensuring that cooking with harmful kerosene is not counted as clean energy access sharply raises the size of the absolute global access deficit from earlier figures.
- Based on this new definition, the share of global population with access to clean cooking edged up from 56.5% in 2012 to 57.4% in 2014.
- Some 80 million people annually gained access to clean cooking in 2012–14. But this was less than the population increase, and 3.04 billion people in the world still did not have access to clean cooking in 2014—a marginal increase in the absolute access deficit after 2012.
- Access to clean cooking increased by 0.46 percentage points of the population each year in 2012–14, far slower than the annual 2.66 percentage point increase required to reach universal access by 2030.
- Improving the enabling environment, increasing demand, and strengthening supply of clean cooking all require greater investment and a sharper policy focus, including attention to less-considered population groups, such as women, displaced people, and those living in slums.

GLOBAL TRENDS

Progress in access to clean cooking, 2012–14

The share of the global population with access to clean cooking, based on WHO's new definition (box 3.1), increased from 56.5% in 2012 to 57.4% in 2014 (figure 3.1). But due to population growth, the absolute population lacking such access continued to grow very slightly, from 3.03 billion in 2012 to 3.04 billion in 2014.

Likely future trends against objectives

In 2013 and 2014, access to clean cooking increased by 0.46 percentage points a year, or no faster than progress in the historical reference period of 2000–10. When the 2030 Sustainable Energy for All (SEforALL) objective of universal access was announced in 2012, it was estimated that the global rate of access to clean cooking would need to increase by 2.22 percentage points each year throughout 2011–30. But because progress has fallen consistently short of this rate since 2010, efforts in the remaining years need to be stepped up to 2.66 percentage points of the population each year—about five times faster than in 2012–14 (figure 3.2).

The outlook for clean cooking shows that the world is far from being on track to meeting the SEforALL goal of achieving universal access to modern energy by 2030. Under the International Energy Agency's (IEA) 2016 *World Energy Outlook* New Policies Scenario (its central scenario), around 1.6 billion people gain access to modern cooking facilities. The projection for access shows less progress than that for electrification. The majority who gain access do so through liquefied petroleum gas (LPG) cookstoves, mainly in urban areas because of supply networks. In rural areas, the most common route to access is through improved biomass cookstoves.

Despite this progress, around 2.3 billion people will continue to rely on the traditional use of biomass for cooking in 2030. Countries in Asia are projected to still have nearly 1.5 billion people without clean cooking access in 2030, and the rest of the deficits concentrated in Africa. Other scenarios, discussed in detail in chapter 6, also point to the need for additional policy action to achieve universal access to clean cooking by 2030.

Due to different structural energy needs and available energy supplies, the use of polluting fuels remains primarily a rural issue. In low- and middle-income countries, 78% of the rural population relied primarily on polluting fuels in rural areas in 2014, against 22% in urban areas (figure 3.3). This pattern is evident in every global region, with particularly high disparities in the Western Pacific. In Africa (excluding North Africa) and Southeast Asia, the use of traditional biomass remains widespread among urban households (box 3.2).

Bolstering policy progress

The modest progress on clean cooking since 2000 indicates that major new interventions are needed to boost current market dynamics and to unlock development. Though widely overlooked by energy access policies that often prefer to concentrate on electricity provision, access to clean cooking is important to modernize the forms of energy for the poorest segments of the population, to improve public health, to promote gender equality, and to fight environmental degradation and climate change. With the spread of more cost-effective clean cooking technologies, the scope for accelerating the uptake of clean cooking is greater than ever before (box 3.3).

Box 3.1

A major redefinition from WHO used in this *Global Tracking Framework*

Up to the last *Global Tracking Framework* (*GTF*) report in 2015, the indicator for cooking looked only at the primary fuel used, and responses were classified simply as solid or nonsolid fuels.[a] Households cooking with kerosene —also known as paraffin—were included as having access to clean cooking because kerosene is a liquid (nonsolid) fuel. But kerosene is a major source of air pollution, with formaldehyde, polyaromatic hydrocarbons, and particulate matter, including black carbon (a major contributor to near-term climate warming). Given the substantial evidence on the health and safety risks of kerosene, WHO guidelines for indoor air quality and household fuel combustion recommend discouraging its use in the home.[b]

These guidelines also strongly recommend that all major household energy end uses (such as cooking, space heating, and lighting) use efficient fuel and technology combinations to ensure health and environmental benefits. Focusing only on fuel limits the usefulness of this indicator for monitoring the impacts of sustainable development, since the emissions are directly correlated with how well the technology or device (cookstoves, lamps, and so on) burns the fuel.

Understanding the type of technology can inform global tracking for energy efficiency and climate impacts. Biomass stoves that burn efficiently enough to be considered "clean" are not yet widely available in low- and middle-income countries. But reformulating this indicator to account for the fuel in combination with technology allows future innovations in biomass stove technologies to be counted toward the Sustainable Development Goals (SDGs) on energy efficiency, renewable energy, and other goals related to sustainability:

- SDG 3: Good Health and Well-Being—"Reducing smoke emissions from cooking decreases the burden of disease associated with household air pollution and improves well-being, especially for women and children."
- SDG 5: Gender Equality—"Unpaid work, including collecting fuel and cooking, remain a major cause of gender inequality."
- SDG 12: Responsible Consumption and Production—"Ensure sustainable consumption and production patterns."
- SDG 15: Life on Land—"Protect, restore, and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss."

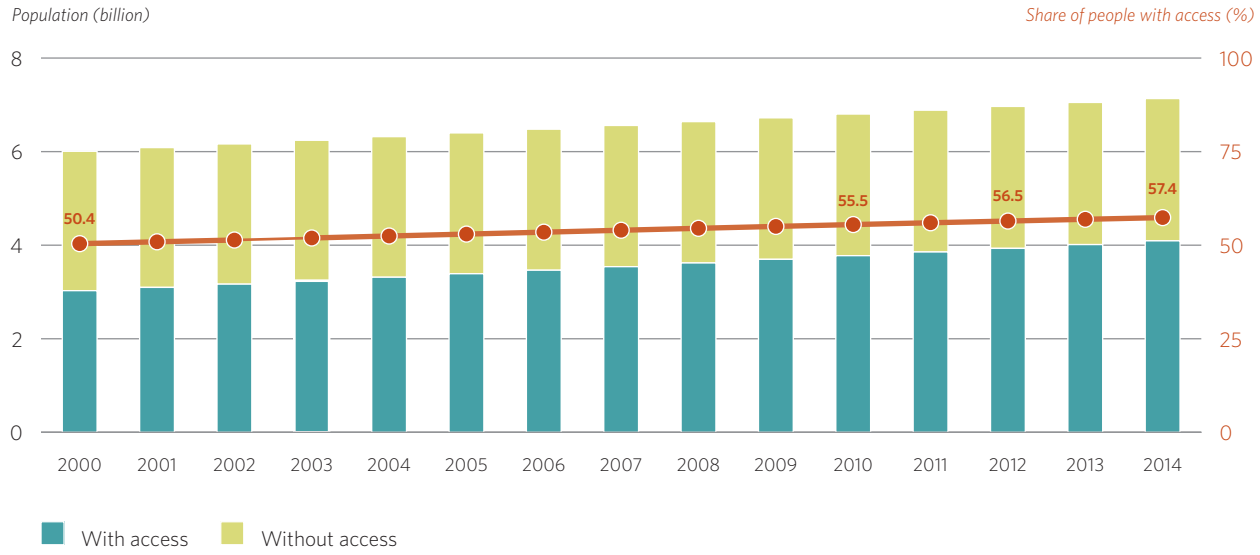
For all these reasons, WHO has reformulated the access to clean cooking indicator to measure the "proportion of population primarily using clean fuels and technologies for cooking," and this has been adopted as part of SDG 7 ("Ensure access to affordable, reliable, sustainable, and modern energy for all").

This reformation automatically increases the cooking access relative to what was reported in previous *GTF*s. For example, in 2012 the 134 million households estimated as using kerosene were not counted as part of the cooking access deficit, but they would be now. This report recalculates the historical series using the new definition back to 2000, and all results are reported in these terms.

a. WHO updated its estimates with the new indicator for 191 countries using a nonparametric statistical model based on 709 usable data points extracted from over 750 household surveys (Bonjour et al. 2013). It updated the model estimates in 2016, and because of the new tracking definition, the starting point estimates reported in *GTF 2015* are different from those here.
b. WHO 2014.

FIGURE 3.1 The access rate to clean cooking rose only very gradually in 2000–14

Global use of clean fuels and technologies for cooking, 2000–14

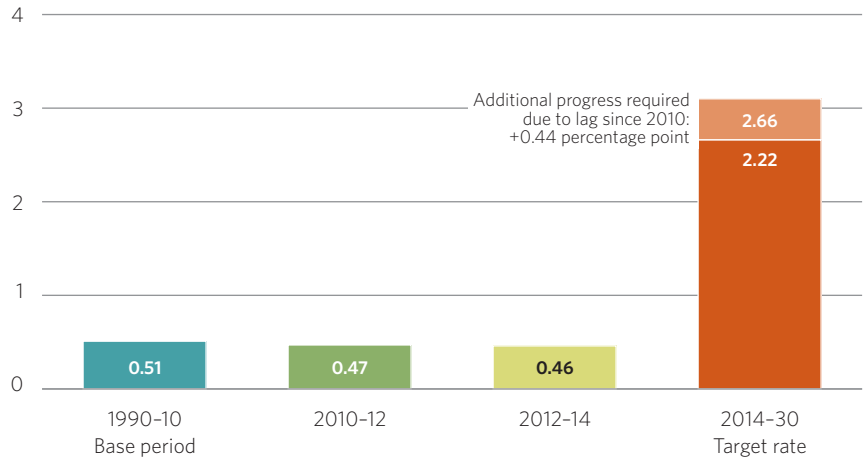


Source: WHO Global Health Observatory; GTF and World Bank World Development Indicators (WDI) data.

Note: Data are recalculated to follow the new WHO definition for the whole period.

FIGURE 3.2 Recent progress needs to increase fivefold if the 2030 universal access objective is to be met

Annual increase in access rate in the historical reference and two tracking periods, and future increase required

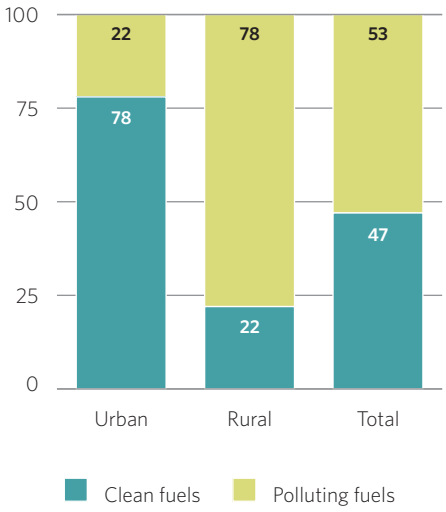


Source: GTF.

Note: The 2030 target rate is broken down into the increase required for 2010–30 and the additional progress required for 2015–30.

FIGURE 3.3 Access to clean cooking is almost four times higher in urban than rural areas

Share of population in low- and middle-income countries with primary reliance on polluting or clean cooking fuels, 2014 (%)



Source: WHO 2017.

With economic development and income growth inadequate to scale up clean cooking facilities, targeted and comprehensive national and multinational policies will be important in making clean cooking accessible and affordable. Some of the more effective policies to support technologies allow for clean combustion of biomass while promoting the switch from biomass to modern fuel use, such as LPG. Simultaneously, policies can see to it that all fuel and technology categories keep becoming cleaner and more efficient.

Clean cooking, already covered by the SDGs and helping to deliver on the Paris Agreement, can continue to be incorporated in national health, energy, environmental, women's empowerment, economic, and regulatory efforts. More specifically, beyond designing targeted subsidies for clean fuels, especially for LPG (which have delivered mixed results), policymakers can remove subsidies for

Box 3.2

Household air pollution in urban areas and slums

Urbanization is increasing, and by 2030 almost 60% of the world's people will live in urban areas (United Nations 2016). Thus, the health risks posed by polluting and unsafe energy use in urban areas and slums may increase unless attention is paid to providing clean energy solutions.

Families in urban areas, particularly slums, and people living in densely populated settings like humanitarian camps often rely on polluting fuels to meet their daily energy needs. Poor urban households lacking a stable electricity supply or affordable gas may turn to kerosene, charcoal, coal, or wood. Inadequate building conditions, along with unsafe and polluting fuels, can lead to hazardous conditions in the home, particularly in slums (Wong et al. 2014).

Access to clean household energy, while more readily available in urban areas, is still a hurdle for poorer neighborhoods and slums. In Accra, Ghana, households in slums suffered from the highest air pollution, often due to inefficient biomass cookstoves (Zhou et al. 2011). And the 22% of urban households primarily relying on polluting fuels for cooking (figure 3.3) fail to account for the substantial "stacking" (parallel use of multiple fuels and technologies) for cooking, which is expected to be higher in slum areas.

Source: WHO 2016.

Box 3.3

Technological advances in stove and fuel systems

A key factor limiting the mass adoption of cleaner and more efficient stoves has been the lack of affordable, user-centered options for households. However, rapid improvements in business models, consumer financing options, stove designs, and fuel systems place the sector on the cusp of a major global effort to scale up access.

Technological improvements range from high-performing forced-draft gasifiers (with internal fans to improve combustion of biomass fuels), to processed biomass fuels (pellets) that burn more efficiently and completely than wood, to gas stoves that produce negligible particulate emissions. Some of these stove models can be charged off-grid using solar or other energy sources, further increasing the chances of adoption.

Technologies that can be used without regular access to electricity are ideal, given the low electrification rates in many low- and lower-middle-income countries. In recent years, the sector has shifted toward higher market shares of cleaner and more efficient fuels and technologies, suggesting that consumers are progressively more interested in adopting the cooking systems with highest potential impacts.

Source: Global Alliance for Clean Cookstoves 2016; GTF.

Box 3.4

Beyond cooking, space heating is a major source of concern for indoor air pollution

Fuels and devices for household space heating can reduce air pollution in and around the home and its health and environmental impacts. Although most attention has focused on the stoves and fuels that households use for cooking, other household energy uses, such as heating and lighting, deserve consideration. These additional uses are notably major concerns in Eastern Europe, Mongolia, and China—the last of which has one of the world's biggest cooking energy deficits.

Some traditional cookstoves are also used to heat the home, and the total time that the device is used is much greater than the time for cooking. To understand household energy use and its impacts, it is not enough to consider only cooking. Even after some households switch to clean cooking fuels such as LPG, they may continue to use an inefficient stove, such as an open fire, for space heating, and in doing so may entirely remove the benefits of clean cooking.

The historical focus on cooking means that national data on fuels and technologies for space heating and for lighting are patchy. Few national surveys collect such data. But a recent analysis found a slow but steady decrease in the use of polluting space-heating fuels in the six countries where time series data were available (WHO 2016). For example, in Armenia, clean fuel use for space heating rose from 40% in 2001 to 61% in 2011.

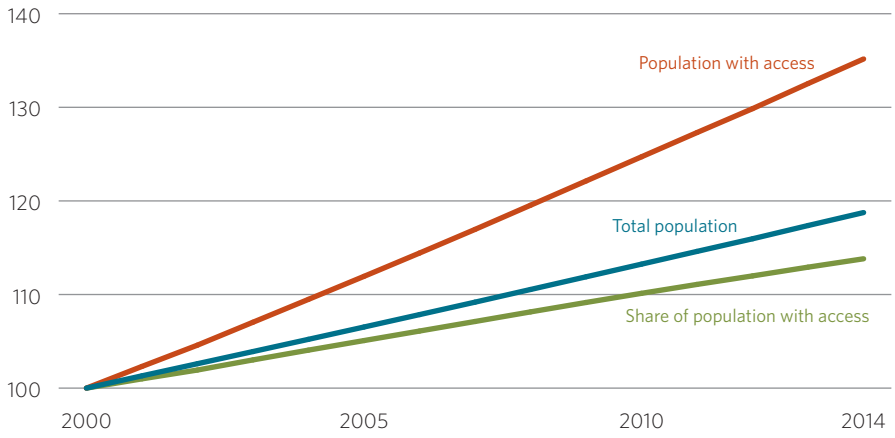
Source: WHO 2016.

polluting fuels like kerosene; establish beneficial taxes, tariffs, and standards that can support the scale-up and affordability of clean and efficient cookstoves and fuels; support consumer education and behavior change communication; and help expand and improve clean fuel infrastructure to low-income and remote customers.[1] The inclusion of gender-sensitive measures is a cross-cutting success factor.

While the discussion and indicators presented here relate to cooking, in temperate zones the choice of fuels for heating is at least as important for household air quality, because heaters typically run for more hours a day (box 3.4).

FIGURE 3.4 The difference in growth rates between the population using clean cooking and the total population is not large enough to reduce the absolute access deficit

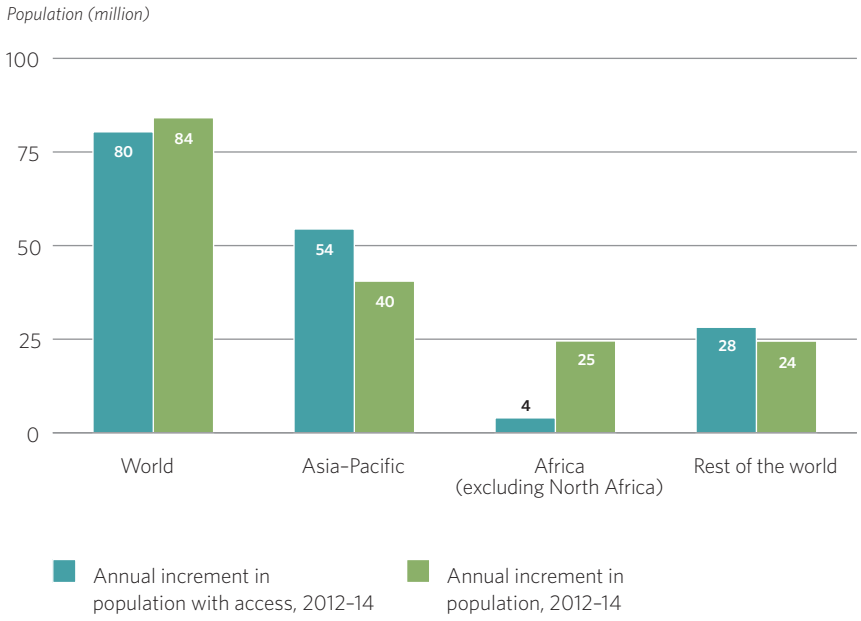
Access to clean cooking and population growth indexed to 2000



Source: WHO Global Health Observatory; GTF.

FIGURE 3.5 The Asia–Pacific region faced the largest access deficit, yet made the most progress

Annual change in clean cooking and population growth, by region, 2012–14



Source: GTF.

DRIVERS OF RESULTS AND TRENDS

Incremental clean cooking access vs. population growth in 2012–14

The speed of increasing the access rate to clean cooking is the outcome of a race between the growth in the population using clean cooking and the growth in the population overall. While the population with access has long been growing faster than the population as a whole (figure 3.4), the difference in growth rates is not large enough for the absolute number of people gaining access each year to exceed the absolute population increase—in contrast to the electricity sector, where the divergence in growth is somewhat wider. Although globally 80.5 million people a year gained access to clean cooking in 2012–14, the total population increased faster—by 84 million a year.

Of the 3.04 billion people globally living without access to clean cooking, the majority live in Asia–Pacific (2.04 billion) and Africa (excluding North Africa) (0.85 billion). Asia–Pacific is expanding access faster than the population, and the reverse is true in Africa (excluding North Africa). Neither region is progressing anywhere near fast enough to meet the 2030 objective.

The Asia–Pacific region's progress in 2012–14 was driven by a mix of strong policy support, economic growth, technological innovation, and greater production and distribution of products and fuels. The region expanded access to clean cooking to 54 million people each year, well ahead of population growth of 40 million a year. Still, the access rate increased annually only by 0.81 percentage points in 2012–14—far below the required increase (to reach the objective) of 3.06 percentage points a year.

Africa (excluding North Africa) is worrying: its total population increased five times more than its population with access to clean cooking in 2012–14 (figure 3.5), such that in 2014 the region accounted for 27% of the global population without access and only 5% of the incremental clean-cooking access in 2012–14 (figure 3.6). The use rate of clean cooking grew by a mere 0.07 percentage points each year in 2012–14—a huge shortfall against the annual 4.6 percentage points to reach universal access by 2030.

Though inadequately captured in the global statistics, the plight of displaced persons is an increasingly pressing social issue and poses its own challenges for providing access to clean cooking (box 3.5).

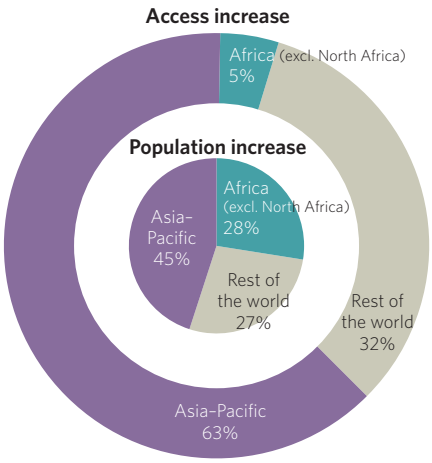
PERFORMANCE BY COUNTRY GROUPS

High-impact countries

The 20 countries with the highest absolute access deficit account for 84% of the global deficit in 2014, home to 2.6 billion people without access to clean cooking.[2] Although the population share without access is highest in Africa (excluding North Africa) (vertical axis, figure 3.7), the highest absolute access deficit is in Asia–Pacific. The deficit is mainly in middle-income Asian countries (horizontal axis, figure 3.7).[3]

FIGURE 3.6 Africa (excluding North Africa) showed the lowest increase in access in 2012–14

Increase in access to clean cooking, and population growth, by region, 2012–14



Source: GTF.

Box 3.5

Cooking for displaced people

Cooking is central to human survival and family well-being, and is an integral element in dealing with any mass displacement of people. However, displaced people are generally left to source their own fuels and the means to prepare their food, and usually resort to solid fuels and three-stone fires or inefficient, polluting cookstoves. UNHCR estimated that 65.3 million people were forcibly displaced worldwide as a result of persecution, conflict, generalized violence, or human rights violations in 2015. To this figure, 97 million people displaced by natural disasters should be added (OCHA 2014). Among displaced people, of the 8.7 million people living in refugee camps, only 3% have access to clean cooking solutions. The Moving Energy Initiative estimates these cooking practices lead to the premature deaths of some 20,000 refugees every year.

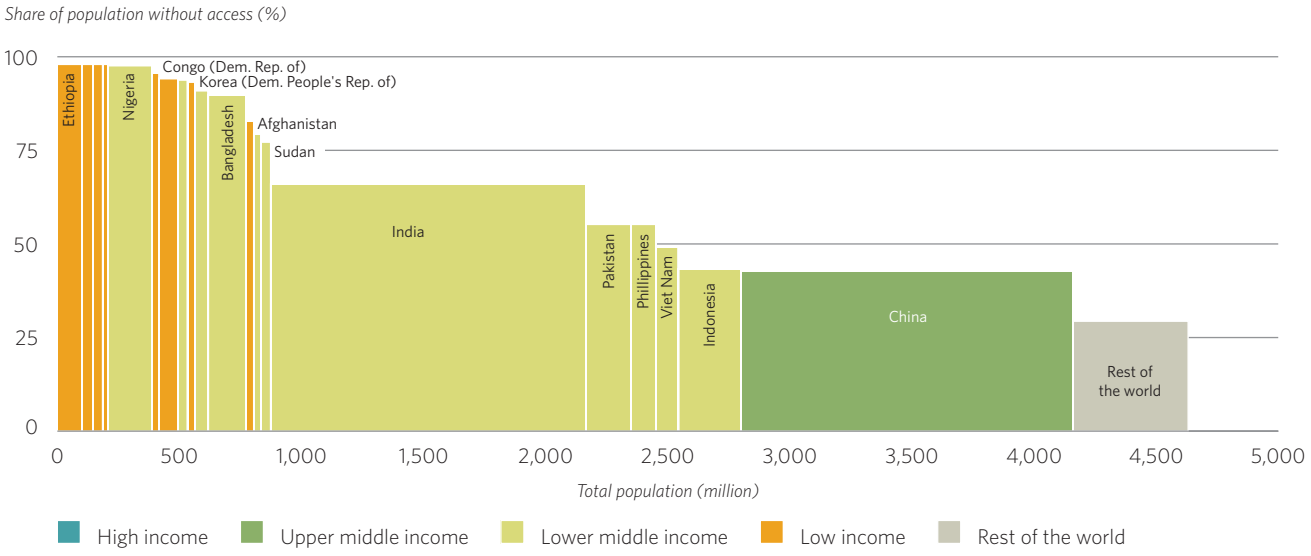
Dependence on polluting fuel has wider social and environmental impacts for displaced people. Women and girls often collect fuel from outside the camp and are thus vulnerable to attacks; fuel collection takes away time for education, parental care, livelihoods, and social activities; where people cannot afford to buy fuel, missing meals and selling food rations is common; and the arrival of displaced people may lead to the clearing of trees for fuel and shelter. As most countries hosting large refugee populations are also suffering from deforestation, this can exacerbate tensions with host communities and governments, and place vulnerable groups at greater risk.

See box 2.7 in chapter 2 for a discussion of the energy needs and use data for displaced people.

Source: Practical Action: Part of the Moving Energy Initiative; UNHCR 2016; OCHA 2014.

FIGURE 3.7 More than two-thirds of people without access to clean cooking live in Asia–Pacific

20 high-impact countries: Share of population without access to clean cooking, and total population in 2014



Source: WHO Global Health Observatory; GTF; WDI.

Note: Country income classification corresponds to that in effect in 2014.

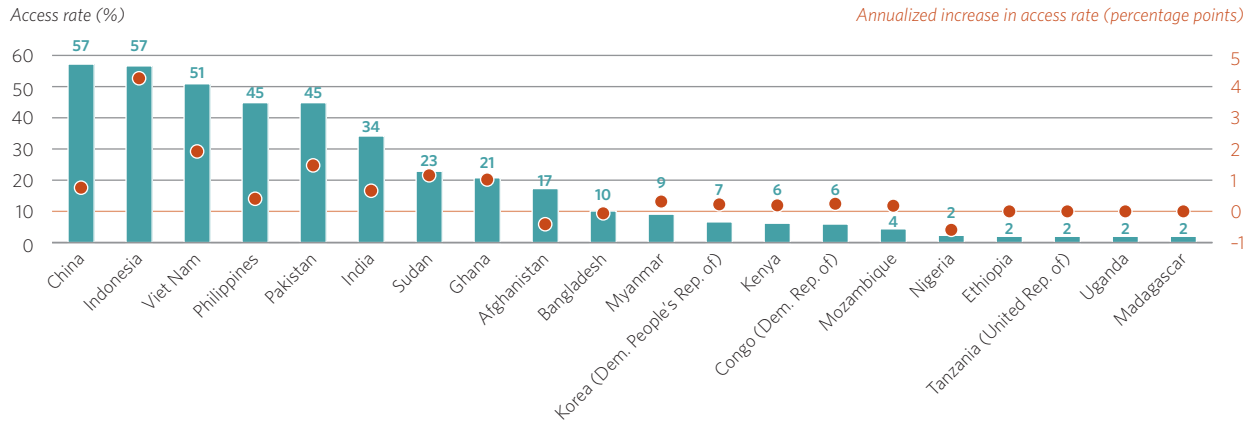
Among the 20 high-impact countries, only four—China, Indonesia, Viet Nam, and Pakistan (in decreasing order)—increased access to clean cooking faster than their populations grew (figure 3.8). For the other 16, the progress made was not enough to catch up with demographic growth in 2012–14. Of concern are Afghanistan, Bangladesh, and Nigeria, all of which saw their access rates fall in 2012–14.

Countries with the lowest clean fuel access rate

Among countries with the lowest clean fuel access rate in 2014, all but Kiribati and Timor-Leste are in Africa (excluding North Africa). Half have a reliance rate on clean cooking of around 2% (figure 3.9). Most countries showed no increase in the usage rate in 2012–14. Guinea-Bissau, Niger, and South Sudan had an annual increase in that rate of only 0.2 percentage points, but Kiribati, Nigeria, and Timor-Leste saw decreases. It would seem that

FIGURE 3.8 Only four high-impact countries expanded access to clean cooking faster than their population growth in 2012–14

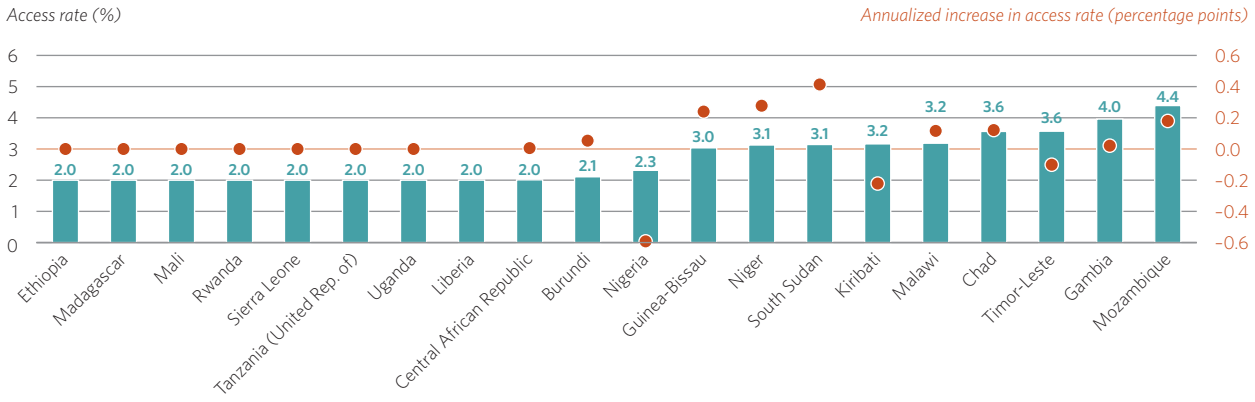
20 high-impact countries: Access rate in 2014 and annualized increase in access rate in 2012–14



Source: GTF.

FIGURE 3.9 Most of the lowest access rate countries showed no progress in 2012–14

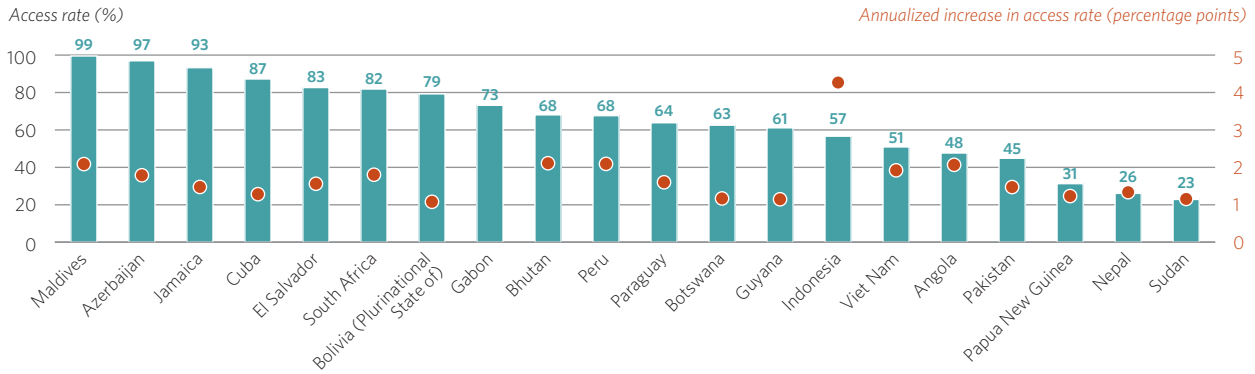
20 countries with lowest clean fuel access rate: Access rate in 2014 and annualized increase in access rate in 2012–14



Source: GTF.

FIGURE 3.10 Among the 20 fastest-moving countries, Indonesia performs exceedingly well

20 fast-moving countries: Access rate in 2014 and annualized increase in access rate in 2012–14



Source: GTF.

Box 3.6

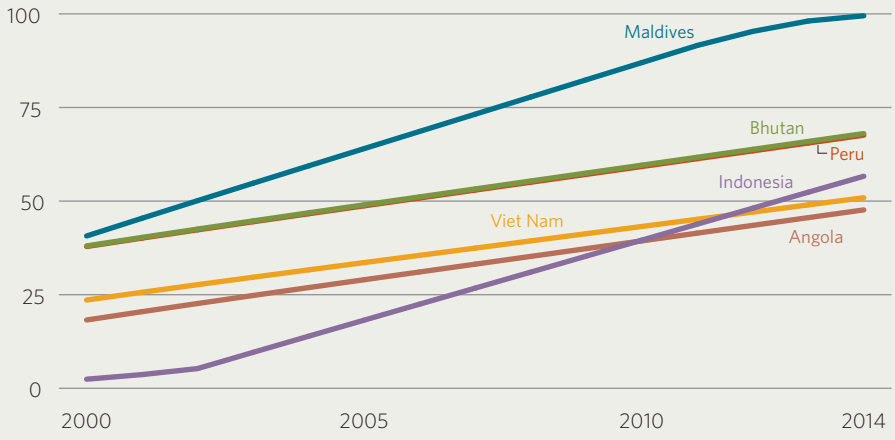
Strong performing countries in 2000–14, with a focus on Indonesia

Only a few countries have made serious headway in access to clean cooking since 2000 (box figure 1). Indonesia and Maldives provided access to around half their populations in 2000–14, while Angola, Peru, and Viet Nam boosted access by about 20 percentage points.

Indonesia's story is of particular interest. Launched in 2007, the Indonesian Kerosene to Liquid Propane Gas Conversion program has begun to bear fruit, converting 56 million households and microbusinesses nationally by 2014.[a] And through the Indonesia Clean Stove Initiative, a results-based financing framework was designed for stove delivery, informed by extensive social and gender knowledge work from results tracking. An innovative stove-testing method incorporates local cooking practices and preferences, and the government facilitated innovation through a market-based approach, including two rounds of open calls for stove technologies.

BOX FIGURE 1 Countries with the highest annual increase in access rate to clean cooking in 2000–14

Access rate to clean cooking (%)



Source: GTF.

a. For a presentation of information on the program, see Pertamina (2016).

a weak enabling environment and poor policy framework prevent adoption of clean fuels and more efficient stoves.

Fastest-moving countries

The fastest-moving countries[4] all increased their usage rate by at least 1 percentage point a year in 2012–14, against an average of 0.46 percentage points globally (figure 3.10). Indonesia made the most progress, 4.3 percentage points a year (box 3.6), though most countries' fast annual increase was barely enough to keep up with population growth. In Sudan, for example, the population without access increased by 200,000 each year.

ANNEX 3.1 METHODOLOGY FOR ACCESS TO CLEAN COOKING FUELS AND TECHNOLOGIES

Key differences from past *GTF* editions include:

- Using the same statistical model to estimate missing data for both access to clean fuels and technologies, and access to electricity.
- Using a different method to calculate the annual growth rate.
- Updating the indicator definition for clean fuels and technologies from "nonsolid and liquid fuels" to "clean cooking fuels and technologies."[5]

Data sources

The WHO Global Household Energy Database (2017) was used for cooking. The database collects nationally representative household survey data from various sources (table A3.1). The database contained 824 surveys collected from 161 countries, including high-income countries, between 1970 and 2014. The countries provided for cooking are only those with underlying data, so there are no estimates for Turkey and Libya.

Population data from the World Bank's World Development Indicators were used for all countries except the Cook Islands and Anguilla (not in that database), so United Nations Population Division data were used. The World Development Indicators database does not have 2013–14 data for Eritrea, 1992–94 data for Kuwait, or 1990–97 data for Sint Maarten, so the 2011, 1991, and 1998 populations were used as proxies.

Estimating missing values

Since household surveys are conducted irregularly, a multilevel nonparametric modeling approach developed by WHO was adopted to estimate missing values in between surveys for both databases.[6]

For clean cooking fuels, only the model estimates are used due to large variances in survey results.

Multilevel nonparametric modeling takes into account the hierarchical structure of the data: survey points are correlated within countries, which are then clustered within regions. Time is the only explanatory variable; no covariates are used. Regional groupings are based on WHO regions and used for cooking.[7]

Calculating the annual growth rate

In contrast to earlier editions, *GTF 2017* uses a simpler, more intuitive annual increase in the access rate, calculated as the difference between the access rate in year 2 and that in year 1, divided by the number of years to annualize the value:

(Access Rate Year 2 – Access Rate Year 1) / (Year 2—Year 1)

This approach takes population growth into account by working with the final national access rate.

TABLE A3.1 Overview of data sources for clean fuels and technologies

Name	Entity	Number of countries	Distribution of data sources	Question
Census	National statistical agencies	85	20.0%	What is the main source of cooking fuel in your household?
Demographic and Health Survey (DHS)	USAID funded, ICF International implemented	71	22.9%	What type of fuel does your household mainly use for cooking?
Living Standard Measurement Survey, income expenditure survey, or other national surveys	National statistical agencies, supported by the World Bank	17	4.1%	Which is the main source of energy for cooking?
Multi-indicator cluster survey	UNICEF	57	11.1%	What type of fuel does your household mainly use for cooking?
World Health Survey	WHO	49	6.9%	
National Survey		63	23.7%	
Other		56	11.3%	

NOTES

1. On a global level, these efforts are largely led and coordinated by the Global Alliance for Clean Cookstoves.
2. High-impact countries are defined as the 20 countries with the highest access deficit in absolute numbers.
3. In contrast to electrification, which is more of an issue in low-income African (excluding North Africa) countries.
4. The 20 countries with the highest increase in clean cooking fuel access rate in 2012–14.
5. See the WHO report *Burning Opportunity: Clean Household Energy for Health, Sustainable Development, and Wellbeing of Women and Children* (2016).
6. The model is described in depth in Bonjour et al. (2013).
7. The WHO regions are African Region, Region of the Americas, South-East Asia Region, European Region, Eastern Mediterranean Region, and Western Pacific Region. See "Who Regional Offices," http://www.who.int/about/regions/en/.

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ENERGY EFFICIENCY

HIGHLIGHTS

- Global primary energy intensity[1] improved at 2.1% a year in 2012–14, slightly better than in 2010–12, but still short of the Sustainable Energy for All (SEforALL) objective of a 2.6% compound annual growth rate (CAGR) over 2010–30. Given the underperformance in intensity improvement since 2010, the effective target rate for 2014–30 is now higher, at 2.8% a year.
- Policies for industry, transport, and buildings have been key drivers of these reductions in energy intensity. The amount of global total final energy consumption (TFEC)[2] covered by mandatory energy efficiency policies grew from 11% in 2000 to 29% in 2014.
- Energy intensity improvements avoided nearly 12 exajoules (EJ) of global TFEC in 2012–14, equivalent to the TFEC of Brazil and Pakistan in 2014. Most of the savings came from the industrial and transport sectors, in upper-middle-income and lower-middle-income economies, particularly China (which alone accounted for almost half of the global energy savings), as well as India and Nigeria.
- Progress in supply-side efficiency remains slow. Average efficiency differences of around 10 percentage points among country income groups, and between generation technologies, signal important potential yet to be tapped.

GLOBAL TRENDS IN 2012–14

The global economy is on a long-term trend of decreasing its energy intensity, moving in the right direction to achieve the SEforALL objective of doubling the historical rate of improving energy efficiency.[3] Reduced intensity means that less energy is required to be extracted, produced, transformed, transmitted, and distributed for each unit of economic output, with all the associated economic, environmental, social, and energy security benefits. Put simply, lower energy intensity means that each unit of energy is more efficient in producing a unit of economic output.

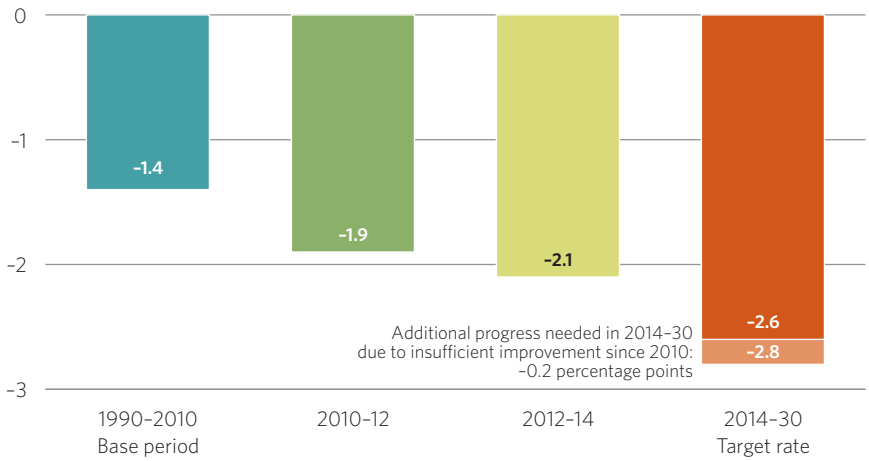
Global primary energy intensity decreased by a CAGR of 2.1% in 2012–14 (figure 4.1), reaching 5.5 megajoules (MJ) per 2011 purchasing power parity dollar (PPP $). This rate of improvement is slightly faster than the 1.9% in 2010–12, and 0.7 percentage points faster than the historical reference period of 1990–2010.[4]

However, this rate of improvement is still short of the 2.6% CAGR over 2010–30 needed to meet the SEforALL objective. Since global performance has fallen consistently short since 2010, there is a need to compensate through an even faster improvement of 2.8% a year in the remaining period to meet the 2030 objective. Moreover, this benchmark rate will continue to increase each year that the improvement rate is not met, making the overall goal yet harder to achieve.

Annual energy intensity movements since 1990 have been highly variable, so the short-term intensity improvements in 2010–14 cannot yet be considered a long-term trend. Moreover, the world has never experienced a sustained decline in energy intensity at the target rate of 2.6%, but since 1990 it has reached this rate in only two years, 1997 and 2007. In short, the SEforALL objective for energy efficiency appears to be very challenging (figure 4.2).

FIGURE 4.1 Global energy intensity is declining, but it must fall even faster to meet the SEforALL objective

Compound annual growth rate of primary energy intensity by period, and target rate for 2014–30 (%)



Source: World Bank analysis based on IEA, UN, and WDI databases, and IEA *World Energy Outlook* gross domestic product projections.

Supply-side efficiency

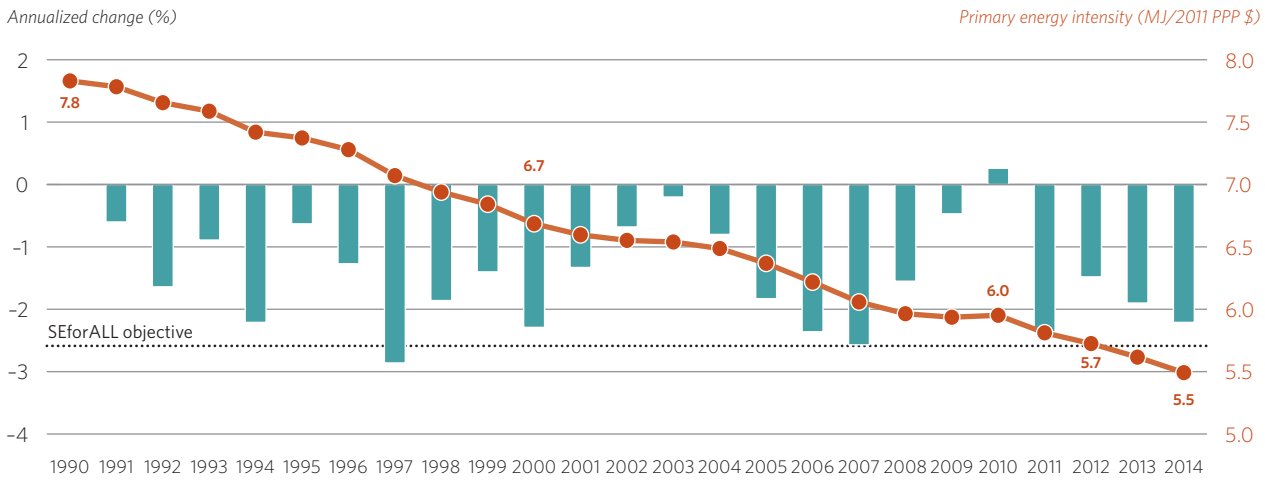
The provision of high-quality energy, such as electricity and natural gas, to end users is a key contributor to development. Increasing the efficiency of energy conversion, transmission, and distribution lowers the need to build additional supply capacity, improving access and reducing environmental impacts.

Worldwide, an ever-larger share of primary fossil energy is being converted into electricity, and fossil fuels will long dominate the generation mix.[5] The efficiency of fossil power generation is thus a crucial determinant of global energy intensity.

The average global efficiency of fossil fuel–fired power generation has increased by

FIGURE 4.2 Historic trends show that the SEforALL objective is challenging

Primary energy intensity: Annualized change and level, 1990–2014



Source: World Bank analysis based on International Energy Agency (IEA), United Nations (UN), and World Development Indicators (WDI) databases.

only 3.6 percentage points since 1990, reaching 39% in 2014.[6] This limited improvement stems from slow progress in the efficiency of coal-fired plants which, given their dominant share in the generation mix, has dampened the efficiency increase of nearly 8 percentage points of natural gas–fired generation in the same period (figure 4.3). In coal generation, the lack of progress has been in part due to the construction of new plants that do not use the latest technology, as well as the rise in self-use of coal by power plants to meet tightening pollutant emissions standards.[7] By contrast, the efficiency increase in gas-fired power plants is in large measure due to the widespread adoption of combined-cycle turbines.

There is a wide gap of nearly 10 percentage points in power generation efficiencies across technologies and country income groups (see figure 4.3). While the optimum generation mix depends on the particular conditions of each country, this gap gives a rough indication of the potential for gains. Progress in China and India will play a major role in increasing global thermal efficiency, given their high and rapidly increasing share in global power generation. Moreover, coal accounts for nearly 75% of power generation in China and 72% in India, whereas the share of natural gas–fired plants is only 1.7% and 8.4%, respectively.

Global electricity transmission and distribution (T&D) losses[8] reached a peak of 9.6% in 2002, generally fell until 2011, and stayed fairly constant at 8.9% in 2012–14. T&D losses in 2014 reached 1,970 terawatt-hours (TWh), equivalent to the combined electricity production of India, South Africa, Australia, and Thailand that year. T&D losses are affected by the efficiency of the grid and its operation, such as climatic conditions, distances, density, and nontechnical matters such as theft (often referred to as commercial losses).

T&D loss rates and trends vary greatly among countries and regions (figure 4.4). Those in high-income countries have stabilized around 7.0%, but those in low-income countries are increasing, reaching 15.8% in 2014. Losses in India are particularly high compared with those in other major countries. If India—the world's third-largest electricity producer and the country with the largest absolute electricity access deficit (chapter 2)—could reduce its T&D losses from the current 22.9% to the world average of 8.9%, it would make available the equivalent of what Poland generated in 2014.

Losses in natural gas T&D have been on a declining trend since 1990, and percentage-wise they are roughly an order of magnitude lower than those for electricity (figure 4.5).[9] This decline comes from reduced leaks and improved pipeline pressurization. In 2012–14, however, losses increased, from 0.6% to 0.8%. This reversal seems to be caused by loss increases in Indonesia, Malaysia, and Pakistan, which together account for 31% of global losses.

DRIVERS OF RESULTS AND TRENDS

Growth of economic output versus total primary energy supply

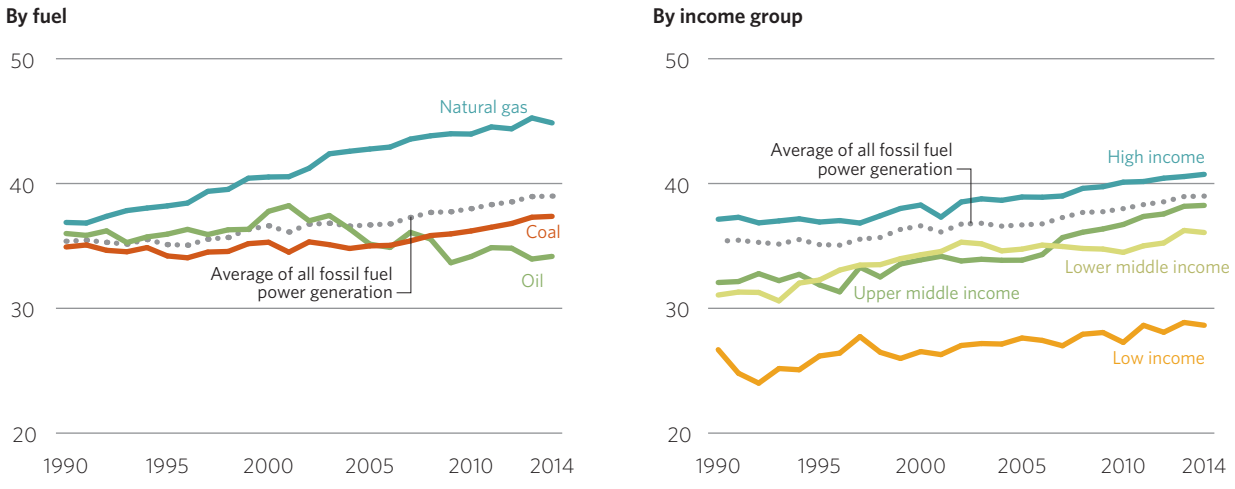
Energy intensity variations are the result of the relative changes of two underlying variables: economic output and the energy required to produce it. The SEforALL objective calls for a decrease in energy intensity, which is achieved when economic output grows faster than energy consumption. When energy consumption is not affected by variations in economic output or by changes in economic structure, both variables are decoupled, which is an important milestone on the journey to a less energy-intensive global economy.

Global gross domestic product (GDP) grew nearly three times faster than total primary energy supply (TPES) in 2012–14, up from roughly twice as fast in 2010–12. This trend reflects the decoupling between both variables, which stalled during the 2008–09 financial crisis, but continued strongly thereafter, especially from 2011 (figure 4.6).

Although all country income groups[10] have decoupled to a degree, the differences vary greatly. The high-income group is the only one where TPES seems to have peaked (in 2007), and has generally decreased slightly since, such that in 2014 TPES was at the same level as in 2004. GDP grew by nearly 19% in the interim. Decoupling in this group continued in 2012–14, when GDP grew at a CAGR of 1.5% while TPES decreased by 0.2%, for an annualized decrease

FIGURE 4.3 The wide efficiency differences between fuels and income groups highlight major opportunities for gains

Thermal efficiency of fossil power generation (main activity producer electricity plants) by fuel and income group (%)

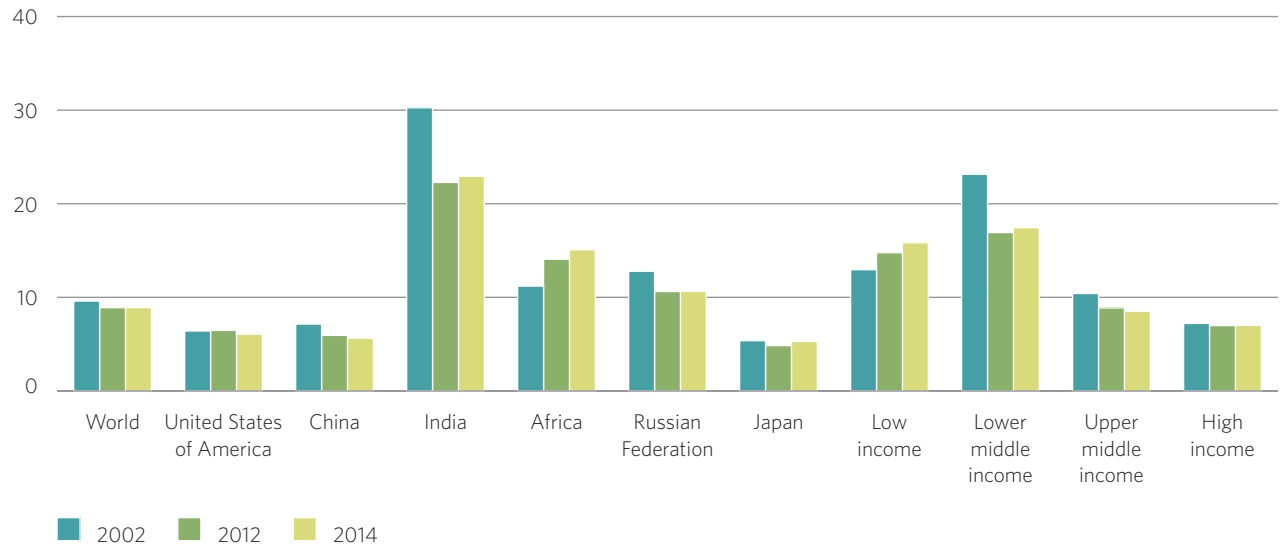


Source: World Bank analysis based on IEA databases.

Note: Data are for main activity producer electricity plants, excluding, for instance, onsite power and heat generation at industrial facilities.

FIGURE 4.4 Global power transmission and distribution losses have improved only modestly since 2002

Selected countries, regions, and income groups (%)

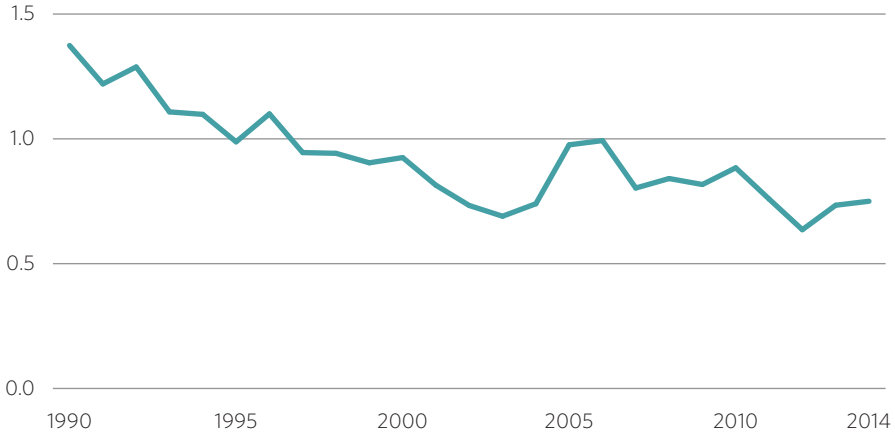


Source: World Bank analysis based on IEA databases.

Note: Losses are calculated as a percentage of supply. They include technical and nontechnical losses, and for some countries they may also include residuals.

FIGURE 4.5 Gas transmission and distribution losses have fallen by nearly half since 1990

Global losses in natural gas transmission and distribution, 1990–2014 (%)



Source: IEA databases.

Note: Data for Canada are only available from 2005, which explains the spike that year.

in energy intensity of 1.6%. In the other income groups, while both TPES and GDP grew strongly in 2012–14, GDP grew faster, for decreases in energy intensity of 2.5% (low-income group), 3.0% (lower-middle-income group), and 2.4% (upper-middle-income group) (figure 4.7).

Given the slow growth in TPES of the high-income group relative to the others, its share in global primary energy supply has declined such that, since 2012, it has been less than 50% of the total for the first time. This declining share is mainly due to the increase in TPES of the upper-middle-income group, whose share reached 36.3% in 2014, against 48.0% for the high-income group that year.[11] This means that progress in world energy intensity, and its average value, are increasingly being influenced by upper-middle-income economies, particularly China.[12] The upper-middle-income group decreased its intensity faster than the high-income group in 2012–14, but has an energy intensity that is still 24% higher (see figure 4.7).

Sector and structural trends

Energy intensity improvement in 2012–14 avoided global TFEC of nearly 12 EJ, equivalent to the TFEC of Brazil and Pakistan together in 2014.[13] Energy savings deliver an array of benefits (box 4.1).

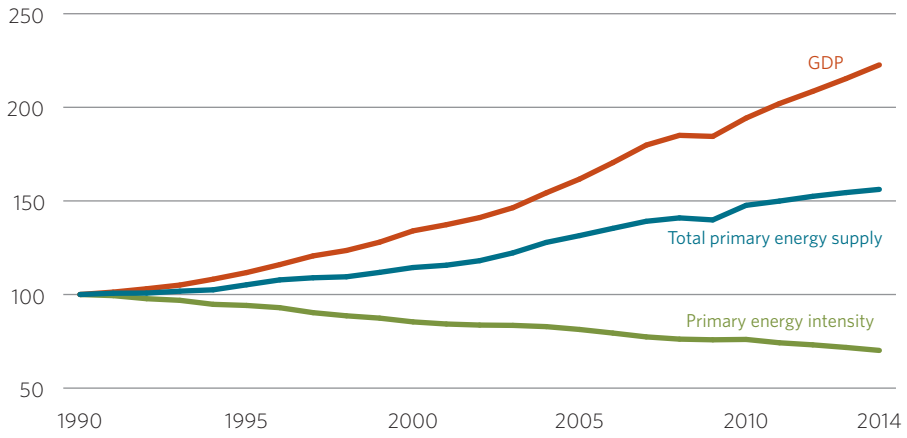
Energy savings are highly concentrated—by sector, country income group, and individual country (figure 4.8). Two energy-intensive sectors (industry and transport) contributed the vast majority of avoided global TFEC in 2012–14. Industry alone accounted for 54% of the energy savings, though only 38% of TFEC. Transport accounted for 38% of savings (with passenger travel accounting for nearly 80% of transport-sector savings).

By income group, upper-middle-income countries accounted for 42% of savings (against a 35% share in TFEC), lower-middle-income countries 28% (15%), and high-income countries 27% (47%).

Five countries accounted for nearly 70% of total energy savings globally: China had by far the largest contribution (47% of savings against a 21% share in TFEC); India (9% and 6%); Nigeria, the United Kingdom of Great Britain and Northern Ireland, and the Russian Federation (together, 13% and 7%); and the rest of the world (31% and 66%).

FIGURE 4.6 Growth in GDP and energy consumption has markedly decoupled since the 2008–09 financial crisis

Trends in underlying components of energy intensity, 1990–2014 (index, 1990 = 100)

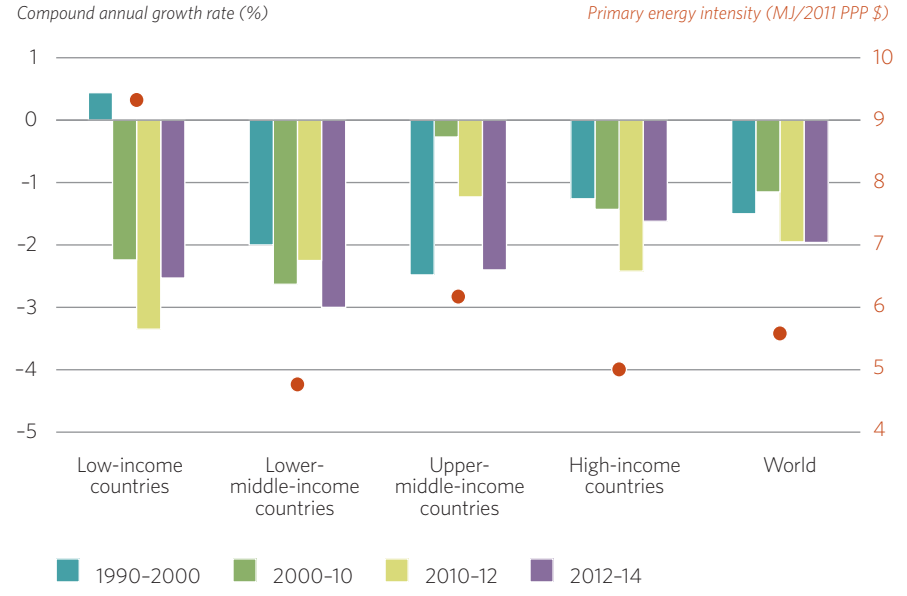


Source: World Bank analysis based on IEA, UN, and WDI databases.

Note: GDP 2011 PPP $ = gross domestic product per 2011 purchasing power parity dollar.

FIGURE 4.7 All income groups are making progress, but still show wide differences in energy intensity

Primary energy intensity: Rate of change, and level, by income group, 1990–2014



Source: World Bank analysis based on IEA, UN, and WDI databases.

The energy savings are attributable to several underlying factors. To analyze these factors, first we decompose changes in global TFEC considering three factors, or effects: activity (increased economic output or population growth), structure (due, for example, to a shift in value added from energy-intensive industries to less energy-intensive services), and energy efficiency (due, for example, to more efficient technologies in industry). Then we analyze trends in five sectors: industry, transport (passenger and freight), services, residential, and agriculture.

Because the analysis is limited to data available for all countries, only high-level estimates can be made, with the exception of transport, where modeling was done by the IEA. This is particularly relevant for the analysis of the residential sector, where the results of this report differ from those of the IEA; the latter are based on end-use data available for a subset of countries.

Decomposition analysis shows that in 2012–14, the 1.3% average annual growth in TFEC was the result of an increase of 2.6% due to higher economic activity partly offset by a 1.3% decrease from improved energy efficiency (figure 4.9). The contribution of structural changes at global level remains negligible, accounting for the remaining 0.1% increase in TFEC.[16,17] Though the relative importance of these three factors varied among income groupings, regions, and countries, energy efficiency improvement was the main factor driving down energy intensity worldwide.

Global TFEC intensities in industry, agriculture, services, and transport are all on a long-term downward trend that continued in 2012–14, while changes in per capita energy consumption in the residential sector has mixed results (figure 4.10 and figure 4.11[18]).[19]

The impact of each sector on overall final energy intensity depends on two key factors: their relative level of energy intensity, and their share in TFEC. For example, changes in energy intensity in industry have more weight in overall intensity than do those in services, given that in 2014 industry was nearly eight times more energy intensive per unit of value added, and accounted for nearly 40% of TFEC, against 8% for services.

Changes in energy intensity in the residential sector—with intensity measured in this report as residential energy consumption per capita—regained levels seen during the historical reference period (1990–2010), increasing at an average annual 0.1% in 2012–14, after a downward shift in 2010–12. The 2012–14 result reflects several factors with opposing impacts on overall intensity. On the one hand, energy use per capita grew because of increased income and subsequent higher ownership of appliances and larger homes, particularly in middle-income and upper-middle-income economies. On the other hand, energy use per capita decreased because of more stringent application of building energy codes and the replacement of appliances with more efficient models, especially in high-income economies.

With the exception of high-income economies, all other income groups showed increased residential energy consumption per capita in 2012–14. This does not imply that

Box 4.1

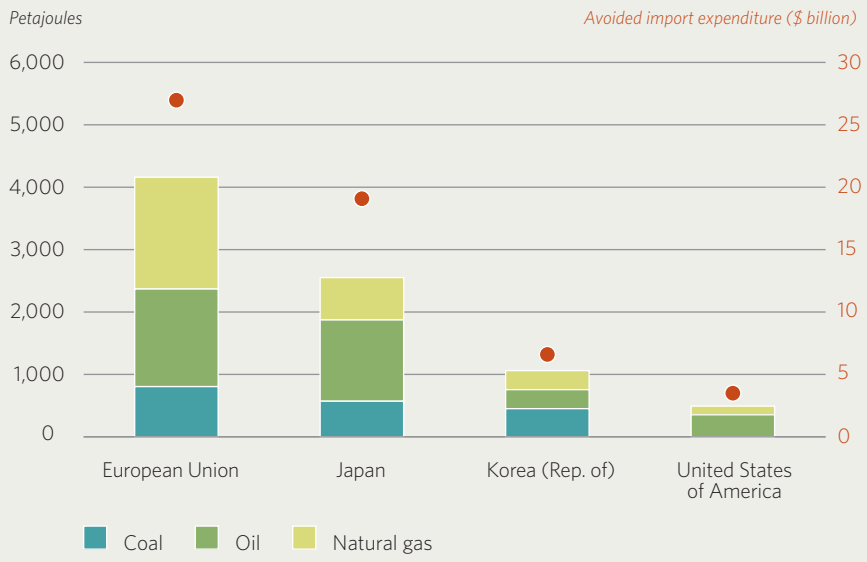
The multiple and sizable benefits of energy efficiency

Energy efficiency investments generate multiple benefits, including greater energy security, economic growth, social development, and environmental sustainability. Their size and value vary across countries and sectors, but have demonstrable positive impacts. In many respects, these wider benefits are more important to consumers, businesses, and governments than just direct energy savings. Effective strategies to increase investment in energy efficiency will need to continue to identify and improve the assessment of the value of multiple benefits to consumers, investors and policymakers.

In its *Energy Efficiency Market Report 2016, the* International Energy Agency (IEA) evaluated some of the multiple benefits generated by energy efficiency investments since 2000 (2016a). It is important to note that the methodology used to calculate energy savings differs from the one used in this report, so numbers are not comparable.[14] Consumers in IEA member countries,[15] for example, saved $540 billion in energy expenditure in 2015, with savings of $700 per capita in Japan, $650 in the European Union (EU), and $500 in the United States of America. IEA countries also avoided 1.5 gigatons (Gt) of carbon dioxide emissions in 2015 due to efficiency gains, and China alone avoided 1.4 Gt.

Energy efficiency also helps lower energy imports. The EU, the world's largest energy-importing bloc, avoided 4,200 petajoules (PJ) of gas, coal, and oil imports in 2015, cutting its import bill by $27 billion (10% of total spending on energy imports). The same year, Japan cut its fuel import bill by $19 billion (15% of total spending) (see box figure 1).

BOX FIGURE 1 Total avoided imports of coal, oil, and natural gas with savings by country or region, 2015



Source: IEA 2016a.

efficiency worsened in these income groups, but rather could signal higher end-use service levels—such as more comfortable indoor temperature—due to higher energy consumption as a result of increased affordability. In high-income countries, where energy services are reaching saturation levels, a decline in per capita energy consumption is generally the result of higher efficiency appliances, better insulation in buildings, and other measures that reduce energy consumption while maintaining service levels. Thus, it is important to understand the country context and improve the quality and quantity of end-use data, in order to better analyze and capture energy efficiency trends in the residential sector.

Energy intensities for passenger and freight transport are estimated from IEA's Mobility Model. Passenger energy intensity for all modes in 2012–14 fell by an average annual 2.8% (figure 4.11a), driven mainly by a structural shift of activity toward less energy-intensive non–Organisation for Economic Co-operation and Development (OECD) regions.

This driver is supported by energy intensities that also decreased over time, both in OECD and non-OECD countries. The fuel consumption per passenger-kilometer (passenger-km) of buses and minibuses decreased by 4.8% per year, the fastest decline of all modes. The energy intensity of air travel had the second-fastest decline, of 3.8% per year. This is the result of increased occupancy rates, combined with improved aerodynamics, use of lighter composite materials, and improved efficiency of jet engines. According to IEA's Mobility Model, since 2011 the energy intensity of air travel, on a passenger-km basis, is lower than that of light-duty vehicles.

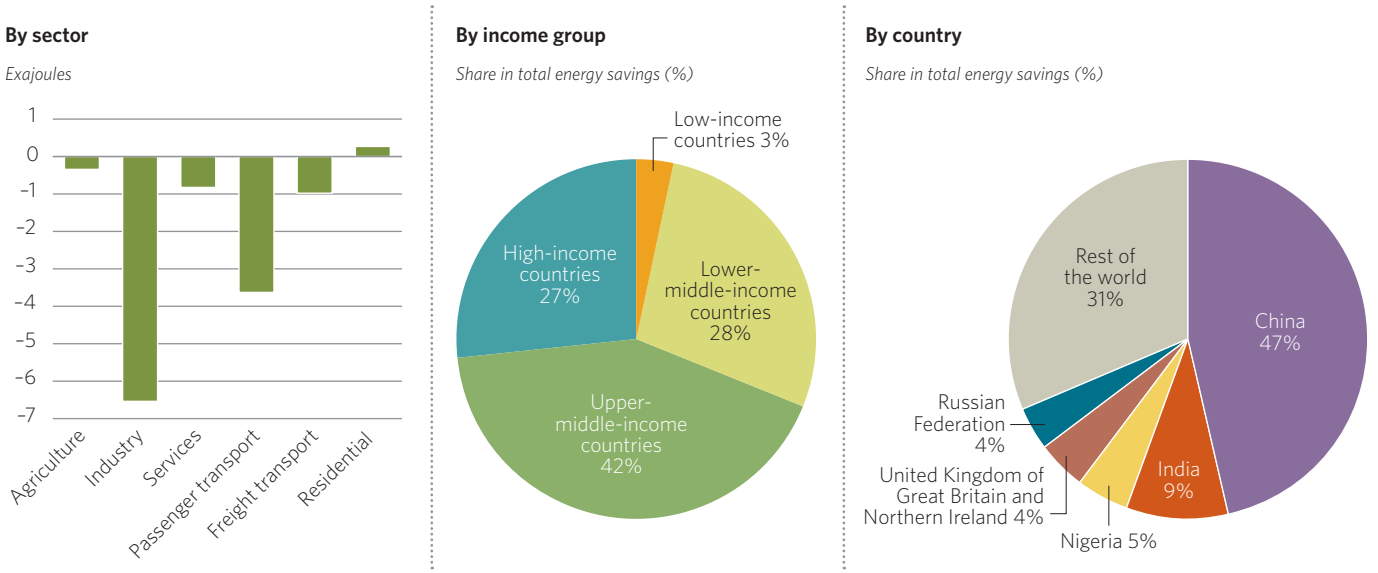
Improvements in these two modes will remain critical, as light-duty vehicles have the highest energy intensity of all modes, account for 64% of passenger energy consumption, and concentrate the highest share of activity at 42% of passenger-km of all modes modeled. Air travel ranks second in energy intensity and energy consumption, and third in activity after light-duty vehicles and buses/minibuses, but activity is growing fast at 6.0% a year.

Freight energy intensity in 2012–14 improved at an average annual 1.1% (figure 4.11b). Shipping, with the lowest energy intensity of all freight modes in the model, saw the fastest improvement, at 3.7% a year (mainly because of a trend to larger ships). This mode accounts for nearly one-fourth of freight energy consumption and three-fourths of total ton-kilometer (ton-km) worldwide. Reductions in freight energy intensity were also driven by light commercial vehicles, with the biggest decline in energy intensity in absolute terms and an annual decrease of 1.3%. This mode exhibits the highest energy intensity of all, at more than six times the second highest (medium and heavy trucks), and accounts for nearly 17% of total freight energy consumption but only 1% of global ton-km. Improvement in medium and heavy trucks was modest at 0.4%. This mode accounts for 56% of freight energy consumption and is second in freight moved (after shipping), with 19% of all ton-km.

Box 4.2 looks at how much energy efficiency investment is being captured by each of these end-use sectors, and in what form.

FIGURE 4.8 Energy savings are highly concentrated

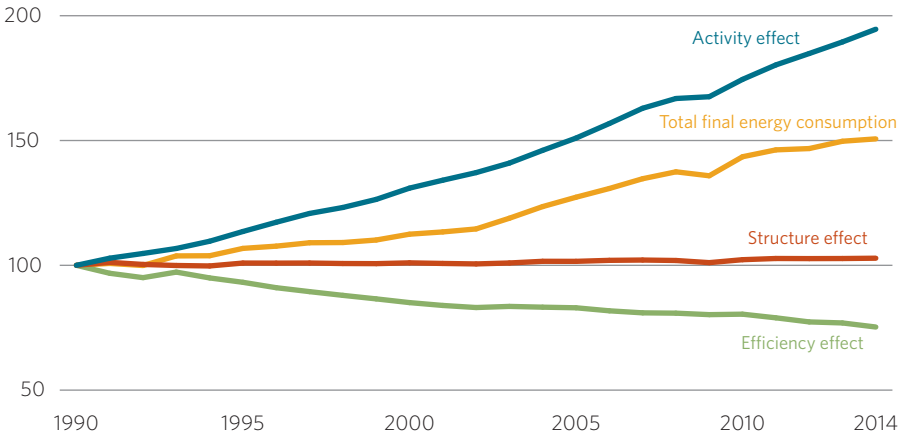
Composition of avoided global total final energy consumption by sector, country income group, and individual country, 2012–14



Source: World Bank analysis based on IEA, UN, and WDI databases.

FIGURE 4.9 The efficiency effect has been the main driver in reducing global energy intensity

Decomposition of trends in global total final energy consumption: Activity, structure, and efficiency effects, 1990–2014 (index, 1990 = 100)



Source: World Bank analysis based on IEA, UN, and WDI databases.

Policies

Several drivers explain underlying sector energy efficiency gains, notably mandatory policies, which have become far more common in the past 15 years. In the *Energy Efficiency Market Report 2016* and the *World Energy Outlook 2015,* the IEA quantified how much of global energy consumption was used in products subject to minimum energy performance standards or in sectors that had policies mandating energy efficiency measures (IEA 2016a; 2015b). It found that the share of global TFEC covered by these mandatory policies grew from 11% in 2000 to 29% in 2014. The growth of energy use subject to mandatory policies outpaced growth of TFEC, at an average annual 9% versus 2% in 2000–14.

Globally, coverage of mandatory standards and regulations is roughly even among transport, industry, and buildings (residential and nonresidential), with differences in sector coverage by blocs and countries (figure 4.12).

In China and India, industry makes up the largest share of TFEC covered by mandatory standards and regulations. In the United States of America and the EU, industry accounts for a smaller share than other sectors because there are fewer mandatory standards and targets. Conversely, virtually all of the U.S. passenger vehicle fleet is covered, as standards have been in place since the 1970s. In the EU, implementation of mandatory vehicle standards started only in 2009.

The difference in coverage of mandatory standards and regulations between most OECD countries and many emerging countries (usually except for China) is pronounced. China has the largest policy coverage of any country, but other emerging countries have the least coverage of the countries evaluated by the IEA, which indicates that there is still large potential for standards and other mandatory policies to save energy. This potential will need to be exploited to achieve the 2.6% global annual energy intensity improvement, as it is countries outside the OECD that will need to lead global intensity reductions by 2030. Further details on countries are in the IEA's Policies and Measures database, and the World Bank's Regulatory Indicators for Sustainable Energy (RISE) database.[21]

FIGURE 4.10 Sector energy intensities are declining, except in the residential sector

Compound annual growth rate of global final energy intensity by sector (%)

Source: World Bank analysis based on IEA, UN, and WDI databases.

COUNTRY PERFORMANCE

High-impact countries

The performance of the world's 20 largest primary energy-consuming countries—"high-impact" countries—is critical to achieving the SEforALL energy efficiency objective. In 2014, they accounted for more than 75% of TPES, with only four countries—China, United States of America, India, and the Russian Federation—accounting for nearly 50% of the TPES, and China alone 22% of the total (figure 4.13).

The pace of improvement in energy intensity varies sharply among these countries (figure 4.14). China lifted its performance from a CAGR of 2.9%[22] in 2010–12 to 4.7% in 2012–14, to become the third-fastest country among the 20, but the one with the greatest impact. India almost doubled its rate of improvement, from a CAGR of 1.4% in 2010–12 to 2.5% in 2012–14, resulting in the second-highest energy savings worldwide after China. By contrast, five high-impact countries increased their intensity in 2012–14; in particular, Saudi Arabia and South Africa both reversed the strong improvements they had made in 2010–12. Thailand and Brazil continued to increase their intensities in 2012–14. In Brazil, this could be related to the significant decrease in hydro generation, while in Thailand it is related to higher TFEC in industry combined with lower GDP growth.

China and India exemplify some important drivers. China's improvements stem from government commitment, clear targets, and long-term policies continued under the country's 12th Five-Year Plan (2011–15). Noteworthy is the Top 1,000 program, which was extended to 10,000 enterprises with energy consumption greater than 10,000 tons of coal equivalent (tce) (down from 180,000 tce under the 11th Five-Year Plan). The program targets all types of industry, not just energy-intensive ones, with more stringent targets, and provides subsidies to achieve these targets. It also imposes energy savings targets on commercial and public buildings, along with a requirement to implement energy management systems.

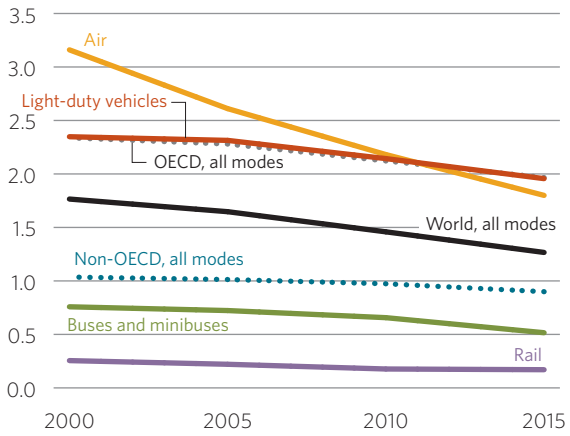
A carbon emissions trading scheme, to be launched in 2017, will be the world's largest cap-and-trade program, and will include six of China's largest carbon-emitting industrial sectors, starting with coal-fired power generation. Another key enabler for energy efficiency improvements is the energy services companies industry, the world's largest. The upshot is that China seems to be on track to achieving its target of 16% reduction in energy intensity, as set out in the 12th Five-Year Plan.[23]

India is advancing on several fronts. Its National Mission for Enhanced Energy Efficiency (NMEEE)—one of eight missions under

FIGURE 4.11 Energy intensity reductions (in percentage terms) have been steepest in buses and minibuses and in shipping

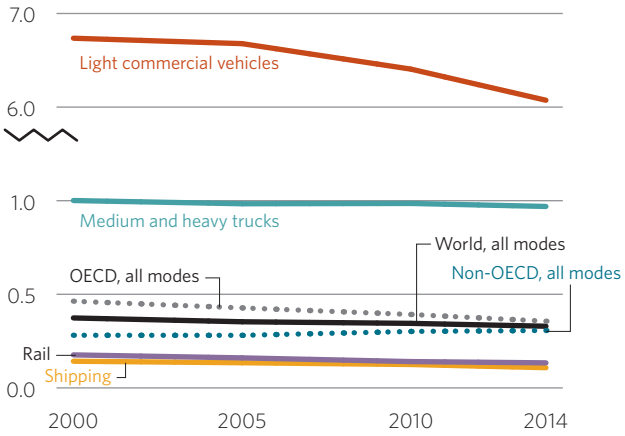
a. Global average passenger transport energy intensity

MJ/passenger-km



b. Global average freight transport energy intensity

MJ/ton-km



Source: IEA Mobility Model.

Box 4.2

Energy efficiency investment is growing

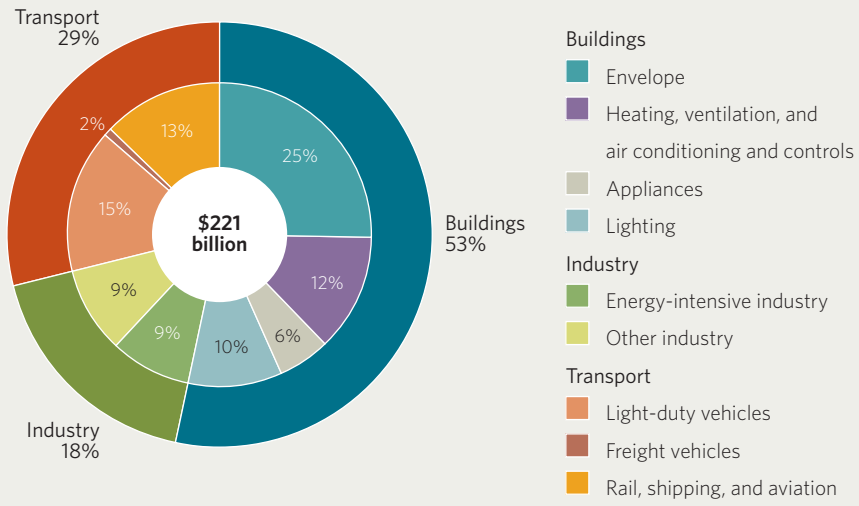
The IEA estimates that global investment in energy efficiency grew by 6% to $221 billion in 2015.[20] This investment growth was led by the building sector, which accounted for more than half the amount (box figure 1), at 9% growth. Building investment was driven primarily by government policies and programs, including financing for building efficiency retrofits and product standards, along with more expansive building energy codes for new buildings and retrofits.

Product standards and utility energy savings obligations in the United States of America, the EU's Energy Performance of Buildings directive and Ecodesign directive, and China's building retrofit financing have been some of the most important policies propelling energy efficiency investment in buildings. The bulk of investment was spent on existing buildings. Government policies have been particularly effective in leveraging private investment: of the $118 billion invested in energy efficiency in buildings, only 6% was direct government spending. New net zero energy buildings are becoming an increasingly important energy efficiency market with global investment at $14 billion, rising from virtually nothing in 2010.

Annual investment in energy efficient transport increased by 3% to $64 billion, primarily on increased global vehicle sales in 2015, which reached records in the United States of America and China (now the world's largest passenger vehicle market). Vehicle efficiency standards also have been important for improving the efficiency of new vehicles and increasing investment. The average performance of vehicle standards for passenger and commercial light-duty vehicles increased by 20–25% in countries with vehicle fuel economy standards since 2010. Investment in efficient road vehicles in 2015 will save up to 1 billion barrels of oil consumption over their lifetimes.

China has been the biggest driver in expanding energy efficiency investment over the past decade, and in 2015, accounted for 41% of global investment in light-duty vehicles and 19% of that in buildings. It also accounted for more than half the $24 billion in revenues for energy services companies, whose efficiency revenues grew at 7% a year over the last decade. Most of these companies' activities in China focus on efficiency investments in industry.

BOX FIGURE 1 Global incremental investment in energy efficiency by sector and subsector, 2015



Source: IEA 2016a.

its National Action Plan on Climate Change—was designed to foster a market transformation through regulatory and policy changes conducive to innovative and sustainable business models for energy efficiency. NMEEE includes four initiatives: (1) the Perform Achieve and Trade Scheme, to establish a regulatory instrument with an associated market-based mechanism targeted at energy-intensive industries; (2) the Market Transformation for Energy Efficiency, to make efficient products more affordable; (3) the Energy Efficiency Financing Program, to support demand-side management programs in all sectors; and (4) the Framework for Energy Efficient Economic Development, to develop fiscal instruments to promote energy efficiency. The Bureau of Energy Efficiency has been a key actor in developing these policies and programs.

The implementation of energy efficiency programs in India accelerated considerably after December 2009, when Energy Efficiency Services Limited (EESL), a public energy services company (ESCO), was created. By early March 2017, EESL had deployed nearly 1.7 million light-emitting diode (LED) street lights under a bulk procurement model with ESCO service delivery, resulting in avoided installed capacity of nearly 63 MW.[24] Even more impactful has been EESL's Unnat Jyoti by Affordable LEDs for All (UJALA) initiative—a market-driven utility demand-side management program to sell and distribute LED light bulbs for households and institutional consumers—that since 2014 has distributed more than 218 million LED lightbulbs, avoiding nearly 5,670 MW of generation capacity.[25] UJALA is achieving market transformation by spurring domestic manufacturing capacity and reducing LED lightbulb prices through competition. In just two years since the program began, retail bulb prices fell from INR550 ($8.4) to INR150–200 ($2.3–$3.0), while EESL sells the bulbs at about INR65 ($1.0) (PTI 2016). Bulk prices fell strongly too, from INR310 ($4.7) to INR38 ($0.6), a nearly 90% reduction (Singh 2016). EESL will also tackle other high-impact market segments, including air conditioners, ceiling fans, and water pumping.

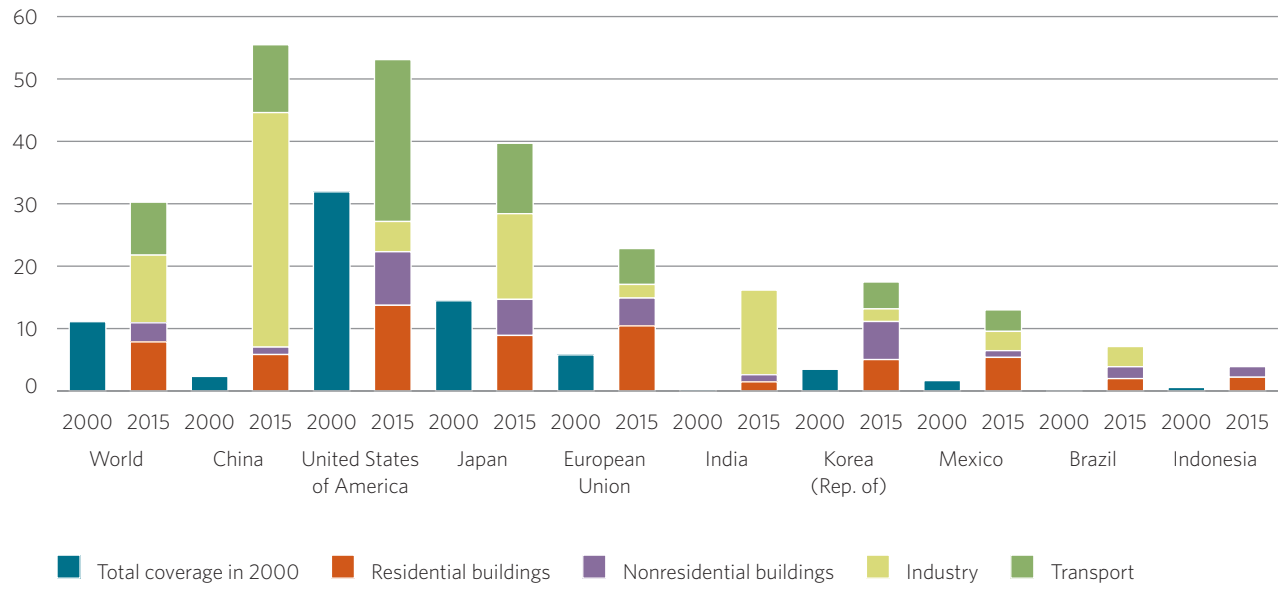
Fast-moving countries

Energy efficiency delivers a raft of economywide benefits beyond energy savings. So even though achieving the SEforALL objective depends heavily on the largest energy consumers, reducing the energy intensity (or increasing the energy productivity) of the economy is important for all countries, independent of size and development level.

The 20 countries with the fastest improvement in primary energy intensity in 2012–14 (figure 4.15) show that reducing

FIGURE 4.12 Share of total final energy consumption covered by mandatory energy efficiency policies by sector

Percent



Source: IEA 2016a.

FIGURE 4.13 Achieving the SEforALL objective for energy efficiency will depend on a handful of countries

Twenty biggest primary energy consumers: Total primary energy supply and energy intensity, 2014

Source: World Bank analysis based on IEA, UN, and WDI databases.

Note: Country income classification corresponds to that in effect in 2014.

FIGURE 4.14 Most high-impact countries are making progress on reducing energy intensity

Twenty biggest primary energy consumers: Energy intensity improvement in 2012–14 and energy intensity in 2014

Source: World Bank analysis based on IEA, UN, and WDI databases.

FIGURE 4.15 Fast-moving countries show it is possible to reduce energy intensity by 5–10% a year, at least for a time

Annualized change in primary energy intensity in the 20 fastest-moving countries, 2012–14

Source: World Bank analysis based on IEA, UN, and WDI databases.

energy intensity by a CAGR of as much as 5–10% a year is feasible, at least for short periods, particularly in countries that start out with high energy intensity. These 20 countries are heterogeneous, representing all income groups, most geographic regions, a wide range of intensity levels, disparate economic structures, and varying underlying trends. Uzbekistan led the group with an annualized improvement of 12.1%, starting from one of the highest energy intensities in the world at 11.2 MJ/2011 PPP $.

Only two countries, Malta and Sierra Leone, have stayed in this group since 2010, suggesting that it is difficult for any country to sustain this kind of pace. This is a point of real import for high-impact countries that have also overperformed global intensity improvements, such as China, India, the Russian Federation, and others, as they may eventually slow. Consequently, over the rest of 2015–30, today's slow-moving countries will have to accelerate their intensity improvements not only to help maintain the global 2.8% CAGR needed to achieve the SEforALL objective, but also to make up for the gap caused by countries and regions that are slowing.

ANNEX 4.1 METHODOLOGY FOR ENERGY EFFICIENCY

Total primary energy supply (TPES) (in terajoules [TJ])	Production plus net imports minus international marine and aviation bunkers plus/minus stock changes (IEA definition). *Data sources:* Energy balances from IEA, supplemented by United Nations Statistics Division (UNSD) for countries not covered by the IEA.
Gross domestic product (GDP) (in 2011 purchasing power parity [PPP] U.S. dollars)	Sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. GDP is measured at PPP at constant 2011 U.S. dollars. *Data source:* World Bank's World Development Indicators (WDI).
Energy intensity of primary energy supply (in MJ per 2011 PPP $)	$\textit{Energy intensity of TPES} = \frac{\textit{Primary energy supply (MJ)}}{\textit{GDP (2011 PPP \$)}}$ Ratio between energy supply and GDP measured at PPP. Energy intensity is an imperfect proxy for energy efficiency. It indicates how much energy is used to produce one unit of economic output. A lower ratio indicates that less energy is used to produce one unit of economic output.
Rate of primary energy intensity improvement (%)	$\textit{CAGR of TPES} = \left(\frac{PEI_{t2}}{PEI_{t1}}\right)^{\frac{1}{(t2-t1)}} - 1\ (\%)$ where, PEI_{t1}: primary energy intensity in year *t1* PEI_{t2}: primary energy intensity in year *t2* Compound annual growth rate (CAGR) of primary energy intensity between two years. Represents the average annual growth rate during the period. Negative values represent decreases (or improvements) in energy intensity (less energy is used to produce one unit of economic output), while positive numbers indicate increases in energy intensity (more energy is used to produce one unit of economic output).
Total final energy consumption (TFEC) (in TJ)	Sum of energy consumption by the different end-use sectors, excluding nonenergy uses of fuels. TFEC is broken down into energy demand in the following sectors: industry, transport, residential, services, agriculture, and others. It excludes international marine and aviation bunkers, except at world level where it is included in the transport sector. *Data sources:* Energy balances from IEA, supplemented by UNSD for countries not covered by IEA.
Energy intensity of total final energy consumption (in MJ per 2011 PPP $)	$\textit{Energy intensity of TFEC} = \frac{\textit{Final energy consumption (MJ)}}{\textit{GDP (2011 PPP \$)}}$ A ratio between final energy consumption and GDP measured at PPP. Energy intensity is an indication of how much energy is used to produce one unit of economic output. A lower ratio indicates that less energy is used to produce one unit of economic output.
Rate of final energy intensity improvement (in %)	$\textit{CAGR of TFEC} = \left(\frac{FEI_{t2}}{FEI_{t1}}\right)^{\frac{1}{(t2-t1)}} - 1\ (\%)$ where, FEI_{t1}: final energy intensity in year *t1* FEI_{t2}: final energy intensity in year *t2* CAGR of final energy intensity between two years. Represents the average annual growth rate during the period. Negative values represent decreases (or improvements) in energy intensity (less energy is used to produce one unit of economic output), while positive numbers indicate increases in energy intensity (more energy is used to produce one unit of economic output).

Energy intensity of industrial sector (in MJ per 2011 PPP $)	$\textit{Industrial energy intensity} = \frac{\textit{Industrial energy consumption (MJ)}}{\textit{Industrial value added (2011 PPP \$)}}$ Ratio between energy consumption in industry (including energy industry own use) and industry sector value added measured at PPP. *Data sources:* Energy balances from IEA and value added from WDI, supplemented by UNSD for countries not covered by IEA or WDI.
Energy intensity of agricultural sector (in MJ per 2011 PPP $)	$\textit{Agriculture energy intensity} = \frac{\textit{Agriculture energy consumption (MJ)}}{\textit{Agriculture value added (2011 PPP \$)}}$ Ratio between energy consumption in agriculture (including forestry and fishing) and agricultural sector value added measured at PPP. *Data sources:* Energy balances from IEA and value added from WDI, supplemented by UNSD for countries not covered by IEA or WDI.
Energy intensity of service sector (in MJ per 2011 PPP $)	$\textit{Services energy intensity} = \frac{\textit{Services energy consumption (MJ)}}{\textit{Services value added (2011 PPP \$)}}$ Ratio between energy consumption in services (including commercial and public services) and services sector value added measured at PPP. *Data sources:* Energy balances from IEA and value added from WDI, supplemented by UNSD for countries not covered by IEA or WDI.
Energy intensity of passenger and freight transport (in MJ/passenger-km and MJ/ton-km)	$\textit{Passenger energy intensity} = \frac{\textit{Passenger energy consumption (MJ)}}{\textit{Passenger activity (passenger-km)}}$ $\textit{Freight energy intensity} = \frac{\textit{Freight energy consumption (MJ)}}{\textit{Freight activity (ton-km)}}$ Ratio between passenger travel and freight energy consumption, and transportation activity measured in passenger-kilometers and ton-kilometers, respectively. *Data source:* IEA Mobility Model.
Energy intensity of residential sector (in GJ/population)	$\textit{Residential energy intensity} = \frac{\textit{Residential energy consumption (GJ)}}{\textit{Population}}$ Ratio between energy consumption in residential sector and population. *Data sources:* Energy balances from IEA, supplemented by UNSD for countries not covered by IEA, and UN Population Division.

Logarithmic Mean Divisia Index (LMDI) decomposition of energy consumption	$D_{tot} = \frac{E^T}{E^0} = D_{act} \cdot D_{str} \cdot D_{eff}$ where the ratio change of energy consumption from year 0 to year T, E^T/E^0, is decomposed to give the activity, structure, and efficiency indexes, D_{act}, D_{str}, and D_{eff}, respectively. Assume that total energy consumption in a specific sector is the sum of consumption in n different subsectors and define the following variables for a certain period: E = total final energy consumption in the sector E_i = final energy consumption in subsector i Q = total activity level of the sector (value added, population, passenger-km, ton-km for industry, agriculture, and services; residential; passenger travel; and freight transport, respectively) Q_i = activity level of subsector i S_i = activity share of subsector i (= Q_i/Q) I = aggregate energy intensity (= E/Q) I_i = energy intensity of subsector i (= E_i/Q_i) Based on the data for year t–1 and year t, the decomposition formulae are given by: $D_{act} = \exp\left(\sum_i \widetilde{w}_i \ln\left(\frac{Q^t}{Q^{t-1}}\right)\right)$ $D_{str} = \exp\left(\sum_i \widetilde{w}_i \ln\left(\frac{S_i^t}{S_i^{t-1}}\right)\right)$ $D_{eff} = \exp\left(\sum_i \widetilde{w}_i \ln\left(\frac{I_i^t}{I_i^{t-1}}\right)\right)$ $\widetilde{w}_i = \sum_i \frac{(E_i^t - E_i^{t-1})/(\ln E_i^t - \ln E_i^{t-1})}{(E^t - E^{t-1})/(\ln E^t - \ln E^{t-1})}$ The activity, structure, and intensity decomposition indexes, setting a certain year as the baseline year (for example, 2010), are derived by calculating the product of the index of each category in previous years as of 2010. Composite economywide decomposition index The LMDI chaining analysis was carried out by decomposing by factor then aggregating by sector. Two independent index decomposition analysis results for the residential, transport, and other sectors (agriculture, industry, and services) were then aggregated to derive the economywide decomposition index: $(D_{eff})_{e-w} = \exp\left(\sum_j \widetilde{w}_j \ln(D_{eff})_j\right)$ Where subscript j denotes the sectors to be aggregated, and D_{eff} results from the formula above. *Data sources:* Energy balances from IEA and value added from WDI, supplemented by UNSD for countries not covered by IEA or WDI, UN Population Division, and IEA's Mobility Model.

Avoided energy demand (EJ)	$\Delta E = \sum_i \overline{w} \ln\left(\frac{I_i^T}{I_i^0}\right)$ where $\overline{w} = \frac{(E_i^T - E_i^0)}{(\ln E_i^T - \ln E_i^0)}$ ΔE= avoided energy demand, or energy savings between two years I_i^T = energy intensity in year T in subsector i Avoided energy demand (or energy saved) was calculated year-to-year (that is, 2012–13 and 2013–14) using two approaches: (a) bottom-up, based on sector energy intensities, and (b) top-down, based on country-level energy intensity. Thus, for example, avoided energy at country level in 2013 was calculated as: Avoided energy in 2013 = $(E^{2013} - E^{2012})/(\ln E^{2013} - \ln E^{2012}) * (\ln I^{2013} - \ln I^{2012})$ where E^{2012}, E^{2013} = total final energy consumption in years 2012 and 2013 I^{2012}, I^{2013} = aggregate energy intensity in years 2012 and 2013 A negative value means a reduced energy use due to energy intensity reduction. *Data sources:* Energy balances from IEA and value added and GDP from WDI, supplemented by UNSD for countries not covered by IEA or WDI, UN Population Division, and IEA's Mobility Model.
Thermal efficiency of power generation (%)	$Efficiency_f = \frac{Output_f}{Input_f}$ (%) where $Efficiency_f$ = thermal efficiency of power generation with fuel f in main activity producer electricity plants $Output_f$ = power output with fuel f in main activity producer electricity plants $Input_f$ = energy input of fuel f in main activity producer electricity plants *Data source:* Energy balances from IEA.
Power transmission and distribution (T&D) losses (%)	$Power\ T\&D\ losses = \frac{Electricity\ losses}{(Electricity\ output\ main + Electricity\ output\ CHP + Electricity\ imports)}$ (%) where Electricity losses = electricity transmission and distribution losses Electricity output main = electricity output from main activity producer electricity plants Electricity output CHP = electricity output from combined heat and power plants *Data source:* Energy balances from IEA.
Natural gas T&D losses (%)	$Gas\ T\&D\ losses = \frac{Natural\ gas\ losses}{Natural\ gas\ supply}$ (%) *Data source:* Energy balances from IEA.

NOTES

1. Primary energy intensity is the ratio of total primary energy supply (TPES) to gross domestic product (GDP), measured at purchasing power parity (PPP) in constant 2011 U.S. dollars.
2. Avoided energy is calculated using 2012 and 2013 as base years (annex 4.1).
3. The *Global Tracking Framework (GTF)* uses energy intensity as an imperfect proxy indicator to measure energy efficiency improvements. For a discussion on the limitations of this indicator, please see previous *GTF* editions (World Bank and IEA 2013; 2015).
4. Revisions of underlying statistical data and methodological improvements explain the slight changes in historical growth rates from previous *GTF* editions. The SEforALL objective of 2.6% improvement in energy intensity in 2010–30 remains the same, however.
5. In 2014, fossil fuels accounted for two-thirds of the electricity generation mix. Coal had the largest share at 40.8%, followed by natural gas at 21.6%. According to IEA projections, the share of fossil fuels decreases to 62% by 2040 in the Current Policies Scenario, and to 52% under the New Policies Scenario, due primarily to the increase in the share of renewable energy generation. Only under the 450 Scenario does this share fall significantly, to 24% (IEA 2016b).
6. This calculation considers main activity producer electricity plants only.
7. Self-use of coal refers to increased energy use to clean the flue gas in coal-fired generation plants (for example, in selective catalytic reduction, fabric filtration, and flue gas desulphurization). In the future, additional efficiency reduction (and increased energy own-use) may result from the adoption of carbon capture and storage technologies.
8. Losses are calculated as a percentage of supply (see annex 4.1).
9. The methodology to calculate gas losses is explained in annex 4.1.
10. Income groups are defined at http://databank.worldbank.org/data/download/site-content/OGHIST.xls.
11. Changes from earlier *GTF* reports are due to revisions in the underlying data and to countries moving between income groups, reflecting changes in their gross national income per capita.
12. In 2014, China accounted for 53% of GDP and 64% of TPES of upper-middle-income economies.
13. The base years for calculating energy savings are 2012 and 2013. Savings were calculated using a top-down approach (for countries and regions), and an approximate bottom-up approach for sector savings, giving similar global savings of 11.83 EJ and 12.04 EJ, respectively (annex 4.1).
14. Savings in this box describe analysis from the IEA's *Energy Efficiency Market Report 2016* and are not comparable to the savings estimate of 12 EJ in this chapter (IEA 2016a). The IEA used 2000 as the base year and savings stem from an in-depth sectoral decomposition, while those in the rest of this chapter have base years of 2012 and 2013 and follow a different methodology (see annex 4.1).
15. See the list of IEA member countries at https://www.iea.org/countries/membercountries/.
16. Because of the lack of end-use data, the analysis could only capture structural changes among industry, agriculture, and services. The results reflect the relatively stable sectoral shares in value added at global level throughout the historical reference period of 1990–2010 and the two tracking periods (2010–12 and 2012–14). Changes in the shares in value added by country income groups, however, have been significant, especially in industry and services, where the long-term declining share of high-income economies has been largely due to the increase in upper-middle-income economies.
17. Detailed analysis of sector structure effects in IEA countries can be found in IEA's *Energy Efficiency Market Reports (2013; 2014a; 2015a; 2016a).*
18. Transport intensities are the result of modeling, based on 5-year intervals, and are thus graphed separately.
19. The following activity drivers were used in each sector: value added (industry, agriculture, services), passenger-km and ton-km (transport), and population (residential). See annex 4.1.
20. The IEA counts investment in energy efficiency as the additional cost of an "energy efficient good" relative to an "average efficiency good." In effect, this efficiency premium is the additional investment required to drive efficiency improvements and subsequent energy savings. The efficiency premium is calculated in different ways for the sectors.
21. See the IEA Policies and Measures database (www.iea.org/policiesand measures) and the World Bank RISE database (rise.worldbank.org).
22. Revisions to TPES and GDP data explain the difference with the intensity reported in *GTF 2015.*
23. The country exceeded the target according to Chinese statistics, achieving an 18.4% reduction in energy intensity in 2011–15. See the Chinese government's "Notice of the State Council on Printing and Distributing the Comprehensive Energy-Saving and Emission-Reduction Work Plan in the 13th Five-Year Plan," published January 2017, at http://www.gov.cn/zhengce/content/2017-01/05/content_5156789.htm.
24. See the EESL website at http://www.eeslindia.org/User_Panel/UserView.aspx?TypeID=1145.
25. Ibid.

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5

RENEWABLE ENERGY

HIGHLIGHTS

- The share of renewable energy in global total final energy consumption (TFEC) increased from 17.91% in 2012 to 18.33% in 2014. This represents an absolute annualized increase in renewable energy consumption of 1.8 exajoules (EJ), equivalent to the annual energy consumption of the Netherlands.
- The progress is equivalent to adding 0.21 percentage points to the renewable energy share in each of the two years, 2013 and 2014, or far below the annually required 0.92 percentage points to meet the Sustainable Energy for All (SEforALL) objective of doubling the share of renewable energy in the global energy mix by 2030.
- The relatively slow pace of increase of the renewable energy share is explained by the fact that while global renewable energy consumption grew at an average annual 2.9% over 2012–14, TFEC also grew at a significant 1.7% annually, holding back the increase of the renewable energy share.
- The growth in renewable energy consumption during 2012–14 came disproportionately from two energy end-use sectors: electricity and transport. By contrast, renewable energy consumption in the heat sector grew at a significantly slower rate. This is a major concern given that heat is the largest of the energy end uses as well as the most challenging to decarbonize.
- Among the different renewable energy technologies, solar photovoltaics (PV) and wind for electricity generation experienced by far the most rapid growth rates, but starting from a very small base. The largest absolute increase in modern renewable energy sources came from hydropower.
- Thirteen of the 20 highest energy-consuming countries improved their share of renewable energy in TFEC. Of these, only in Nigeria was this increase driven by traditional uses of biomass; progress in the other 12 countries was driven by modern renewables. For countries that did not progress over 2012–14, some, like Brazil and Turkey, experienced volatile hydropower production due to climate, while India and Indonesia decreased their traditional uses of biomass—a positive shift despite the downward impact on the share of renewable energy in TFEC.

GLOBAL TRENDS

Progress in renewable energy share in 2012–14

The share of renewable energy in TFEC progressed by an annualized 0.21 percentage points in 2012–14, from 17.91% in 2012 to 18.33% by 2014 (figure 5.1). This represents an absolute annualized increase in consumption of 1.8 EJ per year over 2012–14, equivalent to the annual energy consumption of the Netherlands. A quarter of this progress, or 0.4 EJ per year, is attributed to an increase in traditional uses of solid biomass in developing countries, while the remaining three-quarters, or 1.4 EJ per year, comes from an increase in modern uses of renewable energy, notably hydropower and modern uses of biomass, as well as solar and wind.

Revisions of underlying statistical data series mean that the values of the indicator for the entire period for which we show data (that is, since 1990) changed slightly relative to earlier *Global Tracking Framework* (*GTF*) reports, and based on the latest data the renewable energy share in 2010 stood at 17.51%. This slight downward revision of the base year indicator for 2010 means that the doubling objective by 2030 could now effectively become 35%, instead of the 36% reported in the first edition of this report. However, to maintain consistency with the SEforALL published objective, we keep to the original value of 36%, as this difference affects the overall analysis in only marginal ways.

In 2014, solid biomass used for traditional ways of cooking and heating in developing countries accounted for 8.4% of global TFEC, or 30.4 EJ, while modern forms of renewable energy accounted for 9.9% of global TFEC, or 35.6 EJ. (For uncertainties surrounding the amount of energy consumed in traditional uses of biomass, see box 5.1.) Among modern forms of renewable energy, the largest was solid biomass for modern uses at 15.2 EJ in 2014, followed by hydropower (11.7 EJ), liquid biofuels (3.2 EJ), wind (2.2 EJ), and solar (1.8 EJ). Contributions of geothermal and other types of renewable energy (such as biogas and marine) were small, at 0.6 EJ and 1.0 EJ respectively.

How did the different renewable energy technologies contribute to the overall annualized increase of 0.21 percentage points in 2012–14 (figure 5.2)? The share of traditional uses of biomass is in long-term structural decline, as developing countries modernize their economies and replace solid biomass products with fossil fuels. During 2012–14, both traditional and modern uses of solid biomass fell as a share of TFEC, meaning that their absolute growth rate was slower than that of global TFEC. This decline was more than offset by increases in other forms of renewable energy, notably wind and solar, which each increased their share by about 0.08 percentage points per year of TFEC, as well as hydro and liquid biofuels, which each increased their share by about 0.04 percentage points of TFEC per year.

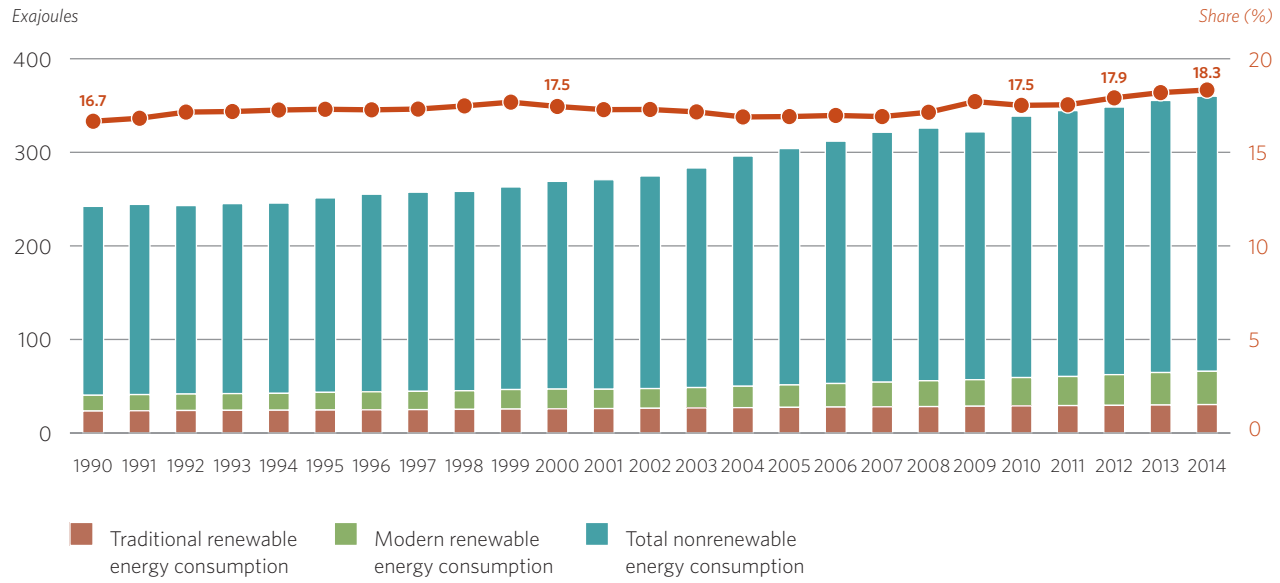
Excluding traditional uses of solid biomass, hydropower, solar, and wind energy made the fastest progress in 2012–14—that is, these technologies contributed disproportionately to the increment in renewable energy consumption in 2012–14 relative to their shares of total renewable consumption in 2012. Renewable energy consumption from solar surged by over 50% from the 2012 total, while wind consumption increased by 37%. These dramatic increases took place from a low base, however, and therefore their contribution to overall renewable energy consumption remains, for the moment, very small (see figure 5.2).

In absolute terms, renewable energy consumption increased in 2012–14 for all the major end uses of energy: electricity, transport, and heat (including heat for cooking). Renewable electricity accounted for 49% of the 2012–14 increase, followed by heat at 42%, and transport at 9%.

Heat is by far the largest end use of energy, representing some 55% of global energy consumption. By 2014, it had already reached a relatively high renewable energy share of 26.3%, owing to a considerable contribution from solid biomass, particularly in developing countries (figure 5.3). However, this renewable share for heat has hardly increased during the past decade, partly because of the lack of incentives for the residential sector to switch to renewable forms of heating and cooling, such as bioenergy, solar, or geothermal. More fundamentally,

FIGURE 5.1 The global renewable energy share continued to increase steadily

Renewable energy share in total final energy consumption, 1990–2014



Source: International Energy Agency (IEA) and United Nations Statistics Division (UNSD) data.

Box 5.1

Uncertainties in data on traditional uses of biomass and their impact on the doubling objective

Consumption of biomass represents by far the largest share in renewable energy consumption (see figure 5.2). According to the data used in this report—a combination of IEA and UNSD datasets—some 30.4 EJ of this consumption occurred in the residential sector of developing countries. But owing to the lack of reliable data on that sector's consumption, the IEA—like this publication—assumes these uses to be mostly inefficient and therefore considers them traditional.

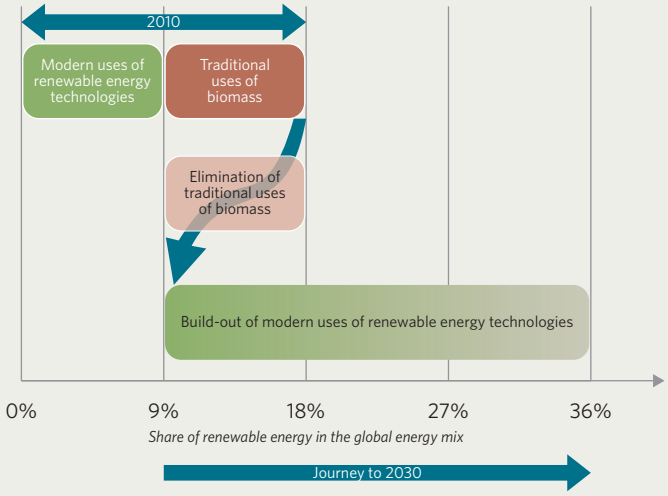
There is considerable uncertainty around this number, however, because of the challenges of collecting accurate data. The first difficulty is that household surveys report on the type of primary fuels used by households, but they do not provide volumes or quantities of fuels used, nor do they provide information on the energy content of these fuels. The second is that fuel supply for households is often informal and therefore is not subject to any financial transaction that could provide an alternative basis for accounting, such as by looking at sales data.

Alternative estimates for traditional uses of biomass can be produced based on a dataset from the Food and Agriculture Organization of the United Nations (FAO). The FAO publishes fuelwood data informed by the modeling of Whiteman, Broadhead, and Bahdon (2002). Fuelwood data are available for the residential sector, and, after standard heating values published by the IEA are applied, the results suggest that the energy of fuelwood used in traditional ways stands at some 13.5 EJ, less than half the number estimated based on IEA and UNSD statistical datasets. This figure does not include crop residues and animal dung, which are also used in some countries' households, but they are not large enough to account for the 17 EJ difference between the FAO and IEA/UNSD datasets (30.4 EJ less 13.5 EJ). This discrepancy suggests that traditional biomass use may be up to 50% lower than the 30.4 EJ reported by this publication.

Although traditional uses account for 8.4% of global TFEC (according to IEA and UNSD data), the useful energy service they provide is much lower. Based on IEA (2014), useful heat from solid biomass delivered to developing countries' households ranges from 3 EJ to 6 EJ (assuming that the 30.4 EJ of biomass used in traditional ways is consumed at efficiencies of 10–20%), and therefore could be replaced by 6–12 EJ of efficient—though not necessarily renewable—fuels like biogas, ethanol, or liquefied petroleum gas, assuming 50% efficiency of conversion from these fuels to heat.

The practical implications of this analysis are twofold. Uncertainties now surround the real figure for the global renewable energy share, with major impacts for calculating the doubling objective for the renewable share in global TFEC by 2030. Furthermore, universal access to clean fuels and technologies for cooking would eliminate traditional uses of biomass and therefore would decrease the current share of renewables to only 9.9%—thereby transforming the challenge of "doubling" the renewable energy share to, in effect, almost quadrupling that share, in order to achieve the original doubling objective (box figure 1). These effects highlight the importance of improving measuring and accounting methods for solid biomass uses.

BOX FIGURE 1. Achieving universal access to clean fuels and technologies increases the challenge of "doubling" the share of renewables



Source: World Bank.

Source: Authors; International Renewable Energy Agency (IRENA) calculations based on FAO dataset; Whiteman, Broadhead, and Bahdon 2002.

this lack of improvement reflects technical challenges of deploying renewable technologies in applications requiring very high heating temperatures.

By contrast, the electricity sector, which started from a lower renewable energy share, has shown steep growth during the last decade, reaching 22.3% in 2014, reflecting major technological advances in renewable power generation and concerted efforts by policymakers to provide incentives for new buildout.

In transport, renewable energy has come from almost nowhere in 1990 to reach a penetration rate of 2.8% in 2014. Continued progress of advanced biofuels, which do not compete with food for their feedstock, is promising for further growth of this sector (box 5.2).

Forward look: Comparison to objectives

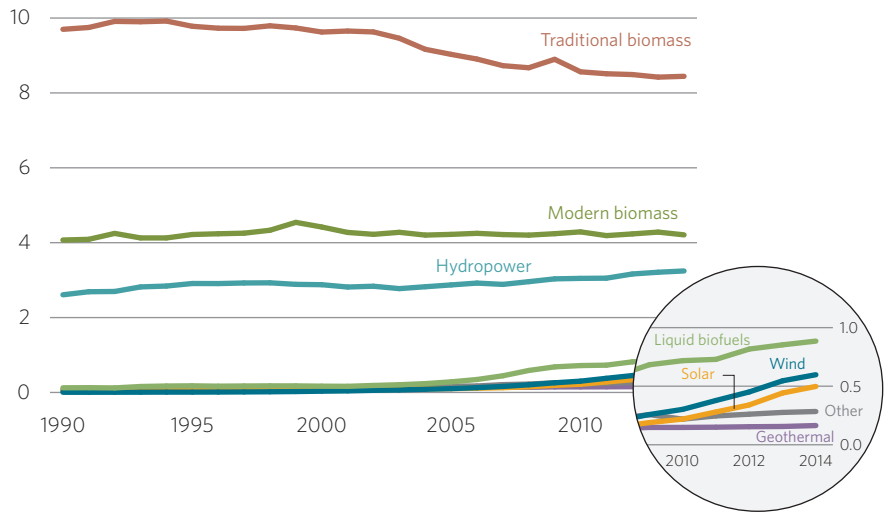
The latest progress of renewable energy share in TFEC, averaging 0.21 percentage points annually over 2012–14, is well below the annual average increase of 1.10 percentage points now necessary to achieve the SEforALL doubling objective by 2030 (figure 5.4). The annual increase needed to achieve the objective rose from 0.92 percentage points each year to this new level due to the slow rate of progress in the renewable energy share since 2010. This number will keep increasing with every year in which progress stays below the current target annual growth rate of 1.10 percentage points.

The increase of the renewable energy share is the outcome of a race between the growth rates of renewable energy consumption and of TFEC. During the latest tracking period, renewable energy consumption grew by an annual average 2.9%, somewhat ahead of TFEC growth of 1.7%. Since 2010, we observe a slight decoupling of the two rates (figure 5.5), but it is still not strong enough to put the renewable energy share on a trajectory to double its 2010 level by 2030.

Modern renewable energy uses reached an average annual growth of 4.2% in 2012–14, the same as for the 2010–12 tracking period. A worrying development is that traditional uses of biomass still continue to grow in absolute terms, and at an accelerating rate, up from 1.0% 2010–12 to 1.4% in 2012–14. Still, this rate was below TFEC growth, so its share continued falling (see figure 5.2). However, the global estimate of traditional uses of biomass is highly

FIGURE 5.2 "New" renewables like solar and wind are increasing fast but from a low base

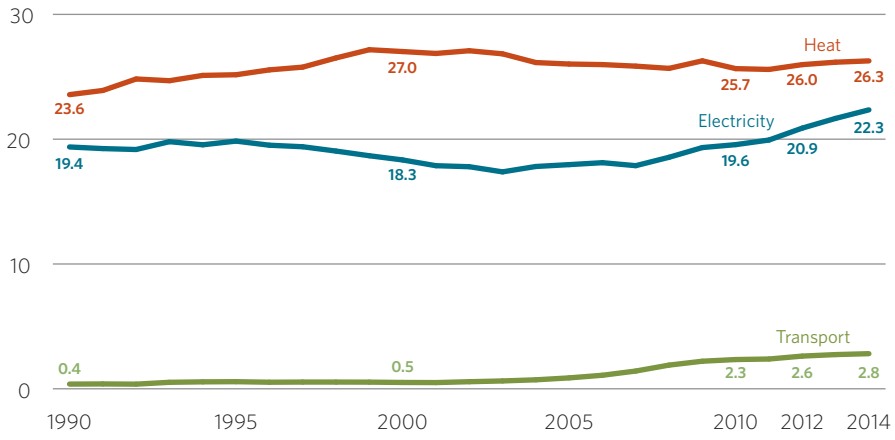
Share in total final energy consumption, 1990–2014 (%)



Source: IEA and UNSD data.

FIGURE 5.3 The share of renewable energy in electricity and transport uses is ramping up, but more efforts are needed on renewable energy in the heat sector

Share in renewable energy use, 1990–2014 (%)



Source: IEA and UNSD data.

uncertain (see box 5.1) and the growth rates reported above are affected by the same uncertainty that surrounds the overall measure.

While we observe a steady progress in renewable energy deployment, long-term scenarios suggest that we are not on a trajectory for doubling of renewable energy share in global TFEC. According to the New Policies Scenario of the *World Energy Outlook* (IEA 2016c), which incorporates existing energy policies and assesses the results likely to stem from the implementation of announced intentions like the climate pledges submitted for the 2015 Paris Climate Conference (COP21), these policies will result in a renewable energy share of only 21% in 2030, still well below the 36% objective. This is consistent with IRENA's REmap analysis in which the Reference Case, representing countries' national energy plans and goals for the period 2010–30, leads to a renewable energy share of 21% in 2030. In fact, even much more ambitious scenarios like the 450 Scenario of the World Energy Outlook (IEA 2016c), which demonstrates a pathway to limit long-term global warming to 2°C above pre-industrial levels, does not achieve a renewable energy share of 36% by 2030, though this 450 Scenario does see the target achieved by 2040. (More details on prospects for achieving SEforALL objectives are in chapter 6, "Future Prospects.")

PROGRESS BY COUNTRY GROUPS

Income groups

Middle-income countries still represented around two-thirds of global renewable energy consumption in 2014, largely because they have yet to complete the transition from traditional biomass (figure 5.6). High- and low-income countries have slowly increased their share, though for very different reasons: mainly strong renewable energy policies for high-income countries, and greater reliance on traditional biomass uses for low-income countries.

High-impact countries

Achieving SEforALL objectives depends critically on the performance of the 20 largest energy-consuming economies, which together account for about three-quarters of global TFEC. These are described as "high-impact" countries because their performance in renewable energy has a high impact on the performance of the world as a whole. Among this group of 20 countries, the largest absolute renewable energy consumption is taking place in China, India, and the United States of America (as conveyed by the area of their rectangles in figure 5.7). The absolute renewable energy consumption of middle-income countries in this group exceeds that of the high-income countries.

Of the 20 largest energy-consuming economies, the renewable energy share in TFEC in 2014 exceeded 20% in five countries (Nigeria, Brazil, Indonesia, India, and Canada). In India, Indonesia, and Nigeria, much of the renewable energy share comes from unsustainable traditional uses of biomass. Brazil and Canada's leadership is built on hydropower generation, and Brazil is also an uncontested leader in the use of liquid biofuels. Not far behind, Spain has a diversified renewable energy portfolio, with sizable contributions of hydropower, wind, and several solar and biomass technologies. At the other end of the spectrum, the Russian Federation, the Republic of Korea, the Islamic Republic of Iran, and Saudi Arabia all have less than 5% of renewable energy in their TFEC.

The progress of these 20 high-impact countries in adopting modern uses of renewable energy in the electricity, heat, and transport sectors remains crucial given their large share in global TFEC. Moreover, moving away from traditional uses of biomass for cooking and heating is

Box 5.2

Progress in advanced biofuels for transport

Biofuels are essential for achieving SEforALL objectives and climate goals, as they are the only direct alternative to petroleum products in the transport sector. Advanced biofuels are sustainable fuels produced from diverse feedstocks including agricultural residues associated with food crops, forest residues like sawdust from lumber production, nonfood energy crops like rapidly growing grasses (such as switchgrass and miscanthus), and short rotation tree species like poplar and eucalyptus. Advanced biofuels can also be produced from solid biogenic waste, including biogenic fractions of municipal and industrial waste, and from algae.

Conversion pathways for advanced biofuels are at different stages of technological maturity with opportunities for innovation across all stages. Synergies between conventional and advanced biofuels production also exist, for example by integrating cellulosic ethanol technologies within existing conventional ethanol plants. These advances can greatly reduce infrastructure and logistics costs, can use residue feedstocks from conventional production, and can benefit from existing industry experience.

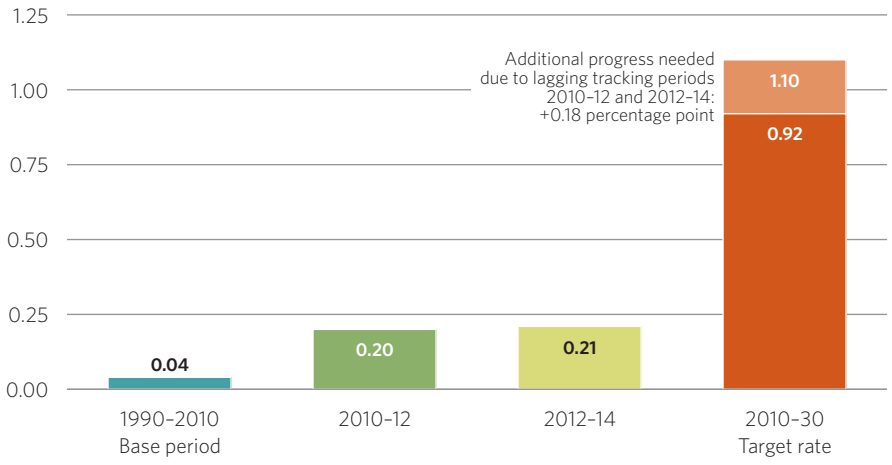
Over 25 commercial and more than 20 demonstration plants are producing about 1 billion liters a year of advanced biofuels globally in the Americas, Europe, Asia, and Oceania, and planned or under-construction plants have the potential to add a further 2 billion liters a year. Yet all this output would still represent only slightly more than 0.1% of global transport's demand for liquid fuels. The pace of advanced biofuels production therefore has to increase exponentially for these fuels to have any real potential of displacing any significant part of petroleum-based transport fuels.

Although policy has shifted to promoting advanced biofuels, most national policies still focus on conventional biofuels. As of end-2015, 66 countries had adopted biofuel mandates at the national or state/provincial level, and only one country (Italy) had adopted an advanced biofuel-blend mandate (REN21 [Renewable Energy Policy Network for the 21st Century] 2016).

Source: IEA 2016a; IRENA 2016c; REN21 2016.

FIGURE 5.4 The scale of the renewable energy challenge increases with every year of insufficient progress

Average annual increase in renewable energy share in total final energy consumption over the base and tracking periods, including increase required to reach the doubling goal by 2030



Source: World Bank calculations based on IEA and UNSD data and SEforALL objective.

crucial for improving the sustainability of renewable energy consumption, particularly in Nigeria, Indonesia, India, and China.

In 2012–14, 13 of these 20 countries improved their share of renewable energy in TFEC (figure 5.8). Progress was driven by modern renewables, except for Nigeria, where traditional uses of biomass continued to grow. Among the countries failing to register progress in 2012–14, some, like Saudi Arabia and the Islamic Republic of Iran, were not active in renewable energy deployment; others, like Brazil and Turkey, saw volatile hydropower production; and still others, like India and Indonesia, decreased their traditional uses of biomass (overall a positive development despite the negative impact on the share of renewables in TFEC). China's increased renewable energy share is noteworthy as it occurred despite a significant decrease in reliance on traditional uses of biomass and is attributable to a more than offsetting increase in modern renewables.

Fast-moving countries

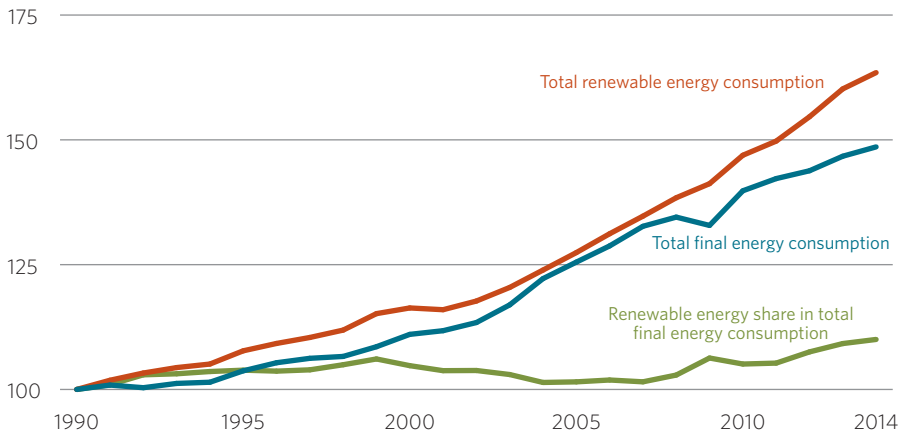
The fast-moving countries are those that are making the fastest progress in 2012–14, measured either by absolute net additions to a country's renewable energy consumption, which tends to favor the larger countries, or renewable energy growth as a percentage of a country's TFEC, which tends to favor countries starting from a low base.

In 2012–14, the 20 fast-moving countries in absolute terms advanced global renewable energy consumption by 1.5 EJ a year. China led by far, adding an annualized 0.5 EJ, driven by hydropower, solar, and wind generation (figure 5.9). The United States of America followed, with an annual 0.2 EJ, despite a decrease in hydropower generation during the tracking period. The remaining 18 countries together added an annual 0.7 EJ to the global renewable energy consumption.

Nineteen of the 20 fast-moving countries in percentage terms were smaller economies (except Italy), of great geographical diversity, with all continents represented (figure 5.10). The rapid percentage increase of renewable energy consumption in Bosnia and Herzegovina was driven by a sharp increase in consumption of solid biomass in the residential sector, which likely consists of inefficient traditional uses. Significant percentage increases in modern renewable energy shares in Uruguay and Gabon were led by increased biomass use in industry, and in Uruguay by increased hydropower generation (owing to abundant rainfall during this time period). The increase in Kyrgyzstan was also driven by increased hydropower generation.

FIGURE 5.5 Since 2010, global renewable energy consumption has grown faster than global total final energy consumption

Growth of total final energy consumption and renewable energy consumption, and of renewable energy share indexed to 1990 level, 1990–2014



Source: IEA and UNSD data.

TRACKING OF COMPLEMENTARY INDICATORS

The evolution of the renewable energy sector is particularly dynamic. Data on the renewable energy share reported above are not yet available beyond 2014, but data for the electricity sector points to further, subsequent renewable energy progress not yet captured here. (However, the available data are not able to convey the wider picture for renewables in the larger heat and transport sectors.)

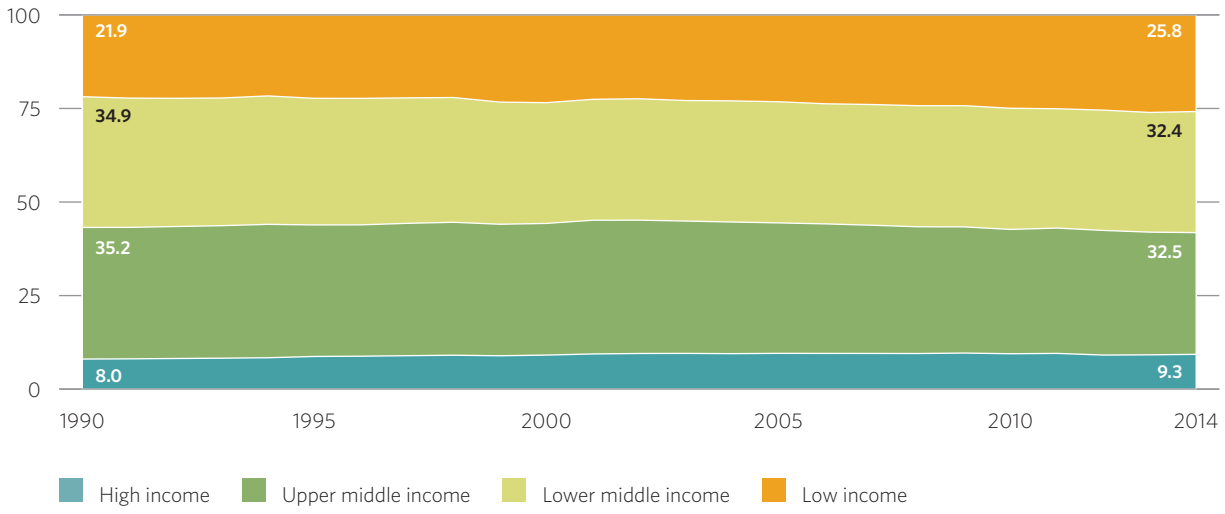
According to IRENA (2016a), global renewable energy installed generation capacity grew by 8.0% annually in 2012–14, reaching 1,808 gigawatts (GW) at end-2014, and accelerated slightly growing by 8.6% in 2015 to 1,965 GW. This is comparable to the IEA (2016a) figure of 1,969 GW of total cumulative renewable energy capacity installed globally at the end of 2015. Based on the dataset compiled from the IEA Data Center and UNSD (figure 5.11), renewable electricity generation reached 5,323 terawatt-hours (TWh) in 2014—22.3% of global power generation—and the IEA (2016a) estimated that renewable generation further increased to 5,660 TWh in 2015.

According to the IEA (2016a), annual renewable electricity capacity growth in 2015 reached an all-time high of 153 GW, with record additions in onshore wind (63 GW) and solar PV (49 GW), together accounting for more than the total cumulative installed power capacity of Canada. For the first time, renewables in 2015 accounted for more than half of net annual additions to power capacity globally, and overtook coal in terms of global cumulative installed capacity.

This record deployment was spurred by further sharp decreases in renewable energy costs, in particular of solar PV and wind, fueling the virtuous circle of wider deployment bringing new cost reductions that in turn encourage further deployment, as well as by policy shifts geared toward smoother deployment of these technologies (box 5.3). The period 2012–14 saw the first successes of large-scale renewable energy procurement using auctions that further continued and spread significantly in 2015 and 2016, bringing record-low prices for solar PV and wind and confirming the competitiveness of renewables with conventional alternatives in several parts of the world. Auction results suggest that new onshore wind projects could be built in 2016 in a number of countries for $60–80/megawatt-hour (MWh), while new PV projects could be built at $60–100/MWh, with the best case for wind and solar PV at around $40/MWh contracted in 2016 for

FIGURE 5.6 Middle-income countries account for some two-thirds of renewable energy consumption globally

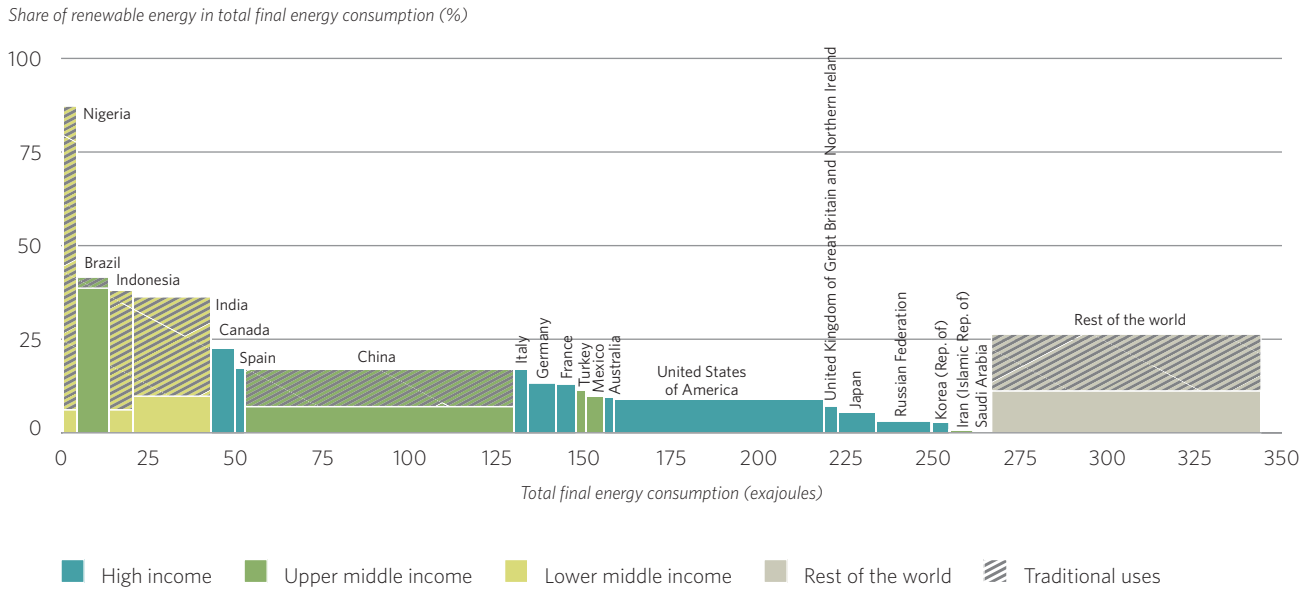
Share of income groups in global renewable energy consumption, 1990–2014 (%)



Source: GTF based on IEA and UNSD data.

FIGURE 5.7 High-impact countries already consume a great deal of renewable energy, but a significant part is still in traditional uses of biomass

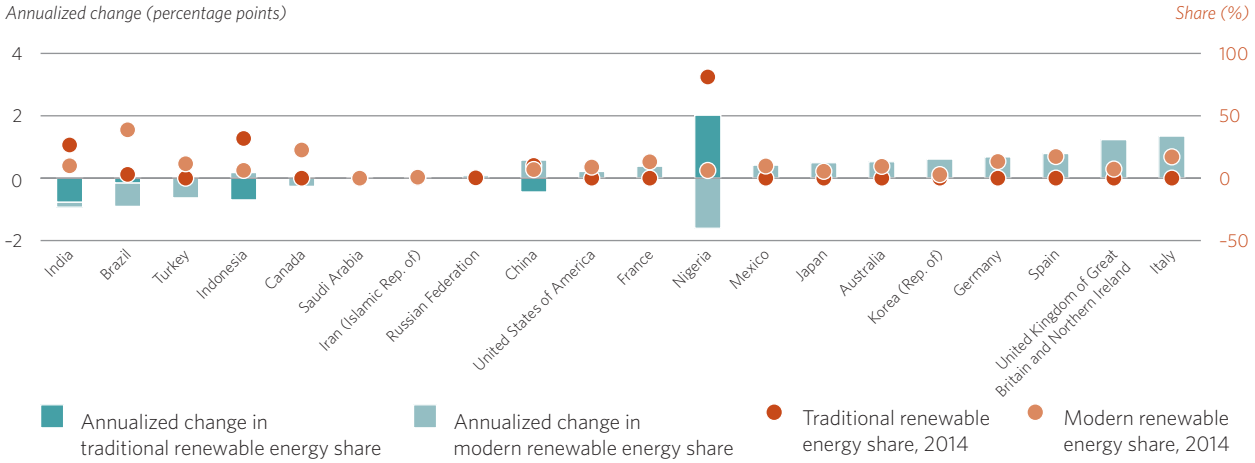
20 largest energy-consuming economies: Share of renewable energy consumption, 2014



Source: IEA and UNSD data.

FIGURE 5.8 Majority of high-impact countries improved their share of renewable energy in total final energy consumption in 2012–14

20 largest energy-consuming economies, 2012–14



Source: IEA and UNSD data.

Note: Country income classification corresponds to that in effect in 2014.

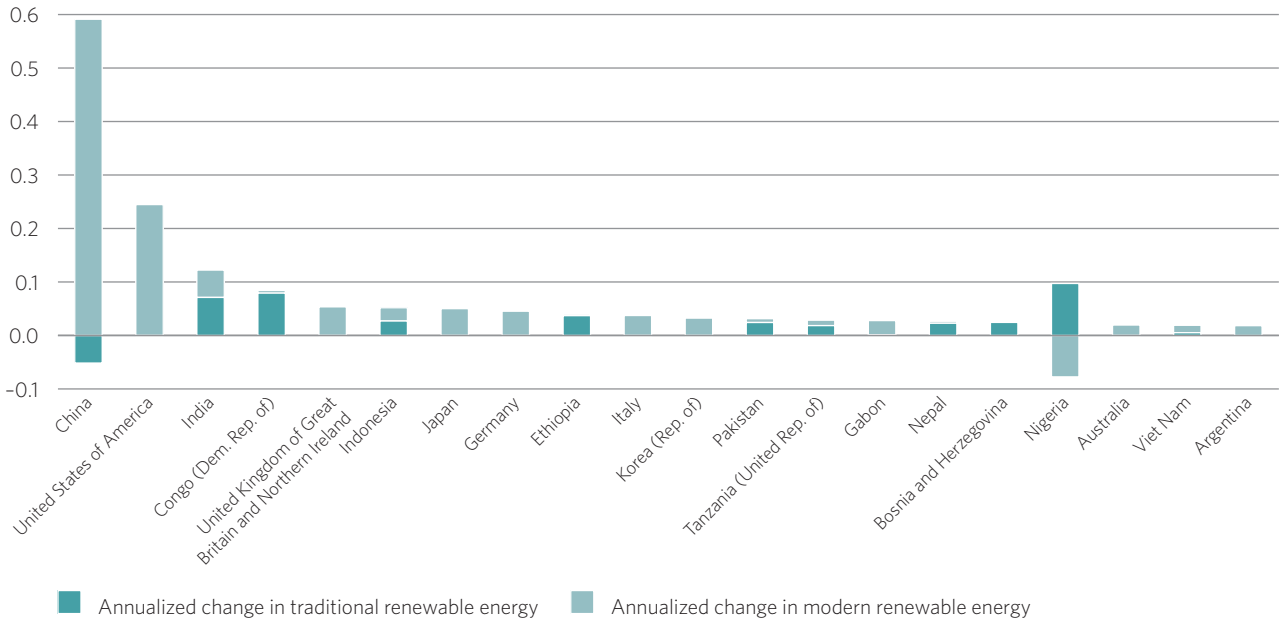
delivery in 2017 and 2018 (IEA 2016a; Dobrotkova, Audinet, and Sargsyan 2017).

With the right regulatory and policy frameworks, further cost reductions for wind and solar, including offshore wind and concentrated solar power, are expected as deployment continues to scale up. IRENA (2016b) expects that by 2025 the global weighted average levelized cost of electricity of solar PV could fall by as much as 59% from 2015 levels, that of concentrated solar power by 43%, and onshore and offshore wind by 26% and 35%, respectively. Cost reductions are expected to be driven by increasing economies of scale, more competitive supply chains, and technology improvements that should raise capacity factors and reduce installed costs—all against a backdrop of increasing competitive pressures that are expected to drive further innovation.

Investments in renewable energy, excluding large hydropower (more than 50 MW), made good progress in 2013–14 (Frankfurt School–UNEP Centre and BNEF 2016), rising from 2012's $257.3 billion to $273.0 billion in 2014 and a record $285.9 billion in 2015. This record happened in a year in which prices of all fossil fuel commodities plummeted; at the same time, it was accompanied

FIGURE 5.9 Some of the world's largest energy consumers added the most renewable energy consumption

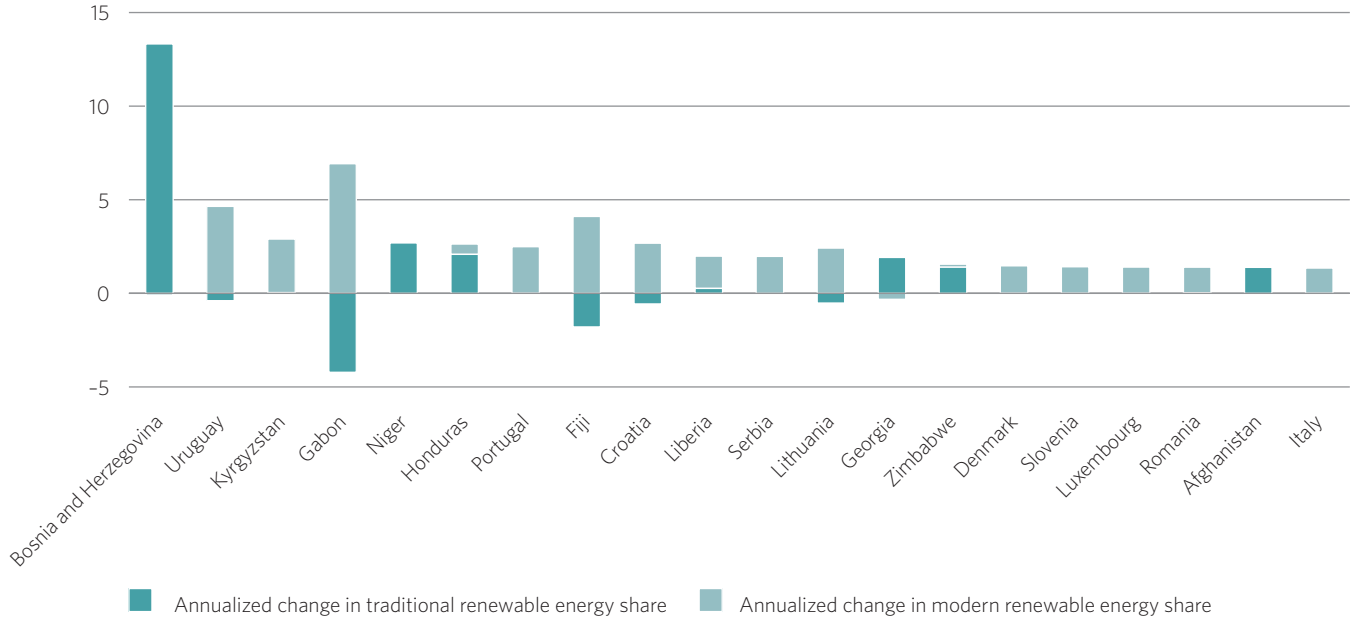
Annualized absolute growth of renewable energy consumption in the 20 fast-moving countries, 2012–14 (exajoules)



Source: IEA and UNSD data.

FIGURE 5.10 The fastest percentage growth in renewable energy consumption was in countries starting from a small base

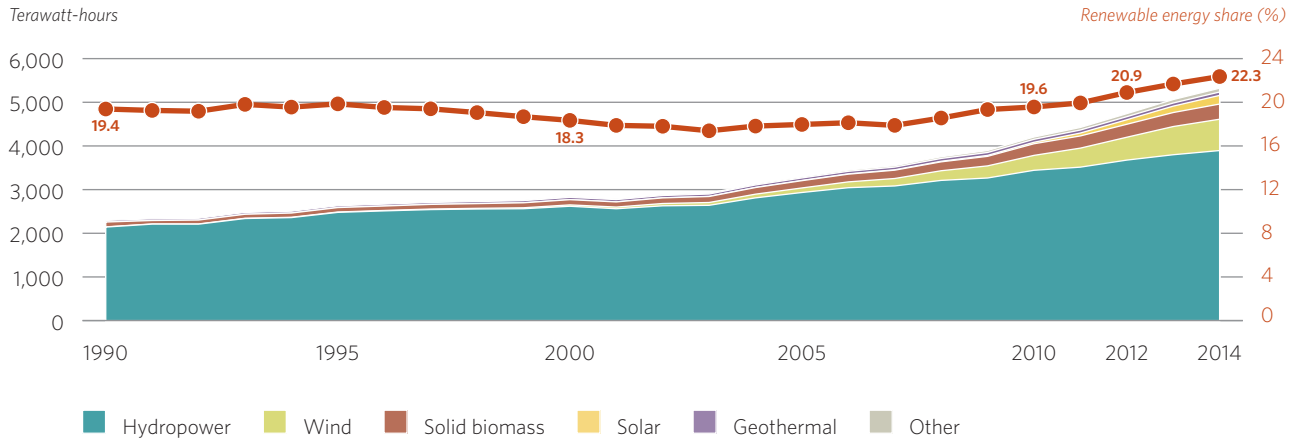
Annualized change in renewable energy share in the 20 fast-moving countries, 2012–14 (percentage points)



Source: IEA and UNSD data.

FIGURE 5.11 Solar, wind, and hydropower generation also have been increasing rapidly in the last decade

Renewable electricity generation by technology, 1990–2014



Source: IEA and UNSD data.

Box 5.3

Recent changes to renewable energy policies

As of end-2015, at least 173 countries had renewable energy targets, and at least 146 had renewable energy support policies at the national or state/provincial level (REN21 2016). While policy design has evolved to continuously encourage the rapid deployment of renewable electricity, equal attention to renewable heat and transport has been lacking.

The most significant policy development over the last few years has been the shift from government set feed-in tariffs (FITs) to competitive auctions with long-term power purchase agreements (PPAs) to determine remuneration for utility-scale renewable power. FIT policies have improved the economic attractiveness of some renewables compared with conventional technologies—driving their initial deployment, technology innovation, and cost reductions, especially for onshore wind and solar PV. But government-set FITs without volume control measures have, in some countries, failed to capture faster-than-expected technology cost reductions and resulted in costly deployment. Although some renewable technologies (onshore wind and solar PV) no longer need high direct financial incentives to attract new investment, they still require a market framework that ensures long-term revenue certainty. Competitive auctions with PPAs have emerged as the policy option that balances the needs of the investor, by providing a long-term remuneration, and the government, by using a competitive price-setting mechanism to control support costs.

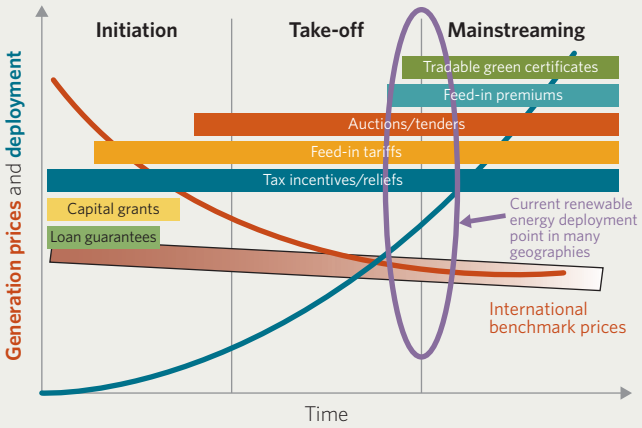
In 2015 alone, 64 countries held auctions for renewable power (REN21 2016). By 2016, record-low prices were observed in winning bids for solar PV in the United Arab Emirates and Zambia (Dobrotkova, Audinet, and Sargsyan 2017), onshore wind in Morocco, and offshore wind in the Netherlands. Several technology-neutral auctions delivered winning solar PV and onshore wind bets at record-low prices, particularly in Latin America.

The prices achieved through auctions in some markets suggest that the levelized cost of energy for some renewable energy technologies (mostly for onshore wind and solar PV) have become comparable to fossil fuel alternatives in some geographies (box figure 1). But this comparable cost does not directly imply that these technologies are fully competitive. Competitiveness assessments should also consider the time and location of generation and grid-integration costs. Such elements address the "system value" of electricity and are being considered in the next generation of policy designs intended to help integrate variable renewables (IEA 2016d, World Bank 2017).

Meanwhile, policy developments in the heat and transport sectors continue to be insufficient to stimulate rapid deployment of renewable technologies in the face of lower fossil fuel prices. Renewable heat markets are localized and complex, and face multiple economic and non-economic barriers that require targeted policy support. For transport, support policies have focused mainly on biofuels (REN21 2016) though electric vehicles are receiving increased attention, as demonstrated by their rapid deployment in recent years.

BOX FIGURE 1 Renewables have become mainstream in many geographies

Policy support mechanisms at different phases of deployment journey



Source: IEA 2015.

Source: IEA 2015; IEA 2016d; REN21 2016; World Bank 2017; Dobrotkova, Audinet, and Sargsyan 2017.

by the aforementioned record amount of new renewable energy capacity added and the record relative importance of developing countries in this growth. Figures from IEA (2016b) show total renewable energy investments in 2015 at $315 billion, of which $288 billion was invested in the power sector, with the rest in renewable energy heat and transport (that is, solar thermal heating installations and liquid biofuels). Against 2011, although 2015's inflation-adjusted renewable energy investments stayed essentially unchanged, cost declines meant that that year's investments produced 40% more renewable energy capacity and 33% more renewable energy power generation than in 2011 (IEA 2016b).

The sharp increase in renewable energy generation capacity and the other investments have created many jobs in the renewable energy industry. According to IRENA (2013; 2015), in 2012–14 the number of direct and indirect jobs in renewable energy, excluding large hydropower, increased from an estimated 5.7 million to 7.7 million, spurred by the rapid growth of solar power and the geographic expansion of renewable energy to more developing countries. In 2015, against the backdrop of overall depressed energy sector employment, the number of renewable energy industry jobs increased further to more than 8 million, with an additional 1.3 million estimated to be directly employed in large hydropower (IRENA 2016d).

Solar PV was the largest renewable energy employer in 2015 with 2.8 million jobs globally, up by 11% from 2014. Bioenergy remained a key employer, with biomass accounting for 822,000 jobs globally, biogas 382,000 jobs, and liquid biofuels 1.7 million jobs in 2015—a 6% decline from 2014, owing to mechanization in some countries and low biofuel production in others. Additionally, IRENA (2016d) research indicates that renewable energy employment displays more gender parity than the broader energy sector.

ANNEX 5.1 DEFINITIONS AND METHODOLOGY

Global Tracking Framework 2017 *Renewable Energy Definitions*

Total final energy consumption (TFEC) (in terajoules [TJ])	Total final consumption of all energy sources excluding nonenergy uses of fuels
Renewable energy consumption (in TJ)	Final consumption of all renewable energy technologies: hydro, solid biomass, wind, solar, liquid biofuels, biogas, geothermal, marine, and renewable wastes.
Wind energy consumption (in TJ)	Final consumption of wind energy.
Hydro energy consumption (in TJ)	Final consumption of hydro energy.
Solar energy consumption (in TJ)	Final consumption of solar energy, including solar photovoltaic (PV) and solar thermal (electricity and heat).
Geothermal energy consumption (in TJ)	Final consumption of geothermal energy (electricity and heat).
Liquid biofuels consumption (in TJ)	Final consumption of liquid biofuels, including biogasoline, biodiesels, and other liquid biofuels.
Biogas consumption (in TJ)	Final consumption of biogas.
Renewable waste energy consumption (in TJ)	Final consumption of renewable municipal waste.
Marine energy consumption (in TJ)	Final consumption of marine energy.
Modern biomass consumption (in TJ)	Final consumption of modern biomass. Modern biomass is defined as all uses of solid biomass not considered traditional (for example, consumption of wood pellets in efficient stove, biofuels or biogas consumption).
Traditional consumption/use of biomass (in TJ)	Final consumption of traditional uses of biomass. Biomass uses are considered traditional when biomass is consumed in the residential sector in non–Organisation for Economic Co-operation and Development (OECD) countries. It includes the following categories in International Energy Agency statistics: primary solid biomass, charcoal and nonspecified primary biomass, and waste. Note: This is a convention, and traditional consumption/use of biomass is estimated rather than measured directly.
Modern renewable energy consumption (in TJ)	Total renewable energy consumption minus traditional consumption/use of biomass.

Methodology

In the *Global Tracking Framework 2013* (*GTF 2013*), it was decided that the monitoring of renewable energy for global tracking purposes should occur as close as possible to the final energy use to remove the influence of the assumptions on the primary energy equivalent for noncombustible sources. This approach corresponds to accounting for renewable energy at the final energy consumption level of the energy balance. The indicator chosen and the methodology developed to calculate it are described below. International Energy Agency statistical data and United Nations Statistics Division data serve as the underlying data used to calculate the indicator. The full methodology—outlined step by step, flow by flow—is explained in *GTF 2015*. A brief overview of the calculations now follows.

Calculating the renewable energy share indicator

The indicator used in this report to track renewable energy within an energy system is the share of renewable energy in TFEC and is expressed as a percentage ($\%REN_{TFEC}$).

This share is calculated as the ratio of final energy consumption of renewables after allocation ($AFEC_{REN}$) to TFEC, calculated from the flows in the energy balances.

The denominator (TFEC) is calculated as the sum of total final consumption minus nonenergy use for all energy sources, or equally, the sum of the energy consumed in the industry, transport, and other sectors. The numerator ($AFEC_{REN}$), by contrast, is not a direct summation of the underlying raw data but a series of calculations reflecting the fact that monitoring occurs at the final energy level. At this level in the energy balance, electricity and heat are secondary energy obtained by different primary energy sources, of which some are renewable. Assumptions need to be made in order to fully account for the renewable component of such secondary sources. It was decided to allocate the final consumption of electricity and heat to renewables based on the share of renewables in gross production.

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6

FUTURE PROSPECTS

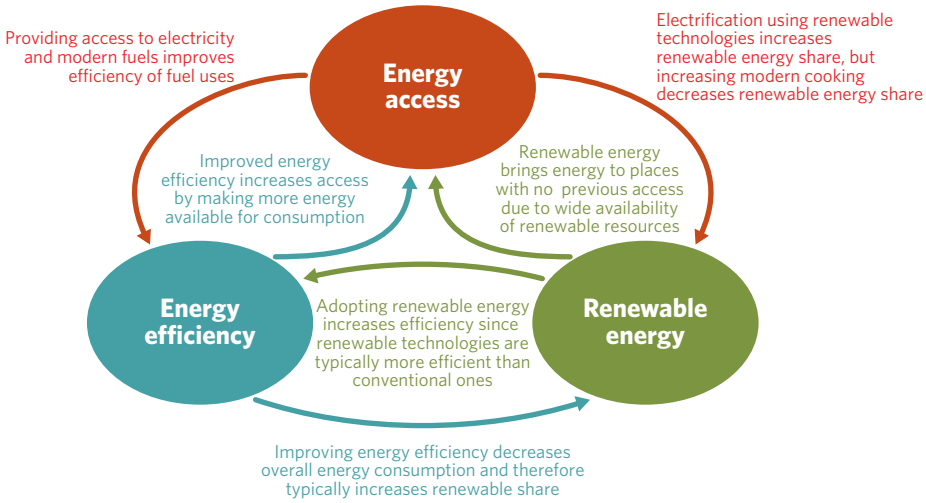
HIGHLIGHTS

- The three pillars of Sustainable Energy for All (SEforALL)—energy access, energy efficiency, and renewable energy—are tied together, which means that falling behind on the objective for one pillar can drag down progress on the others. Even though the global access rate to electricity is improving, the lack of fast progress in access to clean fuels and technologies for cooking ("clean cooking") is holding back both the efficiency of the global energy system and improvements in the sustainability of biomass uses. Similarly, energy efficiency is increasing, but not fast enough to significantly curb the growth of global final energy consumption, keeping the growth of the renewable share in the global energy mix relatively modest.
- The prospects for achieving energy objectives under SEforALL have improved, reflecting declining renewable energy technology costs and political commitments made at the 2015 Paris Climate Conference (COP21). Nevertheless, based on global energy modeling, the world is still not on a trajectory to meet SEforALL's 2030 objectives.
- Global energy scenarios produced by the International Energy Agency (IEA), the World Energy Council, and the International Renewable Energy Agency (IRENA) all suggest that, even with the current levels of policy commitments and likely gains from implementing the announced climate pledges submitted for COP21 and ratified in 2016, the world remains far from the path to achieve the SEforALL objectives by 2030.
- The IEA scenarios suggest that in 2030, more than 780 million people will still be without electricity and 2.3 billion will continue to rely on traditional uses of biomass for cooking. To achieve universal energy access by that target year, annual investments in energy access will need to be around five times higher than recent spending.
- A country-level extrapolation of historic trends—on the basis of statistical models developed by the World Health Organization (WHO) and the World Bank—suggests that among countries that have yet to reach universal access to energy, only 21% are on a trajectory to reach the goal for electricity access and only 15% will reach that for access to clean cooking in 2030.
- On the renewable energy goal, central IEA and IRENA scenarios indicate that current efforts will deliver only a 21% share of renewables in final energy consumption by 2030, and even further efforts along conventional lines will take the rate to only 25–27% at most. Reaching the doubling objective envisaged by SEforALL requires faster adoption of transformational policies, such as a large-scale shift to electrifying transport and some heating applications, and retiring inefficient nonrenewable power plants earlier than currently planned.
- Investments in energy efficiency and renewable energy have climbed to around $250 billion a year each, but this amount still falls well short of the amount needed to achieve SEforALL objectives. For that, IEA and IRENA estimate that investments in energy efficiency need to be, relative to recent spending, three to six times as high, and in renewable energy, two to three times as high.

SYNERGIES AND TRADE-OFFS BETWEEN THE THREE SEforALL OBJECTIVES

The three interlinked pillars of SEforALL present synergies and trade-offs in moving toward the objectives: at times they are mutually supportive, at times they contend with each other (figure 6.1). Increasing energy access does not necessarily help lift the renewable energy share; the latter depends on whether the increase is due to renewable or conventional technologies. Likewise, switching from traditional uses of biomass to modern fuels such as liquefied petroleum gas (LPG) or biogas for cooking and heating simultaneously increases the energy efficiency of these thermal uses of energy, but reduces the overall share of renewable energy. This switch can still be considered positive overall, however, because traditional uses of biomass are inefficient, polluting, and usually unsustainable (see box 5.1 in chapter 5). At the same time, improving global energy efficiency lowers the growth of total energy consumption, allowing—for any given growth rate of renewables consumption—a faster increase in the overall share of renewables in the global energy mix. Finally, adopting renewable technologies (at least those that do not involve combustion) can reinforce the energy efficiency pillar by avoiding the energy losses associated with power generation from thermal fuels.

FIGURE 6.1 Interactions of the three SEforALL pillars



Source: World Bank.

GLOBAL ENERGY MODELING EXERCISES AND PROSPECTS FOR MEETING THE GOALS

The scenarios, forecasts, and other types of global modeling exercises in this chapter consider entire energy systems, the interaction of technologies within those systems, the matching of demand and supply, and the deployment of technologies with realistic economic potential in a given country or sector. Such exercises inherently capture the complex interactions among the three pillars of the SEforALL initiative. By modeling the implications of meeting current policy commitments and ongoing regulatory processes, these exercises provide a sense of where the global energy system is headed. Conversely, models that work backward from a long-term goal provide us with information on the conditions necessary to achieve that goal. Both types of exercises are needed in order to assess the prospects of meeting the SEforALL objectives by 2030.

This chapter covers in detail three sets of 2016 results from global modeling studies performed by the IEA (box 6.1), the World Energy Council (box 6.4), and IRENA (box 6.5). We complement their results with analyses from the World Bank and WHO (box 6.2), and from the International Institute for Applied Systems Analysis (IIASA) (box 6.3), which focus on universal energy access. None of the explicit goals of these modeling exercises exactly matches that of the SEforALL objectives, yet they still inform us of the *types* of actions needed to achieve them.

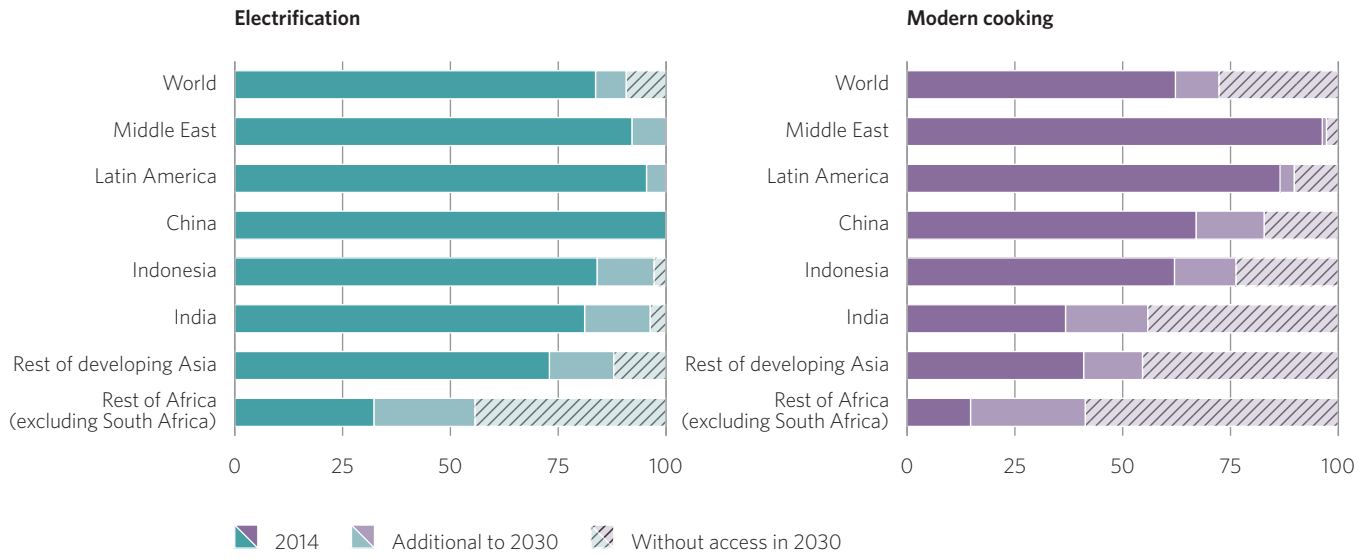
The International Energy Agency's World Energy Outlook

The IEA's latest outlook for access to electricity and clean cooking shows that the world is far from being on track to meeting the SEforALL objective of ensuring universal access to modern energy services by 2030. Under the New Policies Scenario (the central scenario) of the *World Energy Outlook* (*WEO*), from 2014 to 2030 around 1.7 billion people would gain access to electricity and 1.6 billion to modern cooking facilities (figure 6.2). Expanding centralized electricity grids would provide around 60% of the electricity generated for additional access in 2030, but decentralized solutions, particularly from renewables, are critical for providing access in remote rural areas of many countries. The projection for access to modern cooking[1] shows less progress than for access to electricity: of those who gain access, most do so via LPG cookstoves, mainly in urban areas because of the relative ease of establishing fuel supply networks. In rural areas, the most common route to access is improved biomass cookstoves.

Still, around 780 million are projected to remain without electricity in 2030 in this central scenario, and this group is increasingly concentrated in the rest of Africa (that is, excluding North Africa), with around 80% of the estimated total. Some 2.3 billion, spread more evenly across Africa and Asia, continue to rely on traditional uses of biomass for cooking. Even though Asian countries have achieved major progress in providing electricity access, they are projected to have nearly 1.5 billion people without access to modern cooking in 2030.

In this central scenario (box 6.1), the link between global economic growth and energy demand continues to weaken. Improved energy efficiency is playing a vital role in slowing the growth of total final energy consumption to 1.2% on average per year from 2014 to 2030, significantly less than the projected average annual economic growth rate over the same period of 3.1% (2014 $, market exchange rates). This rate of growth is also well below the 1.8% average annual energy growth of the past two and a half decades. At the world level, energy intensity drops significantly by 2030, but still falls short of the SEforALL objective: the target is a 2.1% average annual improvement in 2010–30 (using market exchange terms; 2.6% using purchasing power parity), but the scenario estimates only 1.9% a year in the same period. Although the difference appears small, the extra effort needed is significant and will require stringent energy efficiency measures in all world regions.

FIGURE 6.2 Share of people with access to electricity and modern cooking facilities in the IEA New Policies Scenario



Note: Rest of Africa corresponds to IEA's aggregate of Africa (excluding North Africa).

Source: 2014 data based on IEA energy access database;[2] scenario analysis based on IEA 2016a.

In the New Policies Scenario, the combination of declining costs and supportive policies helps ensure that renewables continue their rapid growth in the power sector. Over the period to 2030, renewables would account for around 60% of total global investment in power generation capacity and overtake coal to become the world's largest source of electricity generation by that year (accounting for one-third of the total electricity generation in 2030). But modern renewables must also permeate other fields of energy use in industry, buildings, and transport where supportive policies are often fewer, costs are sometimes higher, and adoption is generally slower. As a result, modern renewables have yet to achieve deep penetration in transport or heat (the largest of all energy services) by 2030 in the *WEO*'s central scenario, and energy-related greenhouse gas emissions have yet to peak (despite the implementation of global climate pledges made at COP21).

In summary, this central scenario in *WEO 2016* finds that meeting the SEforALL objectives would require more ambitious policy actions on all fronts (table 6.1). The *WEO* has, on several occasions, published scenarios that, by design, achieve universal access to modern energy services, either globally (as in *WEO 2012*, *WEO 2011*, and *WEO 2010*) or for a specific region (India, in *WEO 2015*). Some *WEO* scenarios achieve the SEforALL energy efficiency objectives, such as the Clean Air Scenario in its *Energy and Air Pollution* special report (IEA 2016d), and some achieve a doubling in the share of modern renewables in the global energy mix, but none achieves a doubling of the overall share of renewables in the global energy mix by 2030. As part of the IEA's 2017 *WEO* series, a special focus on energy and development is to be released, including a new scenario and accompanying analysis that achieves universal modern energy access by 2030 (to be published in October 2017).

Energy access projections

Box 6.2 presents basic information on energy access-related databases and models run by the World Bank and WHO. Drawing on extrapolations from the World Bank model, among those 87 countries that have yet to reach universal access to electricity, only 19 are on track to reach full access by 2030. Based on the WHO model, the equivalent figure for the 118 countries that have yet to reach universal access to clean cooking is only 18. Many countries with access deficits may not achieve universal access to electricity or to clean cooking even by 2050 unless their rate of progress improves (figure 6.3). For clean cooking, this indicates the need to expand interventions for transforming the cookstoves and fuels sector to enable widespread access. Based on these simple extrapolations of historical growth rates, the world is on trajectory to 92% electrification by 2030 and 98% only by 2050. Extrapolating the trends to clean cooking fuels and technologies, the world is on trajectory to 63% access by 2030 and 68% by 2050.

On a separate track, IIASA researchers have examined the linkages between universal energy access and climate change goals as well as the investment needs for achieving universal access (box 6.3).

World Energy Council: The Grand Transition

The World Energy Council's three scenarios (box 6.4) indicate that the SEforALL objectives are not likely to be met until 2040–50 and even then are achievable only with strong policy coordination (seen here as the Unfinished Symphony scenario). Universal energy access is met only in the Modern Jazz scenario, as it is one of its goals and it is achieved only by 2060 (table 6.2). The energy efficiency goal is met earlier in this scenario than in the other two goals, but neither scenario reaches the goal before 2040. Figure 6.4 presents details of projected progress on energy efficiency for different regions of the world.

The results of the World Energy Council's analysis show that while energy security is an important underlying driver for clean energy progress, the world needs also the right enabling policies and vibrant technological innovation to deliver on SEforALL objectives. International cooperation, smooth international trade, and a focus on sustainability and climate change mitigation will all help to avoid deadlocks and allow for timely decisions that will speed up the delivery of SEforALL objectives.

Box 6.1

IEA scenarios as published in the *World Energy Outlook*

The IEA's *WEO* scenarios are results from the World Energy Model (IEA 2016c), the principal tool for generating detailed sector and regional projections. This complex simulation model is designed to replicate the functioning of global energy markets, in three main sections:

- Final energy consumption, including residential, services, agriculture, industry, transport, and nonenergy uses.
- Energy transformation, including power and heat generation, refining, and other transformation.
- Fossil fuels and bioenergy supply.

By country/region, outputs from the model include energy flows by fuel, investment needs and costs, carbon dioxide (CO_2) emissions, and end-user pricing. The scenarios are designed to demonstrate the impact of different levels of policy ambition on the evolution of the energy system.

WEO 2016 presents the results of three main scenarios:

- The **New Policies Scenario**—the central scenario—takes into account the policies and implementing measures affecting energy markets that had been adopted as of mid-2016, with relevant policy proposals, even though specific measures to put them into effect had yet to be fully developed. This scenario assumes only cautious implementation of current commitments and plans due to the many institutional, political, and economic obstacles involved, and in some cases to a lack of detail in announced intentions on how thes will be implemented. It includes, for example, the greenhouse gas and energy-related components of the Nationally Determined Contributions pledged under the Paris Agreement (COP21).
- To illustrate the outcome of the world's current course, if unchanged, the **Current Policies Scenario** embodies the effects of only those government policies and measures that had been enacted or adopted by mid-2016.
- The **450 Scenario** sets out an energy pathway consistent with the goal of having around a 50% chance of limiting the global increase in average temperature in 2100 to 2°C above pre-industrial levels, which would require the atmospheric concentration of greenhouse gases to be limited to around 450 parts per million of CO_2 equivalent in the long term.

The *WEO* has published data and analysis on modern energy access for the poor annually since 2002, including databases on electricity access and reliance on traditional uses of biomass for cooking, and an outlook for modern energy access. The projections for electricity access are based on an econometric panel model that regresses historical electrification rates of different countries over many variables, to test their level of significance. Variables determined to be statistically significant and thus included in the equations are gross domestic product (GDP) per capita, population growth, urbanization level, fuel prices, electricity consumption per capita, electrification programs, and technological advances. To estimate the need for additional generation needed, the additional demand from people gaining access is added to the existing residential demand in the World Energy Model and balanced with total electricity generation and generation capacity. The detailed power sector model takes into account losses and own electricity use, and calculates the source of power generation for people gaining access.

For modeling the outlook for access to clean cooking, the World Energy Model takes into account historical trends, which show that economic development and income growth do not automatically lead to a decrease in traditional uses of solid biomass. Reliance on solid biomass rates of different countries is econometrically projected using many variables to assess their level of significance. Variables used include population growth, urbanization level, availability and prices of fuelwood and charcoal, availability and costs of alternative clean fuels and cookstoves, technological advances, and clean cooking programs.

The *WEO*'s 2016 *Energy and Air Pollution* special report presents a Clean Air Scenario that sets a path to achieving universal modern energy access by 2040 in the context of taking stronger specified policy actions to deliver a significant reduction in energy-related air pollution (and the consequent impact on human health).

WEO modeling is further informed by detailed medium-term forecast analyses performed by the IEA for oil, gas, coal, and renewables, and by detailed analysis of energy efficiency markets. For the transport sector, technological performance and some aspects of modeling are informed by analysis in *Energy Technology Perspectives 2016: Towards Sustainable Urban Energy Systems*.

Source: IEA 2016a; 2016b; 2016c; 2016d.

TABLE 6.1 Progress toward the SEforALL objectives in selected IEA *World Energy Outlook* scenarios

2030 SEforALL objective	Metric	2030 target value	Current Policies Scenario	New Policies Scenario	450 Scenario (2°C)
Access to electricity (million)	Number of people without access	0	784	784	784
Access to modern cooking (million)	Number of people without access	0	2,345	2,345	2,345
Energy efficiency (%)	Energy intensity improvement*	2.1	1.6	1.9	2.6
Renewable energy (%)	Share of renewables in total final energy consumption	36	19	20.6	27

Source: IEA 2016a.

* Energy efficiency numbers are reported in market exchange terms, not purchasing power parity terms, as originally defined in the SEforALL objective, due to difficulties in forecasting purchasing power parity.

Box 6.2

World Bank and WHO approaches to modeling energy access

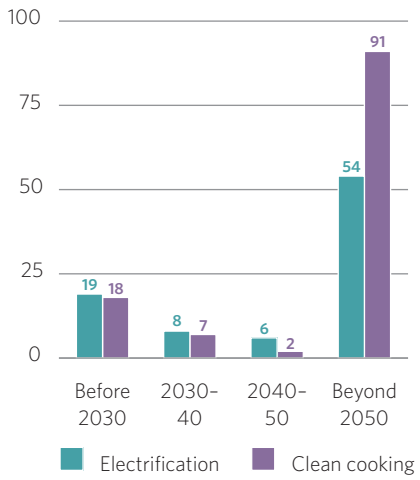
The World Bank maintains a Global Electricity Database of electrification data, which contains results from some 500 nationally representative household surveys, and occasionally censuses, going back to 1990. (Differences between the IEA and World Bank databases are outlined in annex 2.1 in chapter 2.) At the time of this analysis, that database had results from 767 surveys in 144 countries, excluding high-income countries, conducted between 1990 and 2014.

WHO maintains a global Household Energy Database on primary cooking fuel uses. The database collects nationally representative household survey data from multiple sources. The database contains 824 surveys from 161 countries (including high-income countries) conducted between 1970 and 2014.

Few countries conduct surveys annually—a more typical frequency is every three years—which opens up data gaps in the electrification and cooking time series. WHO has developed a multilevel nonparametric modeling approach for estimating the missing data points for clean fuel use (Bonjour et al. 2013) and this model has been widely used for access to cooking (annex 3.1 in chapter 3). This approach has been adapted to electricity access and used for the first time in this publication to fill in the missing electrification data points in 1990–2014 (annex 2.1 in chapter 2).

Source: World Bank and WHO.

FIGURE 6.3 Number of countries reaching electricity and clean cooking access over the coming decades, based on World Bank and WHO extrapolations of 1990–2014 growth rates



Source: World Bank and WHO.

Box 6.3

International Institute for Applied Systems Analysis: Climate and access synergies and trade-offs

The goals of universal access to electricity and to clean cooking can be achieved with additional investment of $65 billion to $86 billion a year through 2030, if that investment is combined with dedicated policies that lower the costs of modern cooking fuels and stoves. Accounting for varying demands and affordability across heterogeneous household groups in both analysis and policy setting remains crucial for success (Pachauri et al. 2013).

Aspirations to provide universal access to electricity are often considered to potentially conflict with efforts to mitigate climate change, but using retrospective analysis of India's data, Pachauri (2014) showed that rising rates of electricity access had little impact on CO_2 emissions. Nonetheless, as larger populations gain access, it becomes increasingly important for developing countries to start reducing carbon intensities of electricity generation in order to ensure sustainable development and avoid future carbon lock-in.

Cameron et al. (2016) show that the potential trade-offs between climate policy and clean cooking access policies might be greater than suggested by previous studies and find that, under stringent mitigation scenarios, the costs of clean fuels go up relative to the baseline, delaying the adoption of clean cooking options. They therefore argue for climate mitigation policies to be accompanied by social protection policies, so as to avoid retarding the transition to modern energy services.

Source: Pachauri et al. 2013; Pachauri 2014; Cameron et al. 2016.

IRENA: Roadmap for a Renewable Energy Future

After all the analysis, the question remains: How to "bend the curve" in order to meet all SEforALL objectives by 2030? IRENA has a roadmap for doing this for renewable energy, the *Roadmap for a Renewable Energy Future* (REmap; see box 6.5). The REmap modeling process is gradually being enriched with detailed analyses for more countries and more sectors, which explore their potential roles in the ongoing renewable energy revolution. The modeling process also has explored interactions with pathways to universal energy access and improved energy efficiency.

IRENA's REmap starts out by estimating that existing policy targets would increase the share of renewable energy consumption from 18% in 2014 to only 21% by 2030 (figure 6.5). The implementation of REmap Options would lift the share further, but only to 25%, still well short of the 36% doubling goal. Universal access to modern energy through renewables leads to a further slight increase in renewable share to 26%, but this is something of a statistical artifact because in IRENA's analysis improved cookstoves using renewable energy are considered modern energy.

The renewables share can further increase to 30% with efforts such as deployment of efficient heating and cooling technologies, renovations in buildings, retrofits in industry, higher electrification of transport, and integrated thinking around renewable energy and energy efficiency, particularly in urban settings. These improved energy efficiency measures push down the overall final energy consumption and therefore increase the renewable energy share.

Reaching a 36% share by 2030—the Doubling Case—would require not only aggressive progress on energy efficiency and a significant increase in commitments at the country level, but also the adoption of major transformative policies. Such policies include modal shifts to large-scale electrification of

Box 6.4

Three scenarios from the World Energy Council

In three scenarios, the World Energy Council explores "The Grand Transition"—global disruptive trends like radical new technologies, greater environmental challenges, and a shift in economic and geopolitical power that will fundamentally reshape the economics of energy (box table 1).

Three scenarios provide energy leaders with an open, transparent, and inclusive framework for thinking about a very uncertain future.

- **Modern Jazz** is a market-driven approach to achieving individual access and affordability of energy through economic growth. It is characterized by market mechanisms, technology innovation, and energy access for all.
- **Unfinished Symphony** is a government-driven approach to achieving sustainability through internationally coordinated politics and practices. It will require strong policy, long-term planning, and unified climate action.
- **Hard Rock** is a fragmented approach driven by a desire for energy security in a world with weak global cooperation, and features fragmented policies, local content, and best-fit local solutions.

Scenarios differ in basic characterizations of the world in 2060 (box table 2). Each scenario contributes to the debate on how environmental goals, energy security, and energy equity can be achieved, taking into account a broad range of industry and policy structures.

BOX TABLE 1 Past and future trends

Trend	Factors that shaped world energy in 1970–2015	Predetermined elements for 2015–60
Population	Global population doubled	Global population will grow by 40%
New technologies	Information and communications technology revolution; rapid productivity growth	Pervasive digitalization; productivity paradox
Planetary boundaries	1,900 gigatons (Gt) of CO_2 was consumed	Only 1,000 Gt CO_2 can be consumed by 2100 to achieve climate goals
Shifts in economic and geopolitical power	Rapid growth of developing nations; growing role for global institutions (such as the United Nations Framework Convention on Climate Change, World Trade Organization, International Monetary Fund, G20)	2030: India becomes the most populous country 2035–45: China becomes the world's largest economy

BOX TABLE 2 The world to 2060

Modern Jazz	Unfinished Symphony	Hard Rock
GDP growth 3.3% per year	GDP growth 2.9% per year	GDP growth 1.7% per year
GDP per capita $30,600	GDP per capita $25,200	GDP per capita $14,700
2015–60: 1,491 Gt CO_2	2015–60: 1,165 Gt CO_2	2015–60: 1,642 Gt CO_2
Digital boost	Sustainable growth	Fragmented markets
Technological innovation	Circular economies	Local content
Economics-focused governance	Broad-based international governance	Fractured and weak international system
Markets	States	Patchwork: states and markets

Source: World Energy Council 2016.

transport and to some extent heating, or early retirement of inefficient nonrenewable power plants.

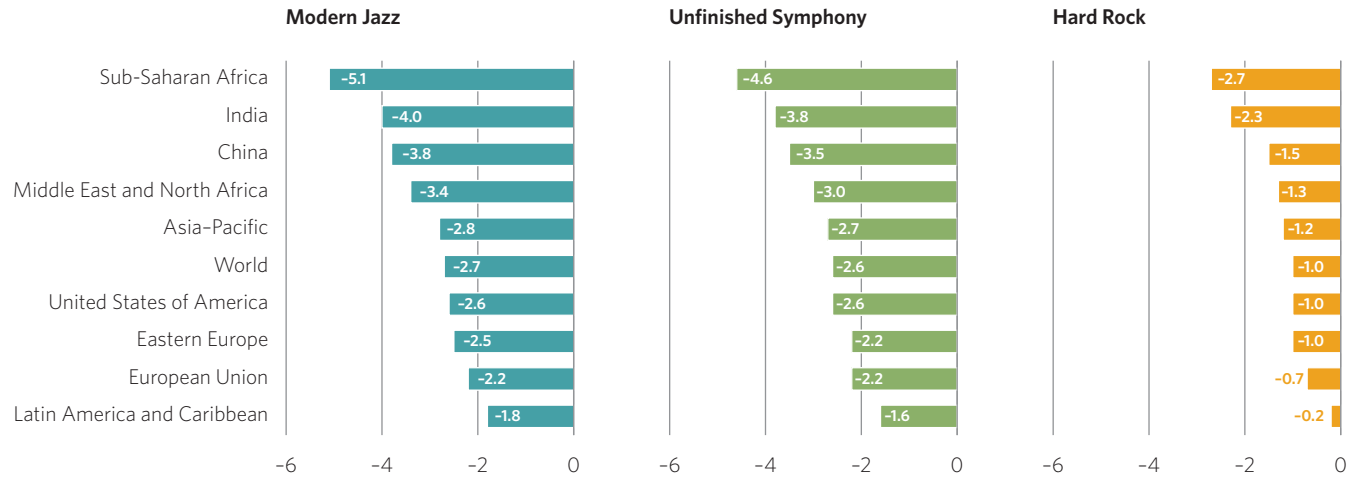
REmap's methodological approach differs from the IEA World Energy Model. REmap Options differ in their ambition for individual countries and are generally less demanding than the IEA's 450 Scenario, though the Doubling Case is the most ambitious of the modeling results presented in this chapter.

The sectoral composition of the Doubling Case against the Reference Case and REmap Options sees major additions in transport and electricity, while in the heat sector a major shift from traditional to modern uses of bioenergy is required to move from the Reference Case to the Doubling Case (figure 6.5). It is the improvements in energy efficiency that make it possible to stabilize the overall energy consumption of the heating sector.

The REmap analysis provides further insights regarding the penetration of renewables in end uses (table 6.3). Industry is often a forgotten sector and some parts of it, especially those in need of high-temperature process heat, are hard to decarbonize. Bioenergy remains the main renewable source for industry, but lower-temperature heating applications can also come from solar and geothermal heat, while onsite renewable power generation can

FIGURE 6.4 Improvements in regional primary energy intensity in World Energy Council scenarios between 2014 and 2060

Annualized change in primary energy intensity, 2014–60 (percentage points)



Source: World Energy Council; Paul Scherrer Institute; Accenture Strategy.

TABLE 6.2 Meeting SEforALL objectives under World Energy Council's scenarios

	Modern Jazz	Unfinished Symphony	Hard Rock
Access to Electricity	2060	Beyond horizon	Beyond horizon
Energy Efficiency	2040	2040	Beyond horizon
Renewable Energy	2050	2040	Beyond horizon

Source: World Energy Council 2016.

help increase industry's renewable energy share.

According to the REmap analysis, public, commercial, and residential buildings can all reach much higher renewables penetration than industry or transport. Bioenergy and solar heating are often the most competitive heating options for buildings; in places with large heating needs, district heating systems fueled by bioenergy, or excess electricity from variable renewable sources, are also viable options.

Renewables in transport, by contrast, do not progress significantly percentage-wise in the REmap analysis owing to the sector's huge size. The limited gains in evidence, though partly attributable to biofuels, owe more to the electrification of transport, which is currently the most viable way to achieve higher renewables penetration in the sector.

Box 6.5

IRENA's *Roadmap for a Renewable Energy Future* (REmap)

REmap is a technology-options analysis that IRENA conducts with national, government-nominated experts. IRENA first collects country data relevant to their national energy plans and renewable energy targets for 2011–30, and then produces a global baseline: the Reference Case. It then, again with national experts, prepares technology options in each sector of the energy system that countries can pursue, based on the realistic potential of renewable energy technologies in a given country beyond the Reference Case: the REmap Options.

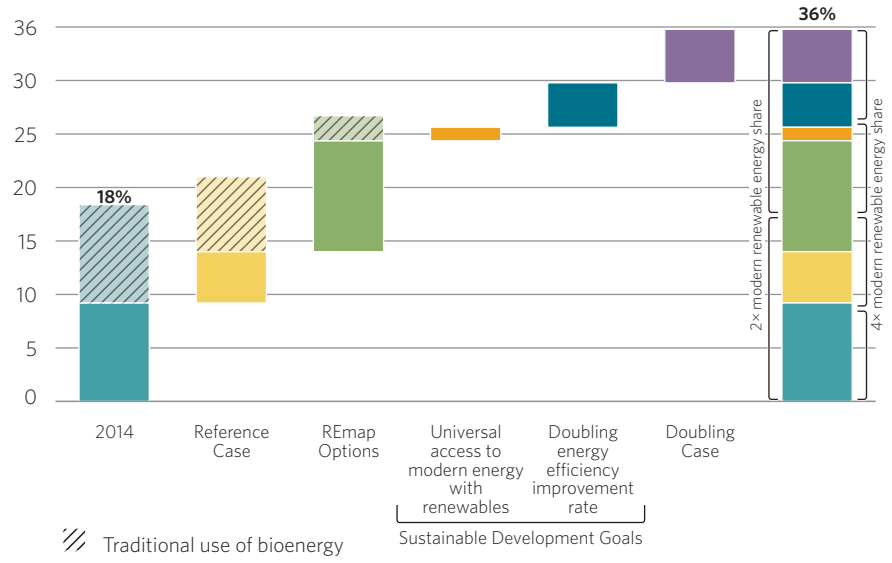
The political feasibility and challenges in implementing each REmap Option differ across sectors and countries, depending on national circumstances and on the level of commercialization that technologies have reached. Factors considered in estimating REmap Options include resource availability, access to finance, human resources and manufacturing capacity, the policy environment, the age of capital stock, and current and future technology costs.

Each REmap Option is characterized by its substitution cost, defined as the annual cost premium of that option against a nonrenewable energy technology used to produce the same amount of energy (such as electricity or heat), then divided by the total renewable energy use in final energy terms. It is based on the capital and operation/maintenance costs in 2030, and considers technological learning and energy-price changes by 2030. REmap estimates costs from business and government perspectives. The business perspective provides a view on how investors would evaluate technology choice. Here, energy prices include taxes, subsidies, and country-specific discount rates based on the expected cost of capital to private sector investors. The government perspective takes a broader societal view, and includes the reduced externalities related to renewable energy.

When the substitution cost is multiplied by the potential of each option, the result is a realistic figure for the system cost associated with the increases in renewable energy deployment featured in the REmap Options. Some externalities considered in REmap include CO_2 and air pollutants, and their impacts on human health and agricultural crops.

Source: IRENA 2016.

FIGURE 6.5
IRENA's REmap: The renewable energy share in total final energy consumption, 2014–30
Renewable energy share in total final energy consumption (%)



Source: IRENA 2016.

TABLE 6.3 Penetration of renewable energy in end uses in REmap
%

	2014	Reference Case	REmap Options	Doubling Case
Industry	11	15	26	35
Buildings	13	22	38	58
Transport	3	5	11	15

Source: IRENA 2016.

TABLE 6.4 Annual investment needs for clean energy based on IEA and IRENA analyses
$ billion

	2015 investments	IEA New Policies Scenario	IEA 450 Scenario	IRENA Doubling Case
Energy efficiency	221	919	1,402	650
Renewable energy	283	299	503	770

Source: IEA 2016a; IRENA 2015, 2016.

MEETING THE 2030 GOALS: INVESTMENT OUTLOOK AND NEEDS

Supply-side energy efficiency investments are embedded in power generation, transmission, and distribution, and are essentially impossible to separate out and track over time. Those on the demand side are projected to rise strongly, relative to current levels, in the *WEO* New Policies Scenario. Over the period to 2030, average annual energy efficiency investments are $919 billion, with 70% of this in the transport sector in response to increasingly pervasive and stringent fuel economy standards, especially for passenger vehicles (IEA 2016a). Investment in more efficient buildings and in their appliances, lighting, heating and cooling systems requires a further 25% of the total. In the IEA 450 Scenario, tighter minimum energy performance standards for a range of energy-using equipment, higher fuel efficiency standards, widespread implementation of net zero energy buildings, and other initiatives push up cumulative spending on efficiency improvements to $1,402 billion annually, more than 50% higher than in the New Policies Scenario (IEA 2016a).

Renewable energy investment averaged $283 billion in 2010–15 (IEA 2016a), close to the level of around $300 billion in average annual investment projected in the New Policies Scenario (although, as technology costs come down, this investment procures increased capacity). The investment needed to achieve the SEforALL renewable energy objective would have to be much higher, however. Average global annual investments for renewables in the 450 Scenario amount to $503 billion, but do not achieve the SEforALL renewable energy objective. The REmap Doubling Case, which is framed around SEforALL objectives, costs an average $770 billion a year just for renewables in the power sector, district heating, industry, buildings, and transport, with a further $650 billion needed for energy efficiency efforts. Table 6.4 summarizes the investment gap for relevant IEA and IRENA scenarios.

Comparable estimates of current financing trends and future investment needs for achieving universal access to electricity and to clean cooking are sparser. The most recent IEA figures (IEA 2011) provided a high-level estimate of investment needs of $45 billion a year, against actual investment flows at that time estimated at $9 billion a year. For clean cooking, the IIASA *Global Energy Assessment* (2012), estimated investment needs of $71 billion annually, though it gives no figures for actual investments.

The World Bank's Access Investment Model provides detailed bottom-up estimates of the cost of reaching universal access in each of 15 countries with large energy access deficits. They reflect differences in population and geography as well as local unit costs, and can be extrapolated to give a global estimate of access investment needs (World Bank and IEA 2015). The model, based on the Multi-Tier Framework (World Bank 2015), allows users to choose the tier of access used to meet the universal access objective, and illustrates how dramatically this choice affects the costs of electrification. Reaching universal access at Tier 1 (enough to light a few light bulbs and charge a mobile telephone) would require investments of $1.5 billion annually up to 2030. By contrast, reaching universal access at Tier 5 (full grid power all day, every day) would require investments of $50 billion annually.

NOTES

1. The IEA uses the concept of modern cooking and not clean cooking, one of the objectives of SEforALL. Modern cooking is defined as any cooking not done using traditional biomass uses, while clean cooking is a narrower category excluding certain polluting fuels (such as kerosene).
2. See the IEA's most recent *World Energy Outlook* Energy Access Database at http://www.worldenergyoutlook.org/resources/energydevelopment/energyaccessdatabase/.

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PART TWO

REGIONAL STORIES

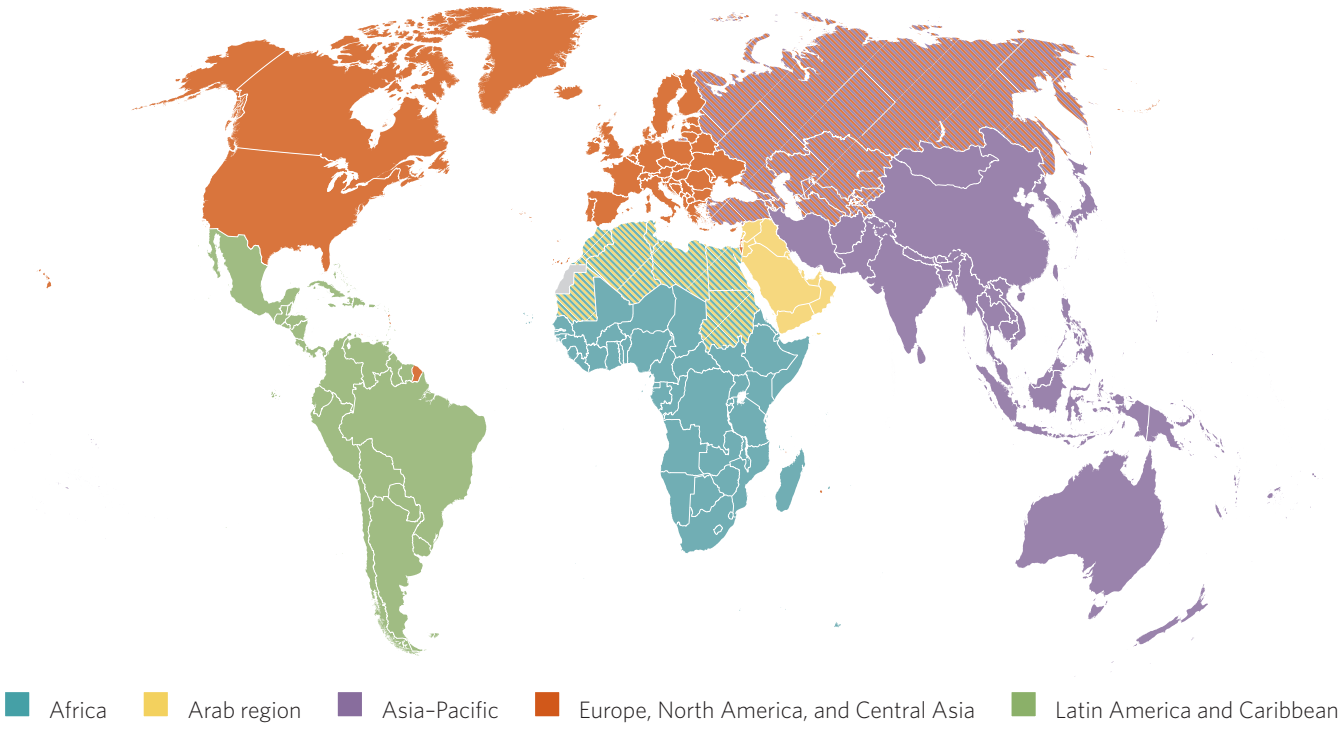
7

REGIONAL INTRODUCTION

This second part of *Global Tracking Framework 2017* provides regional analysis of progress on the three pillars of sustainable energy—energy access, energy efficiency, and renewable energy. The five geographic regions in this report have been defined by the coverage of the five United Nations (UN) Regional Commissions: the Africa region (UNECA); the Arab region (ESCWA); the Asia–Pacific region (ESCAP); the Europe, North America, and Central Asia region (UNECE); and the Latin America and Caribbean region (ECLAC). All regions are further segmented into subregions.

Part 2 has two aims: to uncover the regional trends behind the global results; and to "stand closer" to national policymakers by highlighting individual countries' experiences. Part 2 results from collaboration with the UN Regional Commissions, the coauthors of the regional chapters.

FIGURE 7.1 Five regions



ACCESS TO ELECTRICITY

All regions have made steady progress toward universal access to electricity, except Africa, where only 46.9% of the population had access to electricity in 2014 (figure 7.2). In Africa the population without access numbered 612.6 million, accounting for over half of the global population without access (figure 7.3). The gap between Africa and the region with the second-lowest access widened from about 32 percentage points in 1990 to 43 percentage points in 2014. Asia-Pacific was the second-lowest-access region, with 90.3% electrification in 2014 and a population without access numbering 421.4 million. The Arab region ranked just slightly ahead at 90.4%, though its population without access was much smaller, numbering 35.8 million. The Latin America and Caribbean region reached 97% access and was the closest to universal access after the Europe, North America, and Central Asia region.

Furthest behind in electrification, Africa improved slowly in 1990–2010 at 0.2 percentage points a year, a rate that accelerated after 2010 (figure 7.4). But Africa is the only region where electrification progress falls short of demographic growth (figure 7.5). For Africa to reach universal access by 2030, the pace needs to accelerate more drastically.

Asia-Pacific's electrification grew the fastest in 1990–2010 at 0.9 percentage points a year, boosting access to electricity from 70.2% to 88.0%, but appears to have slowed since 2012. Even so, 46.6 million people a year gained access to electricity in 2012–14, outpacing population growth of 41.9 million a year. Electrification in the Arab region, while starting from a higher level, grew at a slower pace. Electrification in Latin America and Caribbean continued to increase, though the rate slowed as the region approached universal access and further electrification became more difficult.

Rural electrification remained an important unfinished task in all regions except Europe, North America, and Central Asia. Africa's urban-rural access gap was the largest among all regions (figure 7.6), and Africa's urban access lagged behind the rest of the world by about 20 percentage points, its rural access by more than 46 percentage points.

ACCESS TO CLEAN FUELS AND TECHNOLOGIES FOR COOKING

Africa, counting 850.3 million people in 2014 without access to clean fuels and technologies for cooking (here "clean cooking"), had the lowest access among all regions (figure 7.7). Asia-Pacific also lagged far behind: almost half the region's population—2.1 billion—had no access to clean cooking in 2014 (figure 7.8). The Arab region, and Latin America and Caribbean, starting from a much higher 2000 access rate, both showed steady progress, tracking each other closely (see figure 7.7).

Africa not only has had the lowest access to clean cooking among all regions, but its pace of increase also has been the slowest—almost negligible—since 2000 (figure 7.9). Africa's total population grew 3.5 times faster than the population with access to clean cooking in 2012–14 (figure 7.10). Asia-Pacific's efforts in 2012–14 were much stronger, with access growing by 0.8 percentage points and the increase in access outpacing the increase in population. In the Arab region and Latin America and Caribbean, progress slowed in the most recent years as both regions approached universal access, with diminishing returns constraining further expansion efforts.

ENERGY EFFICIENCY

In 1990–2014, reductions in energy intensity, the measurable proxy for increases in energy efficiency, converged toward 5 MJ/2011 PPP $ (megajoules per 2011 purchasing power parity dollar) in most regions (figure 7.11). The steepest decline was in the Europe, North America, and Central Asia region. The drop in Asia-Pacific, starting from the highest level in 1990 among all regions, was also sharp, and in 2012–14 it accelerated (figure 7.12).

FIGURE 7.2 All regions except Africa showed clear convergence toward universal access

Share of population with access to electricity (%)

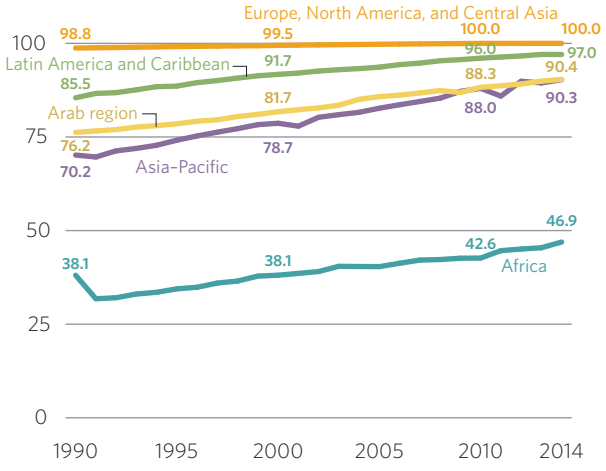


FIGURE 7.3 Over half the global electricity access deficit was in Africa in 2014

Population without access to electricity, 2014 (million)

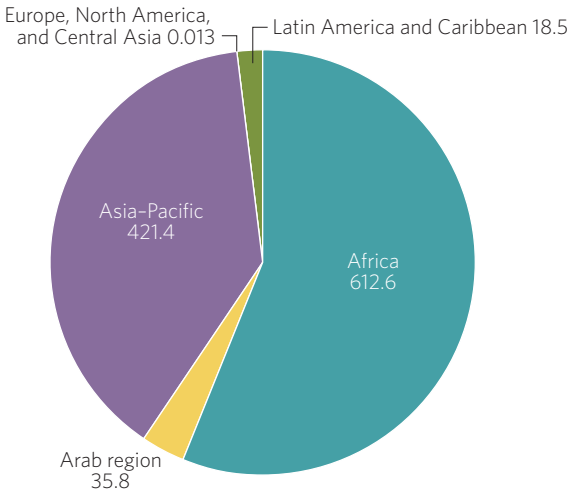


FIGURE 7.4 Among developing regions, Asia-Pacific showed the fastest-rising electrification rate in 1990–2014, Africa the slowest

Annualized change in access to electricity (percentage points)

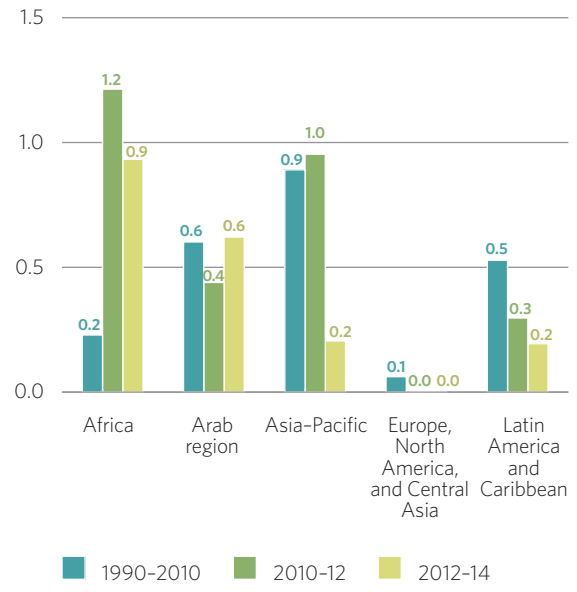


FIGURE 7.5 Africa was the only region struggling to match total population growth with electrification in 2012–14

Population (million)

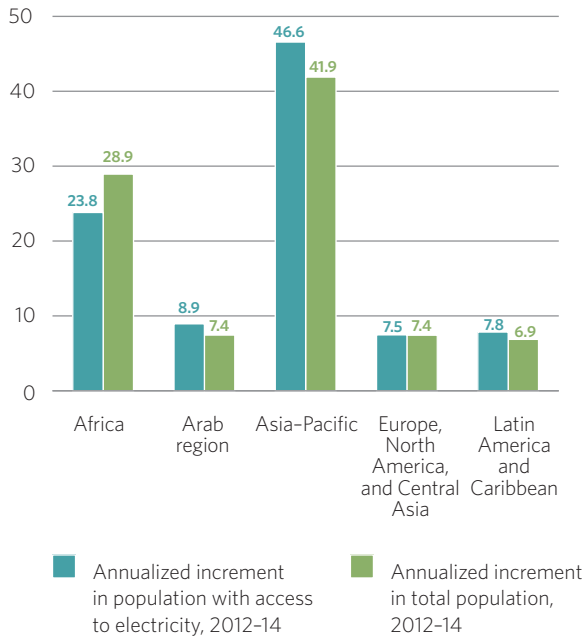


FIGURE 7.6 All developing regions showed urban–rural gaps in access to electricity in 2014

Share of population with access to electricity, 2014 (%)

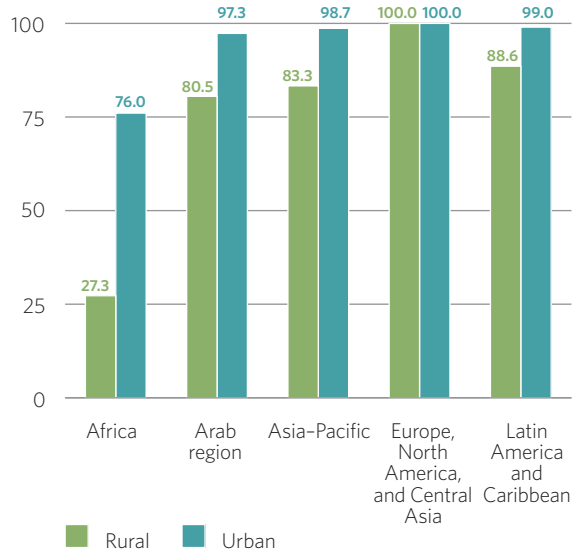


FIGURE 7.7 Africa and Asia-Pacific lagged behind on access to clean cooking

Share of population with access to clean cooking (%)

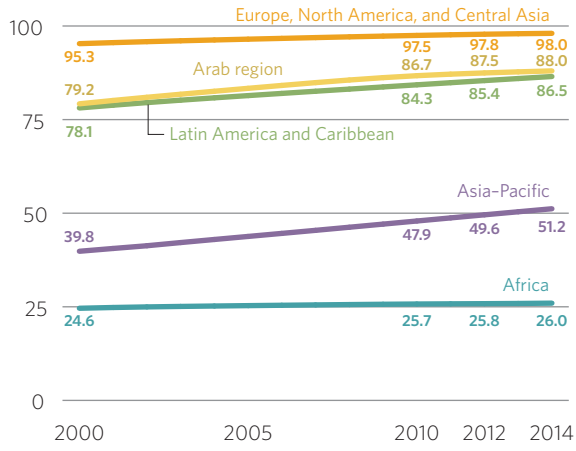


FIGURE 7.8 More than two-thirds of the world's population without access to clean cooking in 2014 lived in Asia–Pacific

Population without access to clean cooking, 2014 (million)

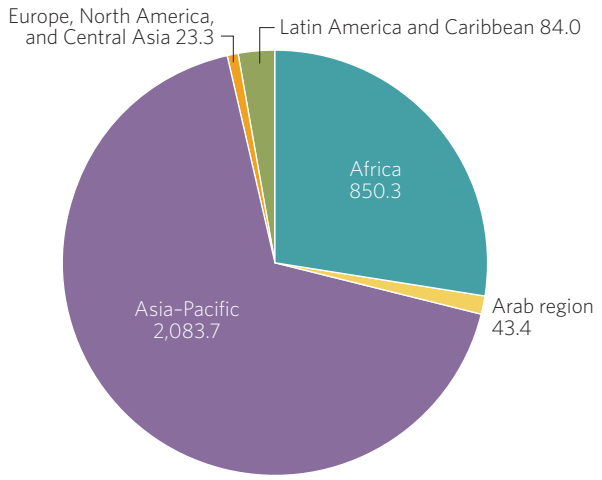


FIGURE 7.9 Asia–Pacific showed the fastest rising rate of access to clean cooking in 2000–14, Africa the slowest

Annualized change in access to clean cooking (percentage points)

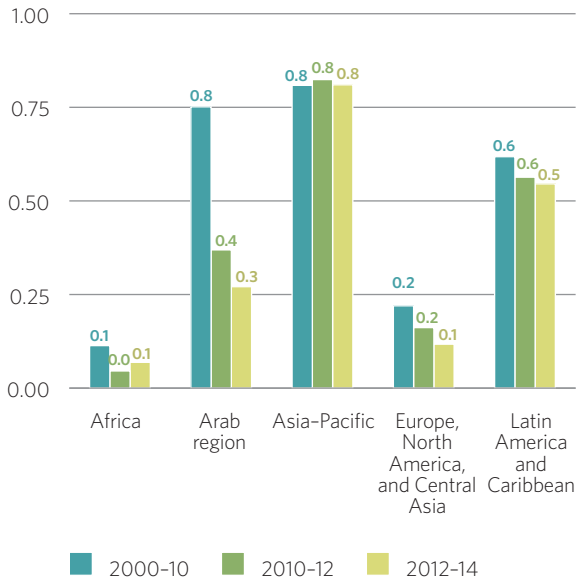


FIGURE 7.10 Access to clean cooking in Africa failed to keep up with total population growth in 2012–14

Population (million)

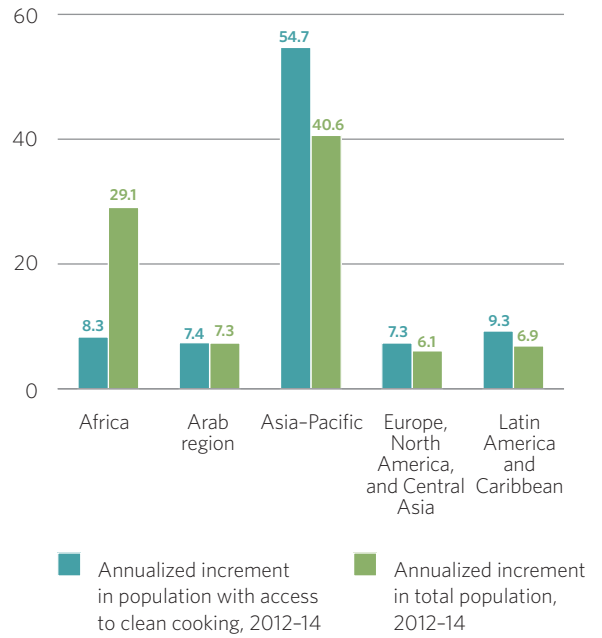
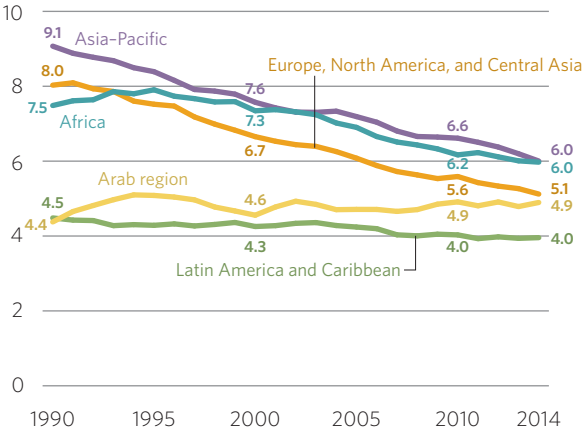


FIGURE 7.11 Most regions converged toward an energy intensity of 5 MJ/2011 PPP $

Energy intensity (MJ/2011 PPP $)



Improvement in Africa, starting from a lower level than Asia–Pacific, was also considerable. Trends in the Arab region and the Latin America and Caribbean region, though beginning at relatively low levels in 1990, did not improve through 2014. Energy intensity in the Arab region actually increased in 1990–2010 and just began to decline in 2010.

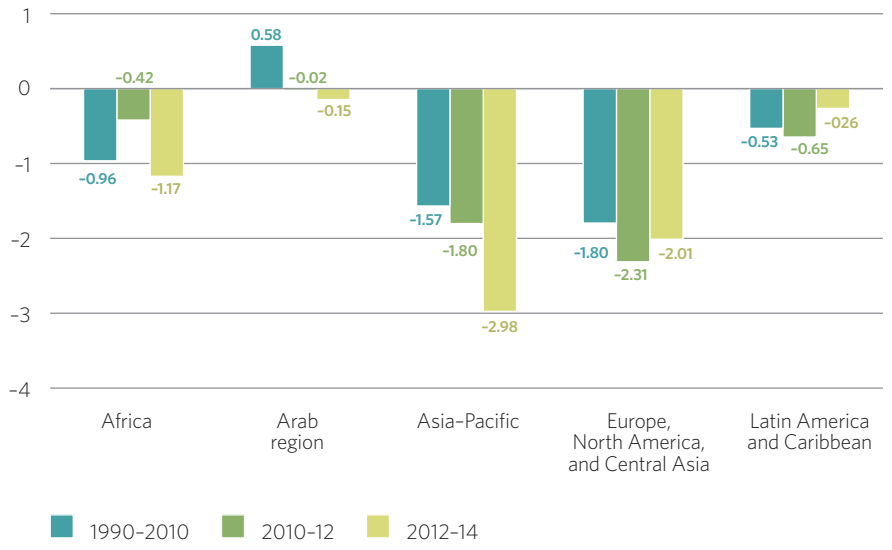
Regions' energy intensity varied by economic sector (figure 7.13). Asia–Pacific had the most energy-intensive industrial sector, and the Arab region the least energy intensive. Europe, North America, and Central Asia had the most energy-intensive agriculture, services, and, especially, residential sectors. Africa had the least energy-intensive agricultural sector, and Latin America and Caribbean the least energy-intensive services sector.

Europe, North America, and Central Asia decoupled energy demand growth from gross domestic product (GDP) growth in 1992. Absolute energy consumption began to decline after 2010 while GDP grew, and the region had achieved the strongest decoupling among all

regions by 2014. Asia–Pacific and Latin America and Caribbean achieved decoupling in the early 1990s, and Africa in the early 2000s, although absolute energy consumption continued to grow, reflecting relatively low per capita energy consumption. In the Arab region, decoupling of energy demand from GDP has been widening.

FIGURE 7.12 The steepest declines in energy intensity in 1990–2014 were in Asia–Pacific and in Europe, North America, and Central Asia

Primary energy intensity compound annual growth rate (%)



RENEWABLE ENERGY

The share of renewable energy in total final energy consumption (TFEC) declined in all regions except Europe, North America, and Central Asia, where the share increased sharply (figure 7.14).

The long-term declining share of renewable energy in most developing regions reflected decreased use of traditional biomass fuels, such as wood, as economies modernized and substituted modern fuels, such as gas, in a wide range of domestic and industrial thermal applications. The decline is likely beneficial on balance, given that traditional uses of biomass are typically very inefficient and have negative health and environmental impacts. The steepest declines were in Asia–Pacific, where the renewable energy share fell to 18.3% in 2014, and Latin America and Caribbean, where it fell to 27.2%. In Asia–Pacific, the decline stabilized in 2012–14. In the Arab and Africa regions, too, declining trends were stabilizing by 2014.

Modern renewable energy, excluding traditional biomass, increasingly attracts policy attention. Latin America and Caribbean, given strong endowments of biomass and hydropower, relied heavily on modern renewable energy long before it became fashionable. The region, throughout 1990–2014, had by far the largest share of modern renewable energy consumption in total energy consumption, 22.9% in 2014 (figure 7.15). Europe, North America, and Central Asia ranked second, getting to 11.1% in 2014, driven by aggressive modern renewable energy policies and targets. Africa, reaching 8.1% in 2014, and Asia–Pacific, reaching 6.8%, also achieved strong growth. The Arab region finished 2014 with the lowest share—a mere 1.8%—continuing a steady decline since 1990.

The share of traditional biomass consumption in TFEC decreased in all regions but remained very high in Africa (figure 7.16). The share also remained quite high in Asia–Pacific despite an almost continuous decline over the period. In other regions, the share of traditional biomass consumption in total energy consumption was very small.

FIGURE 7.13 Asia–Pacific had the highest energy intensity in industry and Africa the lowest energy intensity in agriculture in 2014

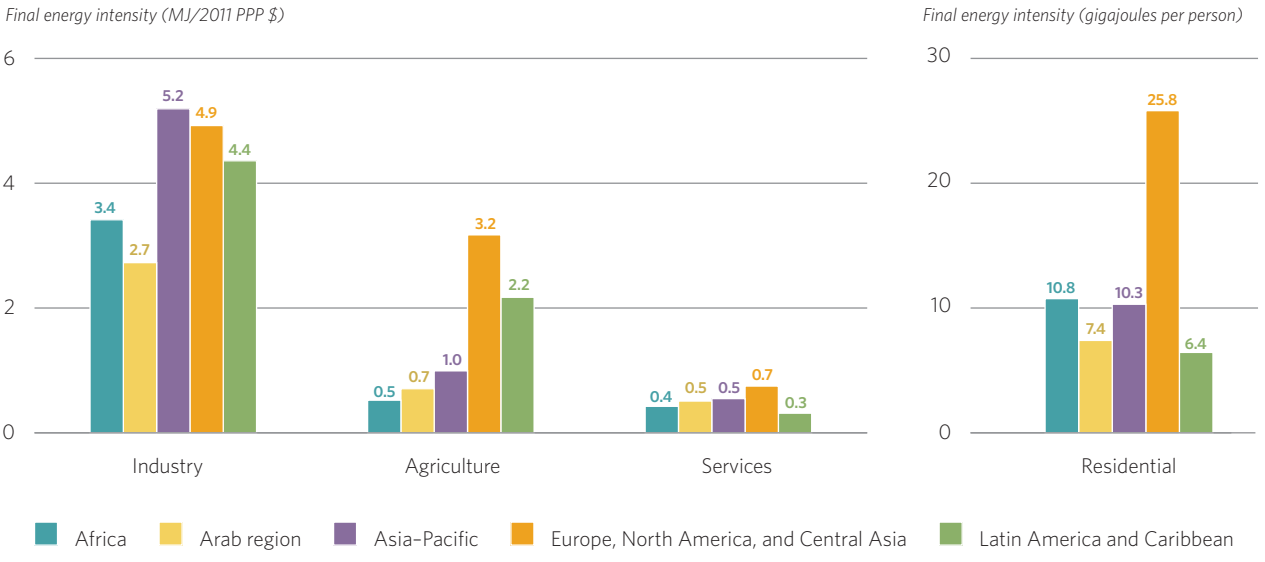


FIGURE 7.14 In all regions except one, the share of renewable energy consumption in total final energy consumption declined in 1990–2014

Share of renewable energy consumption in total final energy consumption (%)

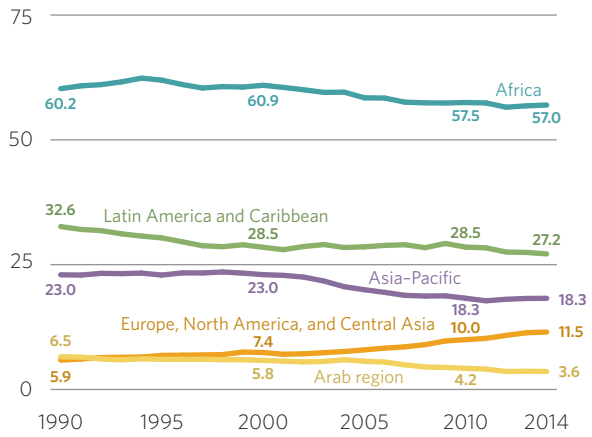


FIGURE 7.15 The share of modern renewable energy consumption increased in three regions in 1990–2014

Share of modern renewable energy consumption in total final energy consumption (%)

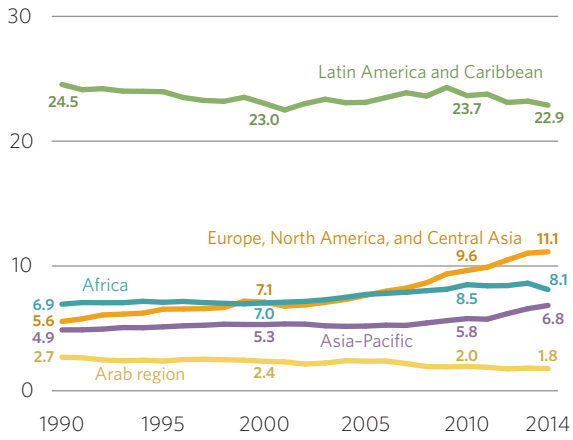
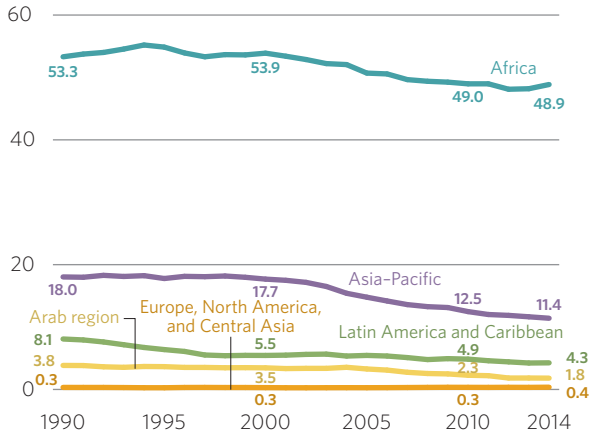


FIGURE 7.16 Africa had by far the biggest share of traditional renewable energy consumption in total final energy consumption in 1990–2014

Share of traditional renewable energy consumption in total final energy consumption (%)



Traditional biomass continued to overshadow other sources of renewable energy in Africa and Asia-Pacific. In Africa, traditional renewable energy represented over 85% of renewable energy consumption in 2014 (figure 7.17). In Asia-Pacific, the share was 63.1%, as hydropower, modern biofuels, and new renewable energy, such as wind and solar power, also contributed. In Europe, North America, and Central Asia, and in Latin America and Caribbean, modern biofuels and hydropower represented the largest part of modern renewable energy, but new renewable energy sources began to contribute considerably to the mix.

In Africa, 76.6% of energy for heat applications came from renewable energy, the highest share among all regions in 2014, showing the widespread use of traditional biomass (figure 7.18). The share in Latin America and Caribbean was the second highest, 30.9%, and in Asia-Pacific the third highest, 23.8%. For electricity, the largest share provided by renewable energy was in Latin America and Caribbean, 53.8%, driven by hydropower. The share in Europe, North America, and Central Asia was 23.3%, in Asia-Pacific, 18.9%, in Africa, 17.8% and in the Arab region, 3.6%—the smallest. In transport, the only regions where renewable energy supplied a tangible share of total energy were Latin America and Caribbean, at 8.3%, and Europe, North America, and Central Asia, at 4.4%, both driven by liquid biofuels.

FIGURE 7.17 Traditional biomass in 2014 was still the main source of renewable energy in Africa and Asia-Pacific

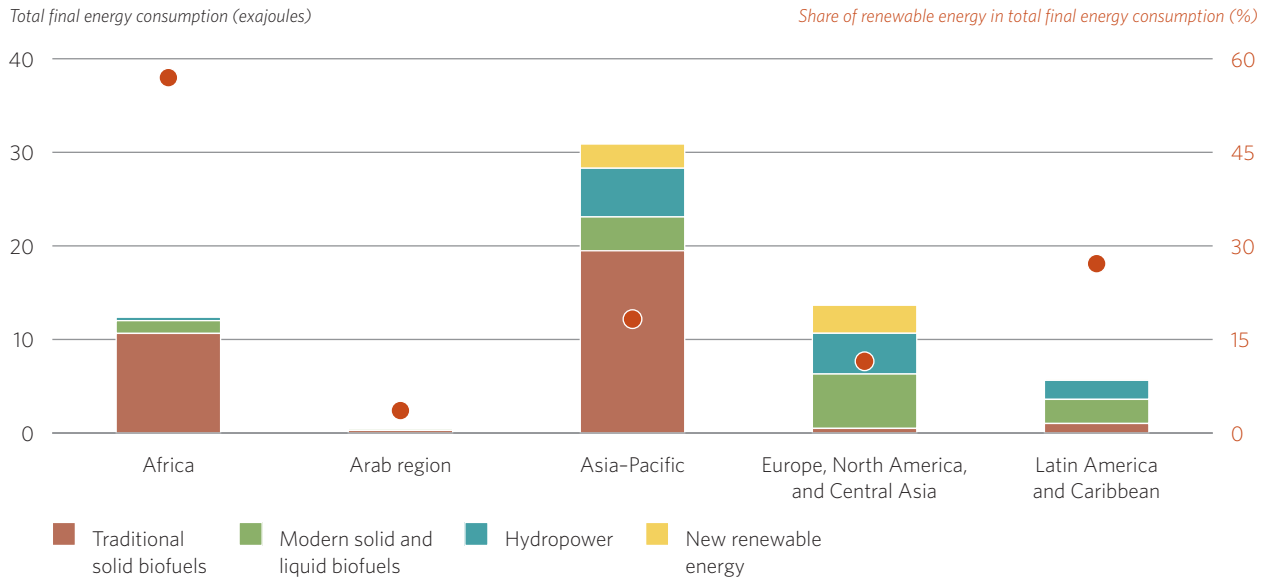
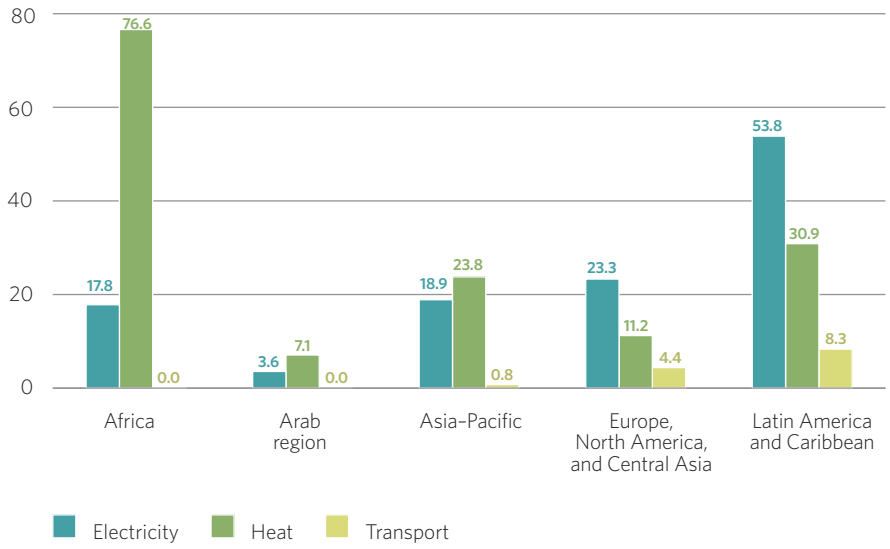


FIGURE 7.18 Africa had the highest share of renewable energy in heat applications in 2014 and Latin America and Caribbean in electricity and transport

Renewable energy share (%)



8

THE AFRICA REGION

The regional profile of the Africa region has been written with the UN Economic Commission for Africa (UNECA).

REGIONAL OVERVIEW

The Africa region comprises 54 countries with a total population of 1.15 billion in 2014, or 16% of the world's population. The region is divided into five subregions: North Africa, Central Africa, Eastern Africa, Southern Africa, and West Africa. However, for this report the Central Africa, Eastern Africa, Southern Africa, and West Africa subregions together have been regrouped into three subgroups by income (table 8.1).[1]

In 2014, Africa accounted for 6.3% of global total final energy consumption (TFEC), produced 5.1% of global gross domestic product (GDP) (2011 PPP $), and emitted 3.4%[2] of global carbon emissions. The region depends heavily on mining and agriculture. Most countries are low-income and have low energy consumption per capita, high dependence on biomass, little focus on energy efficiency, and limited availability of data. The Central Africa, Eastern Africa, Southern Africa, and West Africa subregions account for 60% of the region's GDP and 75% of its total energy supply.

TABLE 8.1 Countries by subregion

North Africa	Central, Eastern, Southern, and West Africa		
	Subgroups		
	High- and upper-middle- income countries	Lower-middle-income countries	Low-income countries
1. Algeria	1. Angola	1. Cabo Verde	1. Benin [c]
2. Egypt	2. Botswana	2. Cameroon	2. Burkina Faso
3. Libya [a,c]	3. Equatorial Guinea	3. Congo (Rep. of)	3. Burundi
4. Mauritania [c]	4. Gabon	4. Côte d'Ivoire	4. Central African Republic
5. Morocco	5. Mauritius	5. Djibouti [c]	5. Chad [c]
6. Sudan	6. Namibia	6. Ghana	6. Comoros [c]
7. Tunisia	7. Seychelles	7. Kenya	7. Congo (Dem. Rep. of)
	8. South Africa	8. Lesotho	8. Eritrea
		9. Nigeria	9. Ethiopia
		10. Sao Tome and Principe	10. Gambia [c]
		11. Senegal	11. Guinea
		12. Swaziland	12. Guinea-Bissau [c]
		13. Zambia	13. Liberia
			14. Madagascar
			15. Malawi
			16. Mali
			17. Mozambique
			18. Niger
			19. Rwanda
			20. Sierra Leone
			21. Somalia [c]
			22. South Sudan
			23. Tanzania (United Rep. of)
			24. Togo
			25. Uganda
			26. Zimbabwe

a. Data on access to clean fuels and technologies for cooking not available.

b. Data on energy intensity not available.[1]

c. Modern renewable energy consumption data either not available or reported being zero.[2]

1. Although all countries reported overall energy intensity, data for energy intensity by sector was not available in 2014 for several countries: energy intensity in agriculture was not available for 27 countries; energy intensity in industry was not available for 10 countries; energy intensity in services was not available for 15 countries. For more details, see data annex 2.

2. Renewable energy consumption data are based on databases of the International Energy Agency (IEA) Energy Data Center and United Nations Statistics Division (UNSD). When data for total, modern, or traditional renewable energy consumption are not available, this may be due to negligible consumption, energy balance data not being available at the necessary level of detail, or uses of renewable energy not being captured by official country statistics as reported to the IEA Energy Data Center and UNSD. Also, traditional renewable energy consumption is assumed to be only the consumption of solid biomass in the residential sector of non–Organisation for Economic Co-operation and Development (OECD) countries (that is, no traditional renewable consumption is assumed to occur in OECD countries). This IEA convention has been adopted in the Global Tracking Framework, due to the heavy reliance on the IEA data (see box 5.1 for further details).

ACCESS TO ELECTRICITY

Regional progress

In 1990, 38.1% of the people in Africa had access to electricity, the lowest rate in the world compared with 73.5% worldwide (figure 8.1). By 2014, 46.9% of the people in Africa had access, but the global rate had climbed to 85.3%. About 612.6 million people still lacked access to electricity in 2014—equivalent to the populations of Indonesia, Brazil, and the Russian Federation combined.

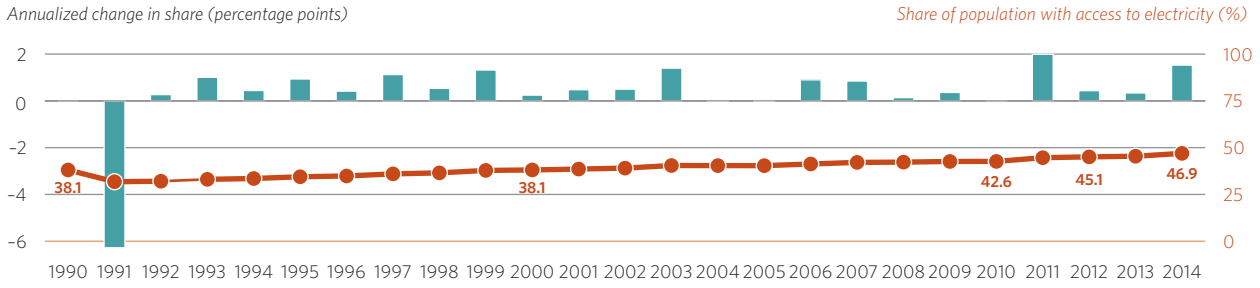
The population in Africa with access to electricity in 1990–2014 grew by about 14.8 million a year, but the total population grew by 27.7 million a year. The pace of expanding access more than tripled, from 0.2 percentage points a year in 1990–2010 to 1.1 percentage points a year in 2010–14. But the pace needs to increase even more dramatically for Africa to achieve universal access by 2030.

Unreliability of power supply, too, challenges a growing number of countries due to insufficient and low-quality electricity supply, causing frequent unplanned outages and load shedding. Many consumers opt for other sources of energy, such as diesel generators, even while connected to the grid.

In urban areas in Africa, the electricity access rate increased from 70.4% of people in 1991[3] to 76.0% in 2014. But about 110.6 million still lacked electricity in 2014, as urban population growth had offset access gains (figure 8.2).

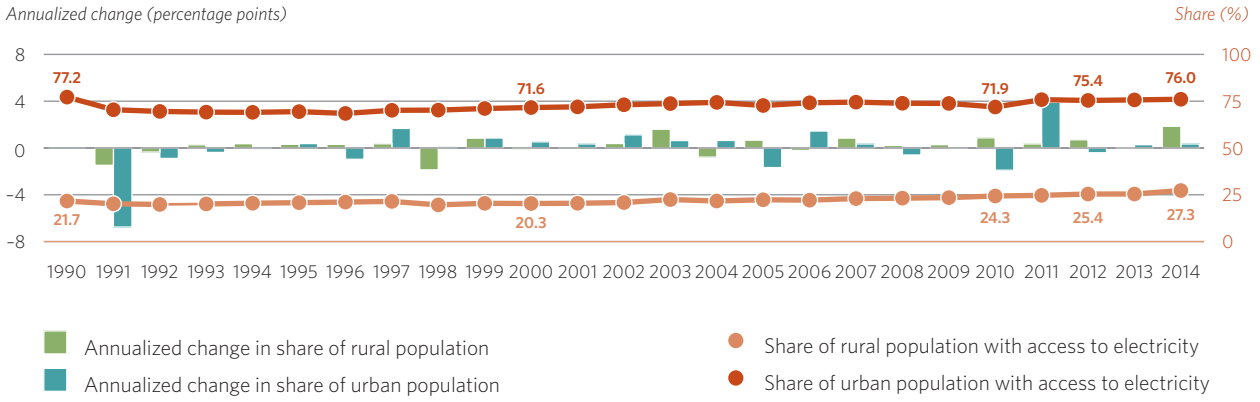
In rural areas, 21.7% of people had access to electricity in 1990, a rate that went up merely to 27.3% by 2014 because the total population had grown much faster than the population with access. About 504 million in rural areas did not have access in 2014. Many countries in Africa adopted programs to accelerate electrification in rural areas, where most of the

FIGURE 8.1 Over half of Africa's population did not have access to electricity in 2014



Note: The drop in access rate between 1990 and 1991 was caused by the addition of one or more countries that do not have electrification data for 1990 and whose access rate was below the regional average at that time.

FIGURE 8.2 Access to electricity grew slowly in rural and urban areas in Africa in 1990–2014

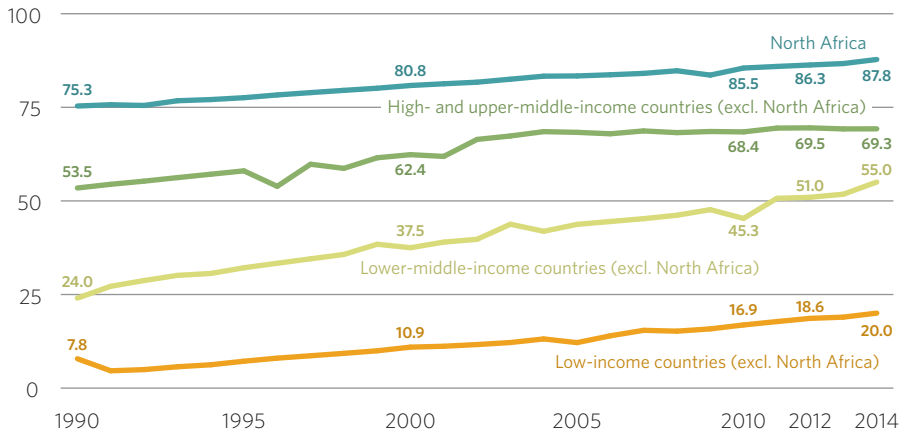


population lives, creating rural electrification agencies and, sometimes, dedicated funds.[4]

Rural electrification programs have largely aimed at extending the distribution grid to new consumers, targeting 80–95% of unserved communities (Crousillat, Hamilton, and Antmann 2010). However, the pace of rural electrification has been slow due to small allocations of resources for grid connections and high connection fees that consumers are expected to pay, leaving a huge gap between the investment required to extend grid coverage and current investment. Rural consumers' low demand often does not justify the costs of grid extension (Golumbeanu and Barnes 2013). Off-grid technology—mini-grids and individual solar home systems—is increasingly being considered as a cheaper supply option for small consumers living far from the grid.

FIGURE 8.3 Electricity access rates were highly correlated with national income

Share of population with access to electricity (%)



Subregional progress

In all subregions, access to electricity rose in 1990–2014, though it struggled to outpace population growth in most. Electricity access is highly correlated with income (figure 8.3), with wide differences between countries (figure 8.4). Only 5 countries (Algeria, Egypt, Mauritius, Seychelles, and Tunisia) had an access rate above 99% in 2014. Of particular concern are the 15 African countries with access rates below 20%.

North Africa had the highest rate among the subgroups of access to electricity, increasing from 75.3% in 1990 to 87.8% in 2014 (see figure 8.3). (Further analysis for North Africa is in the Arab region chapter of this publication.)

Central, Eastern, Southern, and West Africa lagged behind. The rate of access to electricity in Africa (excluding North Africa) increased from 22.9% in 1990 to 37.2% in 2014, adding 11.1 million people each year. Still, about 585.4 million people had no access in 2014.

The electricity access rate in high- and upper-middle-income countries in Africa (excluding North Africa) increased from 53.5% in 1990 to 69.3% in 2014. Most high- and upper-middle-income countries had access rates of more than 60% in 2014. Among the few exceptions were two large countries with sparse populations—Namibia (49.6%) and Angola (32%) (figure 8.4)—that would require huge investments in transmission and distribution infrastructure to connect all households. Angola reported declining electricity access due to damage to infrastructure for generation, transmission, and distribution in the protracted civil war that ended in 2002 (Government of Angola and UNDP 2015). South Africa, with almost two-thirds of the high- and middle-income subgroup's population, reached 86% access in 2014. The pace of electrification in South Africa slowed in 2012–14, as the country focused on increasing generation capacity to address shortages and reconsidered the deployment model of on-grid and off-grid systems (Jamal 2015). Botswana's access to electricity grew the fastest in the subgroup, bolstered by a strong economy, the population's small size, and rural electrification programs supported since 1994. The government has set a national electricity access target of 82% by 2016 and 100% by 2030 (SEforALL 2012).

The lower-middle-income countries in Africa (excluding North Africa), starting from a low electricity access rate of 24% in 1990, achieved the fastest expansion in Africa (excluding North Africa), attaining 55% by 2014. Cabo Verde and Swaziland reported the largest increases. Swaziland has made rural electrification a high priority, aiming for universal access by 2022, according to the National Development Strategy (Government of Swaziland 2014). Nigeria, with more than half the lower-middle-income subgroup's population, exhibited moderate increases in its access rate in 1990–2014 driven by grid expansion and off-grid systems, including personal diesel generators. Djibouti's access rates fell in 1990–2014 because of high connection fees and high electricity costs coming from reliance on imported oil products and absence of more cost-effective alternatives for electricity generation (World Bank 2009). Zambia, with 27.9% access to electricity, and Lesotho, with 27.8%, reported the lowest access rates in the lower-middle-income subgroup in 2014. Zambia has been challenged by limited resources to invest in grid expansion, low affordability of connection fees exacerbated by high unemployment, and harm to the economy from declines in copper prices that lasted until 2011. Lesotho found rural electrification a major difficulty because of its dispersed population and rugged topography; high unemployment in rural areas has exacerbated matters (REEEP 2012).

Low-income countries in Africa (excluding North Africa) have exceptionally low electricity access rates and the slowest pace of expansion in the region. In 1990 the access rate was 7.8% and by 2014 reached only 20%. Three-fourths of low-income countries reported access rates under 30% (see figure 8.4). In 2012–14, only Rwanda and Uganda's rates grew by more than 3 percentage points annually, driven by strong national programs to expand grid electricity and benefiting from the Lighting Africa program, which has enabled 15.8 million people across Africa so far to meet basic electricity needs with small-scale off-grid solar products (Energy Access Practitioner Network 2016). Benin, the Democratic Republic of Congo, and Zimbabwe saw their electricity access rates drop in 2012–14, when economic crises contributed to poor performance.

ACCESS TO CLEAN FUELS AND TECHNOLOGIES FOR COOKING

Regional progress

As with electricity access rates, the Africa region had the lowest rate of access to clean fuels and technologies for cooking (here "clean cooking") among all regions. The share of the population cooking with clean fuels and technologies edged up only marginally, from 24.6% in 2000 to 26.0% in 2014, for an annual increase of 7.1 million users, equivalent to the population

FIGURE 8.4 Fifteen African countries had electricity access rates below 20% in 2014

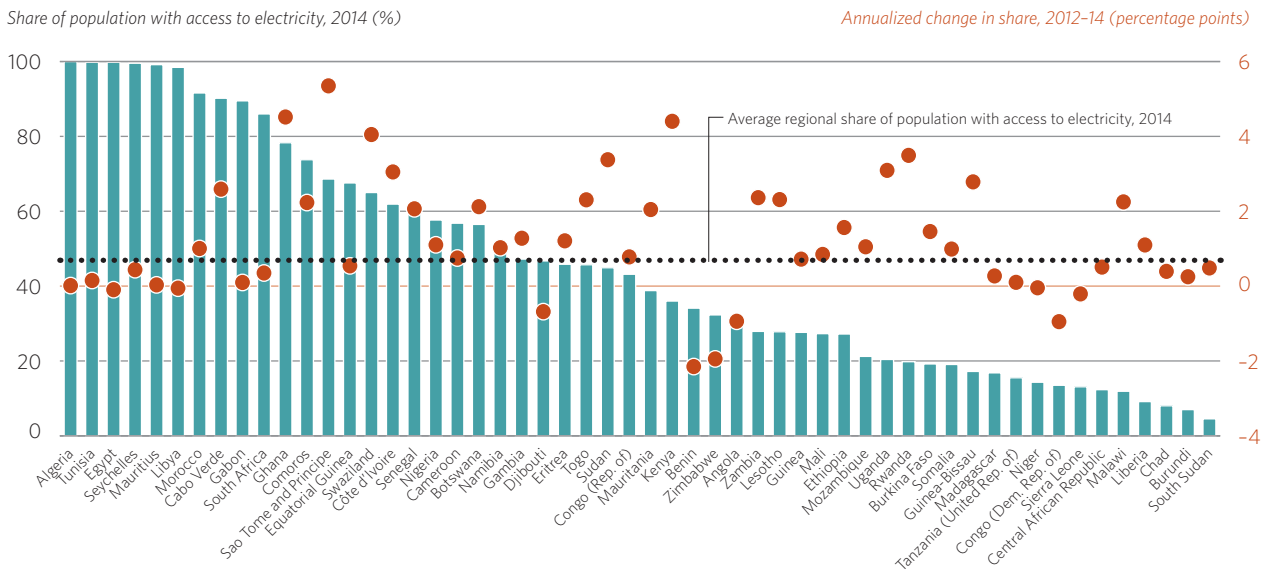
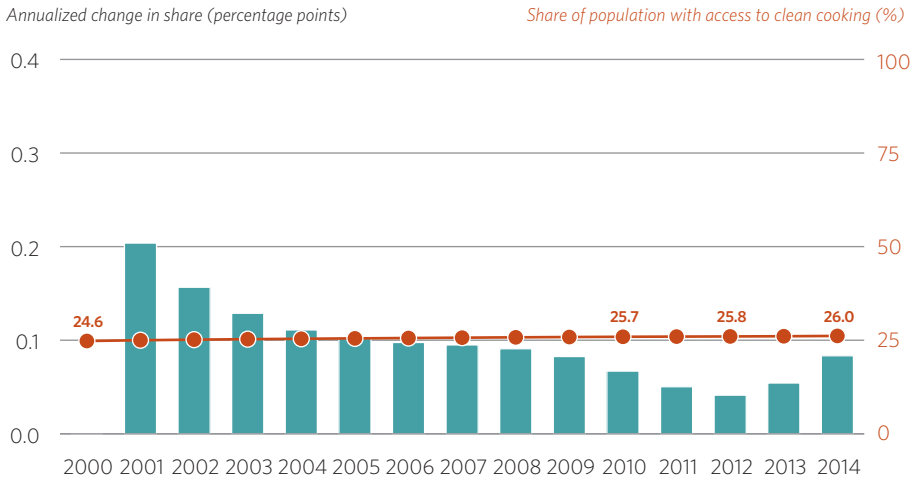


FIGURE 8.5 Africa struggled to improve access to clean cooking, leaving 850 million people relying on traditional, polluting cooking solutions in 2014



of Eritrea and Botswana combined (figure 8.5). Yet the total population increased by 24.4 million a year during the period. About 850.3 million people still lacked access to clean cooking in 2014, equivalent to the populations of the United States of America, Indonesia, Brazil, and Thailand combined.

The main drivers of gains in access to clean cooking are increased use of clean cookstoves and liquefied petroleum gas (LPG). Cooking with electricity is limited, due to high cost (South Africa and Namibia, however, are known to rely heavily on electricity for cooking) (Legros et al. 2009). Biogas and solar cookers have not made a significant impact so far, as they are disseminated only through isolated programs with low budgets.

Clean cookstoves have been disseminated through initiatives such as the Global Alliance for Clean Cookstoves, operating in 19 partner countries in Africa and 4 focus countries since 2010 (GACC 2010). LPG remains unaffordable to many households. Although countries such as Ghana, Kenya, and Senegal have introduced small gas cylinders to improve affordability for low-income households, further effort is required to improve gas uptake. LPG supply is constrained by the paucity of refineries on the continent, particularly in Central, Eastern, Southern, and West Africa.

The transition to clean cooking also requires a transformation of mindsets and cultural practices. Longstanding dependence on traditional biomass (such as charcoal, wood fuel, and cow dung) has restricted households to existing infrastructure and practices. The abundance of easily accessible traditional biomass inhibits faster penetration of other cooking fuels. And even affluent households prefer cooking with traditional fires or charcoal for culinary reasons, such as taste.

Access to clean cooking has not received much government support, and improvised strategies have mainly been promoted through donor funding. African countries have, however, set or are setting the national Sustainable Energy for All (SEforALL) objective for clean cooking in their SEforALL action agendas, which also identify priority activities.

Fuel stacking, in which households use multiple fuels and technologies in parallel, is very common. The practice challenges data collection, as most surveys capture only the primary cooking fuel and disregard other frequently used cooking solutions in the same household. Moreover, biomass surveys are rarely carried out in Africa (excluding North Africa). For instance, comprehensive biomass energy surveys in some Southern and Eastern African countries were carried out over five years ago with support from Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), as part of the Biomass Energy Strategy (BEST) initiative.

Subregional progress

African subgroups presented wide differences in access to clean cooking, which is highly correlated with national income (figure 8.6). Five countries in Africa (excluding North Africa) reached an access rate above 70%, of which all but Cabo Verde were high-income or upper-middle-income countries. The only upper-middle-income country with a share under 40% was Equatorial Guinea, a country experiencing economic and political instability.

North Africa had the highest clean cooking access rate in the Africa region, increasing from 75% in 2000 to 84.9% in 2014. (Further analysis for North Africa is in the Arab region chapter of this publication.) In Central, Eastern, Southern, and West Africa, the share of population using clean cooking barely grew from 11.3% in 2000 to 12.3% in 2014. About 3 million people obtained access each year, while the total population grew seven times as fast.

High- and upper-middle-income countries in Africa (excluding North Africa) were the fastest in expanding access to clean cooking in 2000–14, as the share of population with access grew by 1.7 percentage points a year (figure 8.6). This trend was driven by South

FIGURE 8.6 The gap in access to clean cooking between high- and upper-middle-income countries, and lower-middle- and low-income countries, in Africa (excluding North Africa) widened in 2000–14

Share of population with access to clean cooking (%)

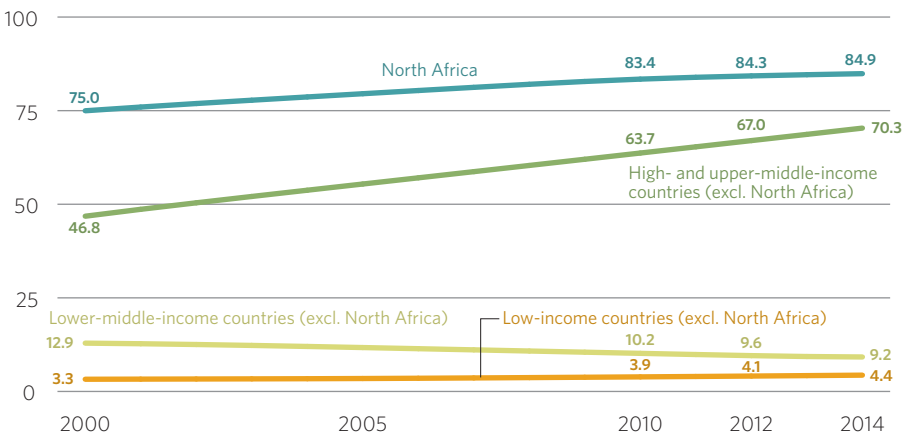
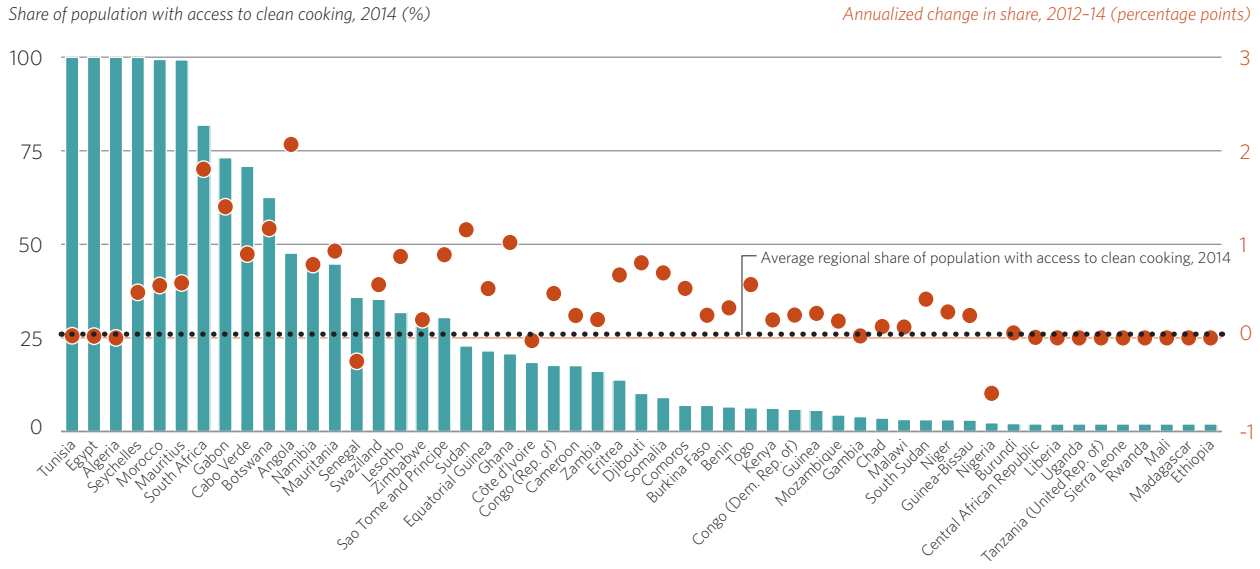


FIGURE 8.7 Most African countries had less than 20% access to clean cooking in 2014



Africa, accounting for over 60% of the population in the subgroup. South Africa reached an 81.8% clean cooking access rate in 2014, following strong uptake of electricity and to some extent LPG (Haselip et al. 2016) (figure 8.7).

Lower-middle-income countries in Africa (excluding North Africa) started from a low rate of access to clean cooking and declined further, with the share of population cooking with clean fuels and technologies falling from 12.9% in 2000 to 9.2% in 2014. This weak performance was driven by Nigeria, which accounted in 2014 for over half the population in the subgroup. Nigeria reported a decreasing rate of access from 13.2% in 2000 to 2.3% in 2014, resulting from a combination of increasingly unreliable electricity supply and low usage of LPG (so that consumers resorted to cooking with traditional biomass) with a rapid increase in total population (Bisu, Kuhe, and Iortyer 2016). Senegal showed declining access rates, due to the complete removal of LPG subsidies in 2009, when the policy of "butanization" ended and some households returned to charcoal for cooking (Nanasta 2014). Ghana had the fastest-growing access to clean cooking, driven by dissemination of clean cookstoves and affordable LPG cylinders.

Low-income countries in Africa (excluding North Africa) showed an extremely low clean-cooking access rate of only 4.4% in 2014, a negligible increase from 3.3% in 2000. All low-income countries reported shares of population with access to clean cooking of under 15% in 2014, except Zimbabwe (31.3%), which had already made significant progress on clean cooking, primarily in the form of electricity, before the economic crisis.

ENERGY EFFICIENCY

Regional progress

The Africa region reported the highest energy intensity (high energy intensity is a measurable proxy for low energy efficiency) among all regions in 2014, along with the Asia-Pacific region, 6.0 MJ/2011 PPP $ (megajoules per 2011 purchasing power parity dollar), compared with the global average of 5.5 MJ/2011 PPP $. In 1990–2010, energy intensity in the region decreased from 7.5 MJ/2011 PPP $ to 6.2 MJ/2011 PPP $ (figure 8.8). Energy intensity improvements partly reflect movements in global oil prices, which boosted GDP of oil-producing nations, particularly between 2000 and 2010. The decline in energy intensity slowed in 2010–12, due to a dip in oil prices in 2009 (figure 8.9), but accelerated again in 2012–14 as GDP returned to higher levels, driven by the recovery of oil prices (Institute for 21st Century Energy 2013). In 2012–14, the Africa region avoided 0.6 EJ (exajoules) of final energy consumption, or 5.1% of global avoided energy consumption, equivalent to the 2014 TFEC of Kenya.

Countries have not focused policy on allocating resources to promoting energy efficiency and have not set targets, though some are starting to do so as part of national SEforALL initiatives. Energy intensity declines are inhibited by the high share of traditional solid biofuels consumption, which is not amenable to large energy efficiency gains. But declines are expected as countries switch from traditional biomass to modern fuels. Some energy efficiency measures were adopted since 2008 in the electricity sector, as utilities attempted to meet growing energy demand and alleviate power shortages.

Changes in energy intensity varied by economic sector. In the industrial sector, energy intensity improved after 2010, driven by a decline in mining and manufacturing in South Africa (figure 8.10). Agriculture in the Africa region reported the lowest sectoral energy intensity among all regions at 0.5 MJ/2011 PPP $ in 2014, compared with the global average of 1.2 MJ/2011 PPP $. Agriculture's energy intensity declined far faster in 2012–14 than in earlier periods, partly because drought led to high food prices and increased imports, fueling GDP growth, while energy demand remained low given the sector's low level of mechanization (IMF 2012). Energy intensity in services, after two decades of decline, recorded the greatest sector increase in 2010–12 and 2012–14, due to expanding information and communications technology infrastructure. The residential sector's energy intensity was flat. Sector data are missing for many countries, even for agriculture, a major activity for all countries in Africa (excluding North Africa). Hard-to-capture data on informal agricultural practices may be

FIGURE 8.8 Declining energy intensity in Africa was driven by rising global oil prices, boosting GDP through oil revenues

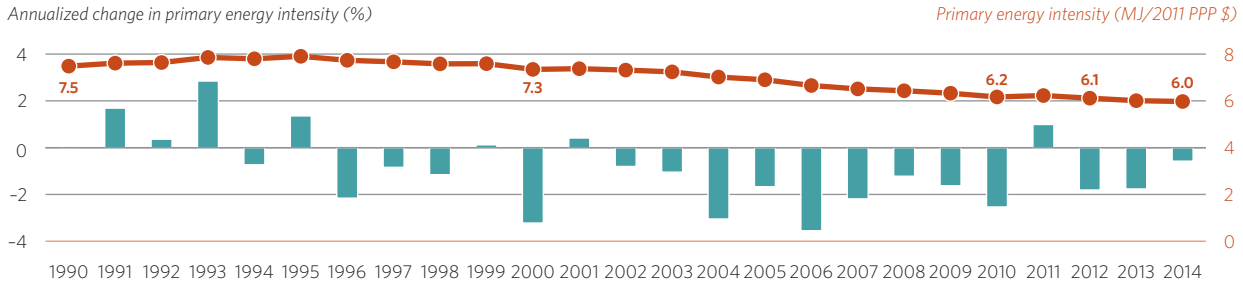


FIGURE 8.9 Energy intensity's decline slowed in 2010–12 due to a dip in oil prices in 2009

Primary energy intensity compound annual growth rate (%)

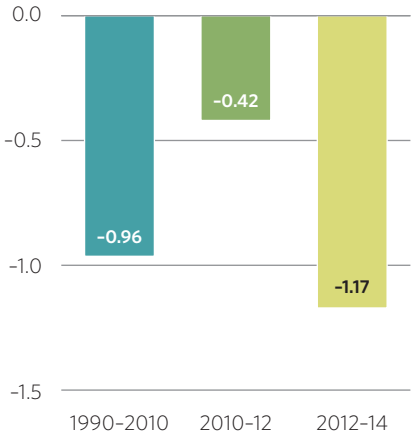
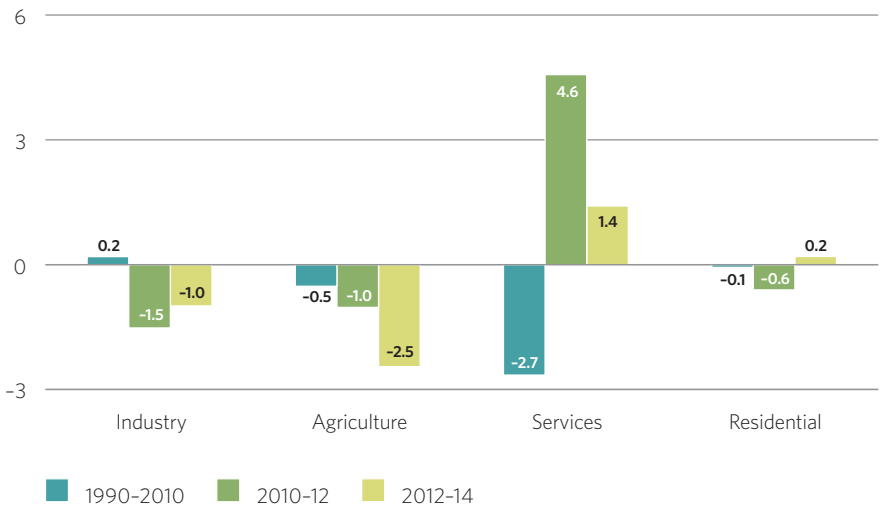


FIGURE 8.10 All sectors presented improving trends in 2010–14, except services

Final energy intensity compound annual growth rate (%)



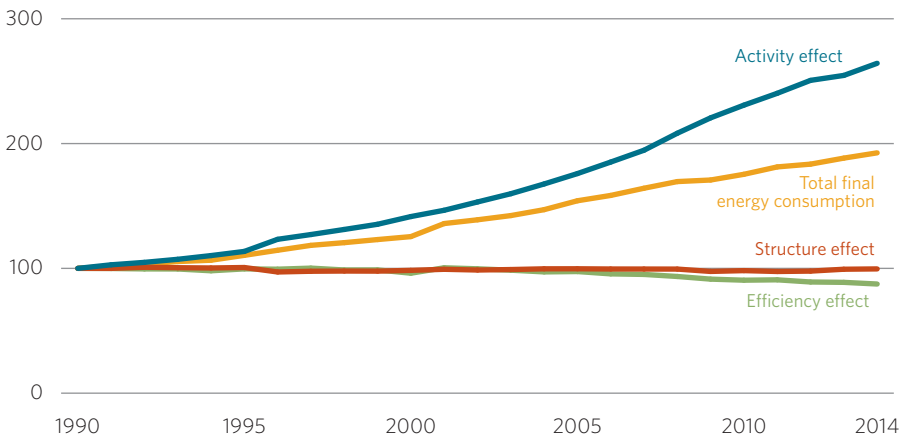
missing, and data on industry and services may also have large gaps.

Supply-side efficiency in electricity generation showed a modest improvement in the region. The efficiency of thermal power generation increased modestly from 35.7% in 1990 to 36.7% in 2014, despite the high proportion of generation by coal-fired plants, whose lower efficiency dropped further in 1990–2014. Transmission and distribution losses of electricity increased from 10.4% in 1990 to 15.1% in 2014, the third-highest rate after Latin America and Caribbean and the Arab region. By contrast, transportation losses in natural gas decreased from 1.6% in 1990 to 0.5% in 2014.

The decomposition analysis[5] of trends in TFEC shows that decoupling of economic growth from energy consumption began over a decade ago (around 2003–04), when GDP from oil and services increased faster than total primary energy supply (see figure 8.11). The economic structure (balance between agricultural, manufacturing, and services activities) remained unchanged.

FIGURE 8.11 Decoupling in the Africa region was initiated over a decade ago, driven by GDP's lift from rising oil revenues

Index (1990 = 100)



Subregional progress

Energy intensity was stable in North Africa but declined across Central, Eastern, Southern, and West Africa. Africa's low-income countries' energy intensity of 10.3 MJ/2011 PPP $ in 2014 was roughly double the global average, despite a steep reduction since 1990. Africa's middle-income countries reached much lower levels of energy intensity, in the 6–7 MJ/2011 PPP $ range. Africa's high- and upper-middle-income country group became somewhat more energy intensive than the lower-middle-income group in the early 2000s, likely due to higher levels of industrial activity (figure 8.12).

North Africa's energy intensity was the lowest in the Africa region, at 3.9 MJ/2011 PPP $ in 2014. (Further analysis for North Africa is in the Arab region chapter.) The Central, Eastern, Southern, and West Africa subregions reported the second-highest level of energy intensity among all regions in 2014, 7.3 MJ/2011 PPP $, equivalent to the level reached by the Eastern Europe, Caucasus, and Central Asia subregion.

Energy intensity in high- and upper-middle-income countries in Africa (excluding North Africa) grew in 2012–14 after declining steeply in 2010–12 by 3.7% (compound annual growth rate). The subgroup's energy intensity was the second highest in Africa in 2014, 7.5 MJ/2011 PPP $$. Trends are driven by South Africa,[6] whose high 2014 energy intensity of 9.2 MJ/2011 PPP $$ in 2014 is due to its energy-intensive industries and mining (figure 8.13). South Africa's energy intensity declined steeply in 2010–12, when the mining and manufacturing sectors contracted and shortages of energy supply increased, before rising again in 2012–14. Gabon's energy intensity increased the fastest in 1990–2014: total energy supply increased faster than GDP beginning in the early 2000s, when there was a surge in biomass supply (Enerdata 2016).

Lower-middle-income countries in Africa (excluding North Africa) showed wide energy intensity variations in 1990–2014. The subgroup's energy intensity overall declined sharply, reaching 5.8 MJ/2011 PPP $ in 2014, heavily influenced by Nigeria[7] and its industrial sector. Nigeria's energy intensity declined steeply beginning in the mid-2000s, driven by a growing GDP that coincided with rising oil and gas prices.

Low-income countries in Africa (excluding North Africa) reported the highest energy intensity across the continent and the world, 10.3 MJ/2011 PPP $ in 2014. These countries are hugely reliant on traditional biomass, whose combustion is inefficient and contribution to GDP limited. However, energy intensity has been declining since 2000 as these countries shift from traditional biomass. Mozambique's energy intensity declined the fastest when GDP increased faster than energy supply because of

FIGURE 8.12 Energy intensity remained stable in North Africa, but declined in the rest of the continent in 1990–2014

Primary energy intensity (MJ/2011 PPP $)

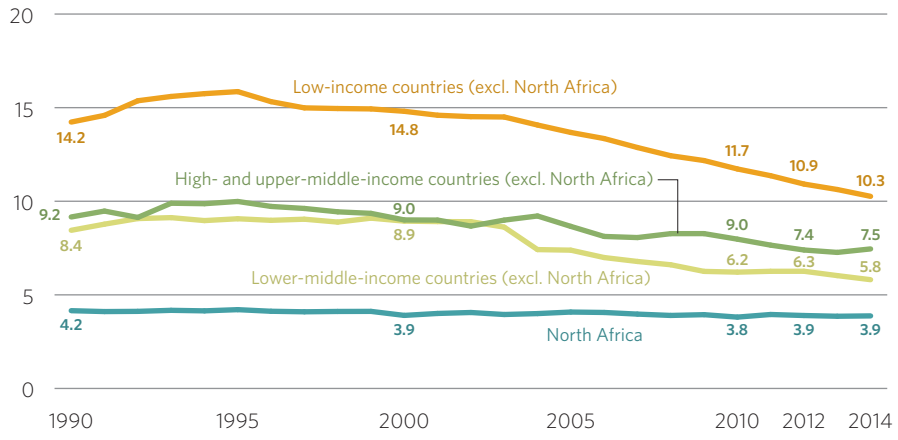
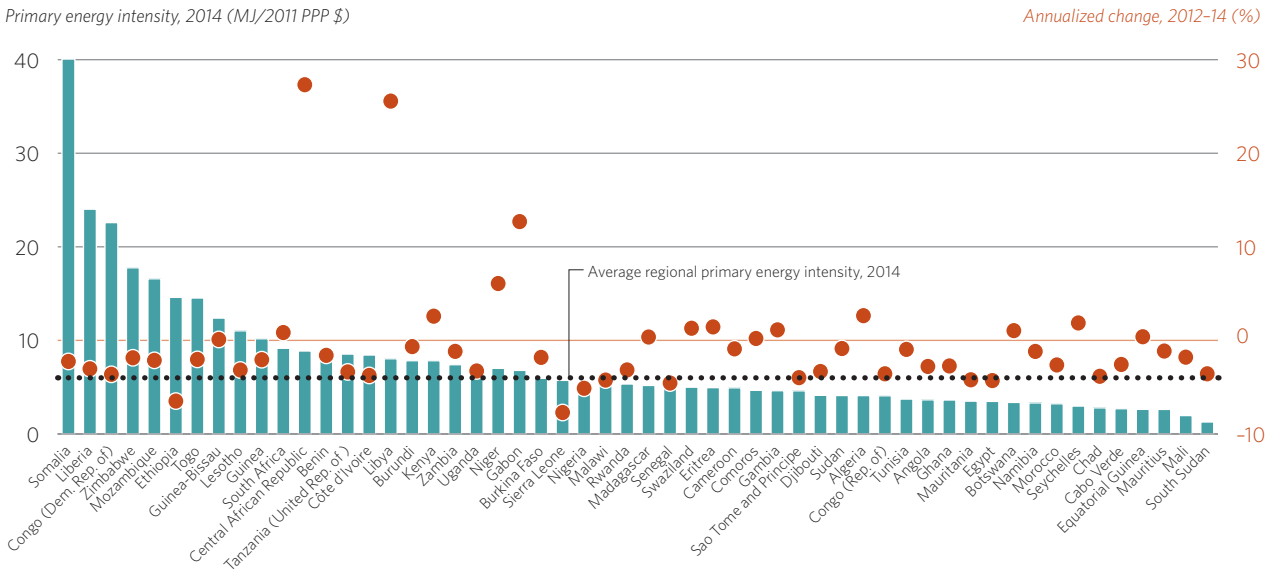


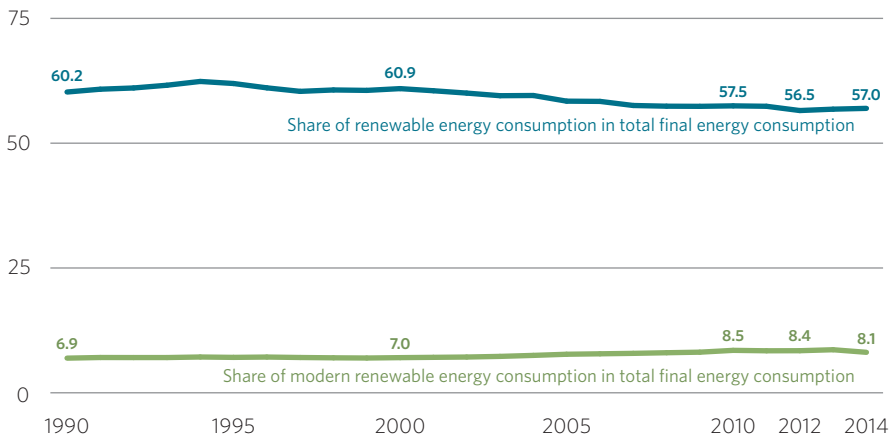
FIGURE 8.13 Energy intensity varied from about 40 MJ/2011 PPP $ in Somalia to around 1 MJ/2011 PPP $ in South Sudan in 2014



aluminum exports after the early 2000s and coal exports after 2011 (OECD 2013). Somalia's energy intensity was the highest in the subgroup because its energy mix is completely dominated by locally available charcoal and firewood. Somalia, after the state collapsed in the early 1990s and incomes dropped, floundered at importing energy to boost the economy (Federal Government of Somalia and AfDB 2015).

FIGURE 8.14 Africa maintained the highest share of renewable energy consumption in the world in 1990–2014

Share (%)



RENEWABLE ENERGY

Regional progress

Africa's renewable energy consumption was 57% of TFEC in 2014, the highest share in the world, driven by reliance on traditional biomass. That share, down from 60.2% in 1990, reflected a modest shift from traditional biomass to modern fossil fuels as economies developed (figure 8.14).

Biomass resources are abundant in most countries in the Africa region. Other renewable resources vary by location: hydropower in Egypt, Mozambique, and Zambia; geothermal energy in the Rift Valley; solar energy in North Africa and Southern Africa; and wind power in North Africa and along the southern coast. Fossil fuels can be least-cost options for countries that have them.

Uptake of traditional biomass consumption generally tracks population growth, especially in countries with abundant biomass such as those in Central, Eastern, Southern, and West Africa. Total energy supply is not much reduced there even when economic sectors such as agriculture and mining perform badly.

Grid and off-grid electricity solutions based on modern forms of renewable energy have been tried across the continent to increase electricity access, secure a reliable power supply, and ensure energy sustainability. Modern liquid biofuels have also been introduced in some places to reduce petroleum imports. Nevertheless, fossil fuel supply is often increased to meet growing energy demand. And hydropower, a major source of modern renewable energy in Africa, is often affected by drought and may cause fluctuations in a country's renewable energy consumption from one year to the next.

Newer renewable energy technologies—solar photovoltaic, wind, and small hydropower—have shorter lead times than traditional power generation and can attract investments more easily, especially as their costs have recently become comparable to those of conventional power plants. But in Africa most renewable energy (and energy efficiency) technologies are imported, and their restricted supply channels and high total costs for equipment, shipping, and tariffs (landed costs) constrain dissemination. However, efforts in the Africa region to manufacture equipment, such as solar panels in Mozambique and wind turbines in South Africa, may improve access.[8]

Electricity trade through power pools has helped alleviate power shortages and expanded markets for renewable energy. South Africa, for example, stands a chance to increase its share of renewable energy in its electricity mix, which is dominated by coal, by importing low-cost hydropower from its northern neighbors (ECA 2009). The Ethiopia–Kenya interconnector, under construction, will allow exchange of hydropower from Ethiopia with the East African Power Pool and eventually the predominantly fossil fuel-based Southern African Power Pool.

Innovative policies to attract private sector investment have been implemented. Competitive bidding has helped increase the share of renewable energy in South Africa since 2011. Feed-in tariffs have attracted some similar investments, particularly for smaller plants under 5 MW. Renewable energy policies and strategies stipulated in the SEforALL Action Agenda and Investment Prospectus are taking off in many African countries. Other programs such as Power Africa, the Africa Clean Energy Corridor, the Africa-EU Energy Partnership, African Development Bank New Deal on Energy, Energy and Environment Partnership in Southern and Eastern Africa, and National Determined Contributions under the Paris Agreement on climate change are promoting renewable energy.

Modern renewable energy consumption increased from 6.9% of TFEC in 1990 to 8.1% in 2014. Modern solid biofuels, representing 77% of modern renewable energy consumption in 2014 (figure 8.15), are used in simple furnace and boiler systems to raise steam for electricity generation and other industrial processes such as tobacco curing, tea processing, beer brewing, and fish drying. Modern solid biofuels also provide direct heat for brick burning, lime burning, and cement kilns (Practical Action 2008). They stand out because they can be locally sourced, avoiding fluctuating costs and shortages associated with poor fuel supply networks, especially where modern commercial fuel supplies or electricity are remote. Hydropower supplied 20.7% of modern renewable energy in 2014. All other sources—liquid biofuels, geothermal, wind power, and solar power—provided negligible shares of modern renewable energy in 2014, despite strong growth in 2012–14.

Data availability is problematic in several countries but should be improved by renewable energy programs and target monitoring. Modern and traditional biomass need to be clearly distinguished and accounted for—for example, use of solid biofuels for tobacco curing is associated with woodland depletion.

Subregional progress

The penetration of renewable energy across Africa is inversely tied to income (figure 8.16). In low-income and lower-middle-income countries, the share exceeds 80% due to reliance on traditional biomass. The switch from traditional biomass to modern, often fossil-based, energy sources seems to take place between the

FIGURE 8.15 In Africa modern renewable energy was dominated by solid biofuels in 1990–2014

Modern renewable energy consumption (exajoules)

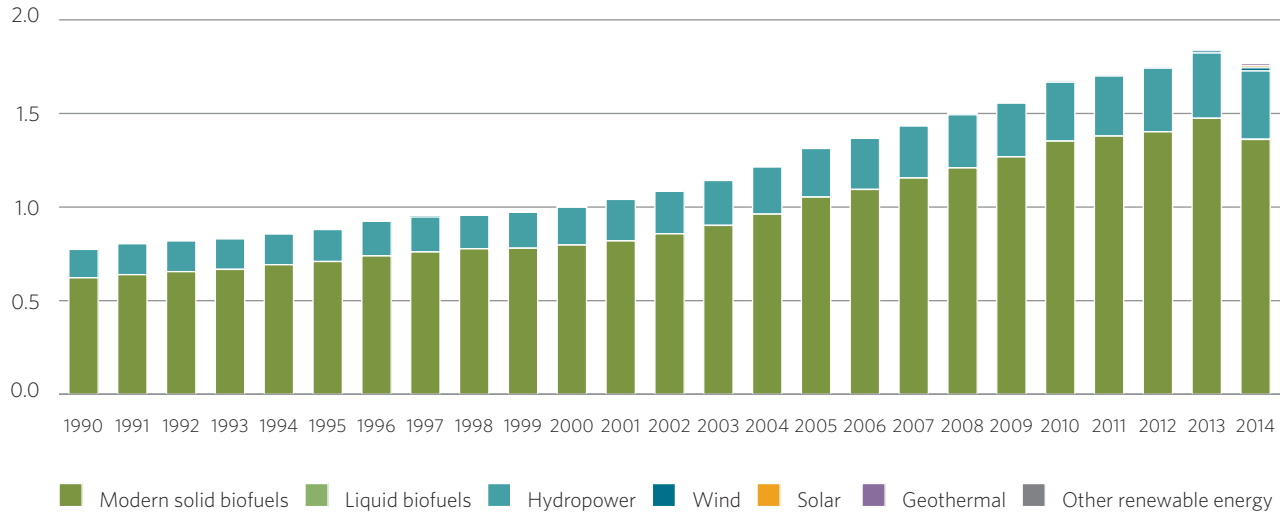
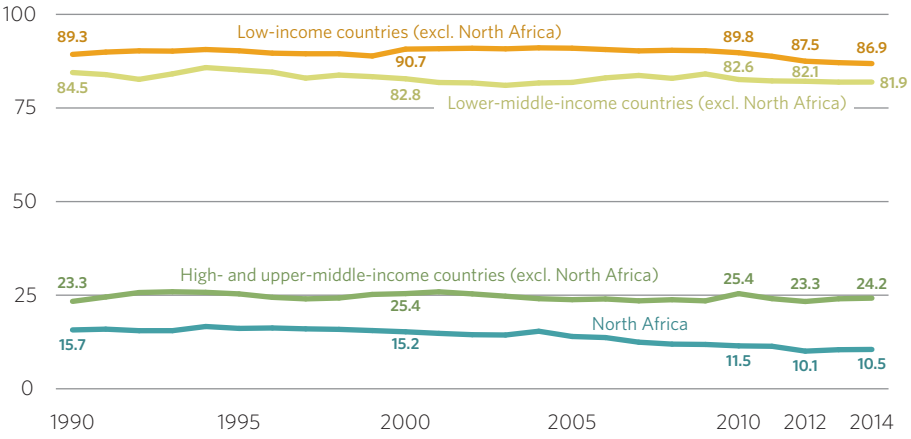


FIGURE 8.16 Share of renewable energy consumption in total final energy consumption was negatively correlated with income, influenced by heavy reliance of traditional renewable energy in poorer subgroups

Share of renewable energy consumption in total final energy consumption (%)



lower-middle-income, upper-middle-income, and high-income groups, where the renewable energy share falls below 25%.

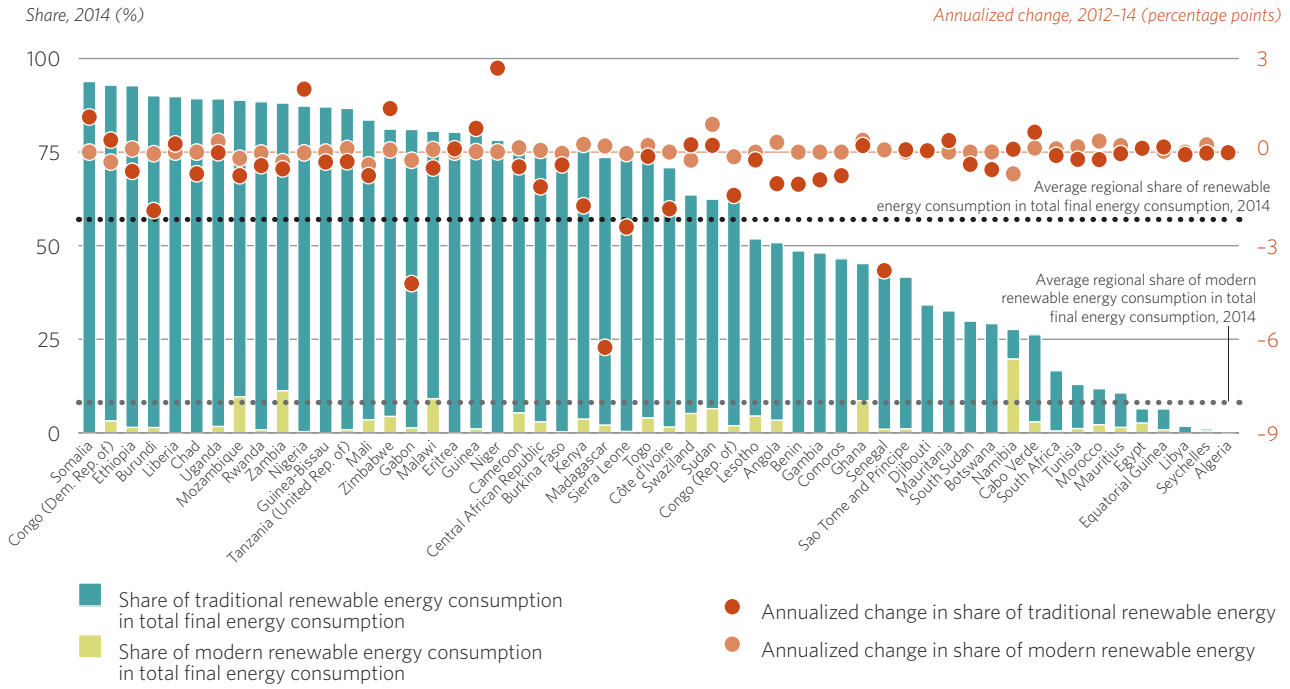
North Africa's share of renewable energy consumption in TFEC was 10.5%, the lowest in the Africa region, in 2014 (figure 8.16). Shares of both modern and traditional renewable energy consumption declined over 1990–2014, with the share of traditional renewable energy consumption declining faster. In 2012–14, however, the shares of both expanded, with the share of modern renewable energy consumption increasing faster. (Further analysis for North Africa is in the Arab region chapter.)

In Central, Eastern, Southern, and West Africa, the share of renewable energy consumption in TFEC remained stable in 1990–2014 and was 70.5% in 2014. The share of traditional renewable energy consumption fell marginally during the period to 61.4%, while the share of modern renewable energy consumption increased moderately to 9.0%.

In high- and upper-middle-income countries in Africa (excluding North Africa), the share of renewable energy consumption in TFEC reached 24.2% in 2014. The share of traditional renewable energy consumption was the lowest in Africa (excluding North Africa) in 1990–2014, 17.7% in 2014, due to high penetration of fossil fuels in several countries. Conversely, the share of modern renewable energy consumption increased in 1990–2014, although in 2014 it was three times smaller than the share of traditional renewable energy consumption. Change accelerated sharply in 2012–14, particularly because South Africa (figure 8.17) initiated the Renewable Energy Independent Power Producer Procurement Program in November 2011 to boost investments in modern renewable energy. Going forward, the share of renewable energy consumption in South Africa is expected to increase further because by August 2014 five bidding rounds had been completed, leading to 92 renewable energy projects accounting for over 6,327 MW, mainly in wind and solar power (DoE of South Africa 2014).

Lower-middle-income countries in Africa (excluding North Africa) showed a high share of renewable energy consumption, 81.9% of TFEC, in 2014, dominated by traditional renewable energy consumption, 73.9% of TFEC that year. The subgroup's share of modern

FIGURE 8.17 Africa's high share of renewable energy reflected high yet falling reliance on traditional biomass in many countries in 2012–14



renewable energy consumption increased from 6.9% of TFEC in 1990 to 8.0% in 2014. The Rift Valley of Africa has high potential for geothermal power generation, and Kenya has taken the lead in exploiting the resource. The Kenyan government formed the Geothermal Development Company in 2009, a semi-autonomous state-owned company, as a special-purpose vehicle to fast-track geothermal resources. It has a target of 5,450 MW of installed capacity by 2030, up from 593MW in 2014 (Government of Kenya and SEforALL 2015). In 2014, Kenya reached the 13th highest position globally for geothermal energy consumption. Also in 2014, Cabo Verde reached the highest share in Africa of wind power consumption in total renewable energy consumption at 2.7%, up from 0.1% in 2010, promoted by a supportive market structure for investment in renewable electricity generation and strong political will to shift from unsustainable fossil fuel imports (IRENA 2014).

Low-income countries in Africa (excluding North Africa) had the highest share of renewable energy consumption in total energy consumption, at 86.9% in 2014, driven by traditional renewable energy consumption, which was also the highest at 75.1% that year. Modern renewable energy consumption is mainly modern solid biofuels in most countries, and hydropower in countries such as the Democratic Republic of Congo, Ethiopia, and Mozambique. Use of new modern renewable energy sources is slowly increasing in the subgroup. Wind consumption was reported in 2014 only by Ethiopia, which set targets to exploit its large potential in wind power (ASD 2015). With an installed capacity of 171 MW, Ethiopia has the largest installed wind capacity in the Eastern Africa region and is fifth in the continent. In 2012, the 51 MW Adama 1 wind project became the largest wind farm in the region, surpassed in 2013 by the 120 MW Ashegonda Wind Farm, the largest in Africa (ASD 2015).

NOTES

1. Following the World Bank classification for 2014, high-income countries had a gross national income (GNI) per capita of $12,736 or above; upper-middle-income countries had a GNI per capita between $4,125 and $12,735; lower-middle-income countries had a GNI per capita between $1,046 and $4,124; and low-income countries had a GNI per capita of $1,045 or below.
2. 2013 data.
3. The reference year for the analysis is 1991 instead of 1990 because in 1991 five countries with extremely low access were added (Mali, Rwanda, Somalia, Swaziland, Togo), decreasing significantly the average access rate (from 77.2% in 1990 to 70.4% in 1991).
4. For instance, all Southern African Development Community (SADC) countries have such rural electrification agencies or units, except Seychelles and Mauritius (which are already fully electrified).
5. The decomposition analysis explains the energy consumption trends through three underlying forces: the activity component, the efficiency component, and the structural component.
6. In 2014, South Africa accounted for over two-thirds of the subgroup's GDP and over 80% of the subgroup's total primary energy supply.
7. In 2014, Nigeria accounted for two-thirds of the subgroup's GDP and total primary energy supply.
8. In the past, only batteries and charge controllers have been produced in countries of the Africa region.

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9

THE ARAB REGION

The regional profile of the Arab region has been written with the UN Economic and Social Commission for Western Asia (ESCWA).

REGIONAL OVERVIEW

The Arab region comprises 19 countries, divided into four subregions, with a population of 372.1 million in 2014, representing 5.1% of the world's population (table 9.1). Natural resources vary widely, while water scarcity and food security are major challenges overall. Income and wealth vary widely in the region, which includes high- and middle-income countries (with a combination of exporters and net importers of energy), as well as three least developed countries (LDCs) with high levels of energy poverty.[1]

In 2014, the region accounted for 5.1% of the world's total primary energy supply, 7.8%[2] of its carbon dioxide emissions, and 5.6% of its gross domestic product (GDP) (2011 PPP $), much of it generated in the Gulf Cooperation Council (GCC) subregion. Fossil fuels still dominate much of the region's primary energy mix. Arab economies account for some 40% of the world's proven crude oil and around a quarter of global natural gas reserves (IEA 2016), and are major net exporters of energy to international markets. Fast-growing energy demand in the region, coupled with prospects of the Middle East becoming a global economic center by 2030 alongside the Asia–Pacific region, drives the need to diversify energy sources and to move to a more sustainable energy sector.

TABLE 9.1 Countries by subregion

Arab North Africa	Mashreq	Gulf Cooperation Council	Arab least developed countries
1. Algeria	1. Egypt	1. Bahrain [a,d]	1. Mauritania [f]
2. Libya [b]	2. Iraq [e]	2. Kuwait [a,d]	2. Sudan
3. Morocco	3. Jordan	3. Oman [a,d]	3. Yemen [e]
4. Tunisia	4. Lebanon	4. Qatar [a,d]	
	5. Palestine (State of) [b]	5. Saudi Arabia [a]	
	6. Syrian Arab Republic [e]	6. United Arab Emirates [a]	

a. Access to electricity rate estimated to be 100%.[1]

b. Data on access to clean fuels and technologies for cooking not available.

c. Data on energy intensity not available.[2]

d. Total renewable energy consumption data either not available or reported being zero.[3]

e. Traditional energy consumption data either not available or reported being zero.[4]

f. Modern renewable energy consumption data either not available or reported being zero.[5]

1. GCC countries did not report their access to electricity rate.

2. Although all countries reported overall energy intensity, data for energy intensity by sector was not available in 2014 for several countries: energy intensity in agriculture was not available for 7 countries; energy intensity in industry was not available for 3 countries; energy intensity in services was not available for 3 countries. For more details, see data annex 2.

3. Renewable energy consumption data are based on databases of the International Energy Agency (IEA) Energy Data Center and United Nations Statistics Division (UNSD). When data for total, modern, or traditional renewable energy consumption is not available this may be due to either negligible consumption, or energy balance data not being available at the necessary level of detail, or uses of renewable energy that are not captured by official country statistics as reported to the IEA Energy Data Center and UNSD.

4. Ibid. Also, traditional renewable energy consumption is assumed to be only the consumption of solid biomass in the residential sector of non–Organisation for Economic Co-operation and Development (OECD) countries (that is, no traditional renewable consumption is assumed to occur in OECD countries). This IEA convention has been adopted in the Global Tracking Framework, due to the heavy reliance on the IEA data (see box 5.1 for further details).

5. Ibid.

ACCESS TO ELECTRICITY

Regional progress

The Arab region ranked third globally in 2014 in access to electricity, after the Europe, North America, and Central Asia region, and the Latin America and Caribbean region, closely followed by the Asia–Pacific region. The Arab region's access rate reached 90.4% in 2014, up from 76.2% in 1990, as 7.8 million people (equivalent to the population of Jordan) gained access each year (figure 9.1). Improved access rates were driven by the prevalence of middle- to high-income countries in the region, where governments supplied electricity (and clean fuels and technologies for cooking) widely. High rates of urbanization in the GCC and Mashreq subregions also supported the access rate. The region's oil and natural gas endowments helped many countries across the Middle East and North Africa close gaps in access to electricity and to clean fuels by the 1990s and 2000s. However, about 35.8 million people in the region (equivalent to Iraq's population) still lacked access to electricity in 2014, 21.7 million of them in Sudan. Three LDCs accounted for over 85% of the Arab region's remaining deficit in access to electricity.

In urban areas, the rate of access to electricity, 93.8% in 1990, reached 97.3% in 2014, but about 5.8 million urban people remained without access. In rural areas, access increased from 59.4% in 1990 to 80.5% in 2014, but about 30.4 million people still lacked access (figure 9.2). In countries with incomplete access (below 98%), rural access rates persistently lagged far behind urban ones. The urban–rural gap ranged from around 10 percentage points in Morocco to over 60 percentage points in Mauritania. Access is often restricted by geography, including remoteness of settlements and villages, particularly in mountainous areas, that are uneconomic to connect to the main grid. Recently, several off-grid and mini-grid solutions based on renewable energy have become cost-competitive with diesel generators, suggesting that levelized energy costs of such projects will fall, provided that governments give initial support (IRENA 2015; IRENA 2016).

The quality and reliability of electricity supply is frequently forgotten. Service disruptions and power outages are common in many countries even though access is universal, following decades of underpricing electricity and consequently underfunding of national utilities, underinvesting in infrastructure and neglecting it, delaying market liberalization, and lack of legal frameworks or economic incentives to attract private investment. In Yemen, Iraq, and the State of Palestine, destruction of infrastructure in conflict has further exacerbated these problems.

Subregional trends

All subregions reached close to universal access with electrification above 95% by 2011 except the Arab LDCs, which struggled to close the gap with the other subregions (figure 9.3). Among the few countries that had not achieved universal access, Libya, Morocco, and the Syrian Arab Republic were well on their way while the Arab LDCs lagged far behind (figure 9.4).

Access in the Arab North Africa subregion grew the fastest in the region, from 74.7% in 1990 to 96.7% in 2014 (see figure 9.4). The subregion has benefited from policies supporting access, particularly in rural areas, since the early 1990s. Morocco was the last North African country to close its urban–rural access gap in the 1990s and 2000s, with a dedicated program that electrified more than 35,000 villages and some 1.9 million rural households over 15 years (El Katiri 2016).

The Mashreq subregion also has high electricity access rates, which already stood at 92.2% in 1990 and reached 99.1% in 2014. However, in conflict-affected countries such as Libya, infrastructure and power generation

FIGURE 9.1 The Arab region had sustained growth in electricity access rates in 1990–2014 but still fell short of universal access

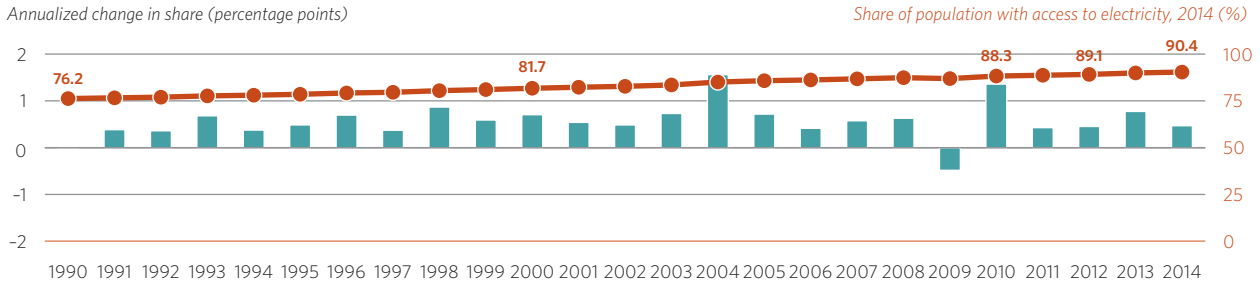
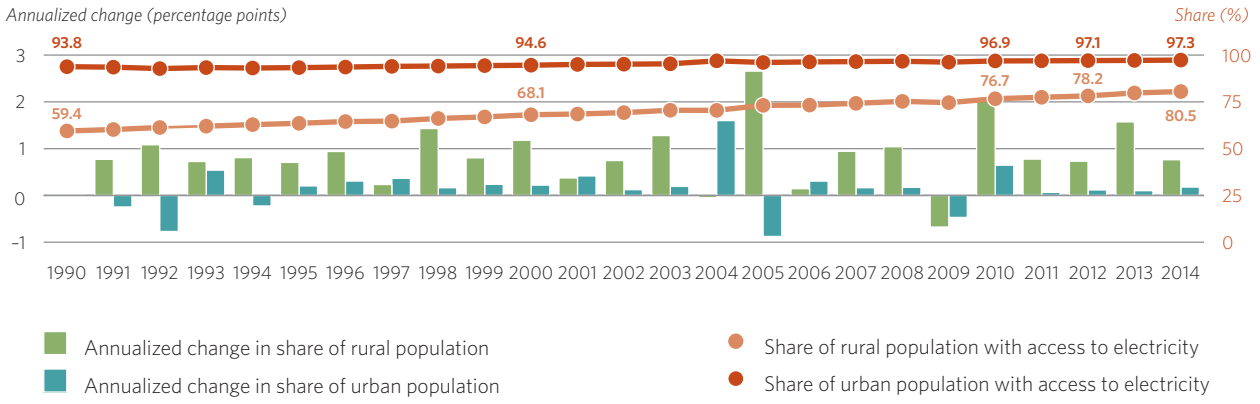


FIGURE 9.2 The gap between rural access and nearly universal urban access in the Arab region has been narrowing gradually over the last 25 years



have been severely affected, and data collection has been undermined (UN ESCWA 2015b; UN ESCWA 2016b). Service disruptions have become more frequent, affecting large parts of the subregion's population. In the State of Palestine, Gaza suffered from endemic power cuts and load shedding due to high costs of imported electricity and destruction of infrastructure in conflict (UN OCHA 2013). In addition, the living conditions of the large number of refugees in various countries have gone undocumented.

The GCC economies are among the wealthiest nations in the Arab region and enjoy virtually universal access. Small gaps in coverage remain in remote and mountainous territory in Saudi Arabia and Oman, but the high rate of urbanization in the GCCs' smaller members, coupled with very small populations of merely a few million and very high per capita income mean that access is universal.

The Arab LDCs continue to face the largest gap in electricity access. The subregion's electricity access rate moved from 31.8% in 1990 to 54.8% in 2014. Access rates in 2014 ranged from a high of 72% in Yemen, to 44.9% in Sudan, to a low of 38.8% in Mauritania (see figure 9.4). These rates result from decades of underinvestment in infrastructure coupled with low urbanization, dispersed rural settlements, and underlying development problems that feed a vicious circle of high poverty and low electrification. Even so, Mauritania's urban access surged from 3.0% in 1990 to 63.9% by 2014.

FIGURE 9.3 Universal access to electricity was largely achieved across the Arab region in 2014, with the notable exceptions of the Arab least developed countries

Share of population with access to electricity (%)

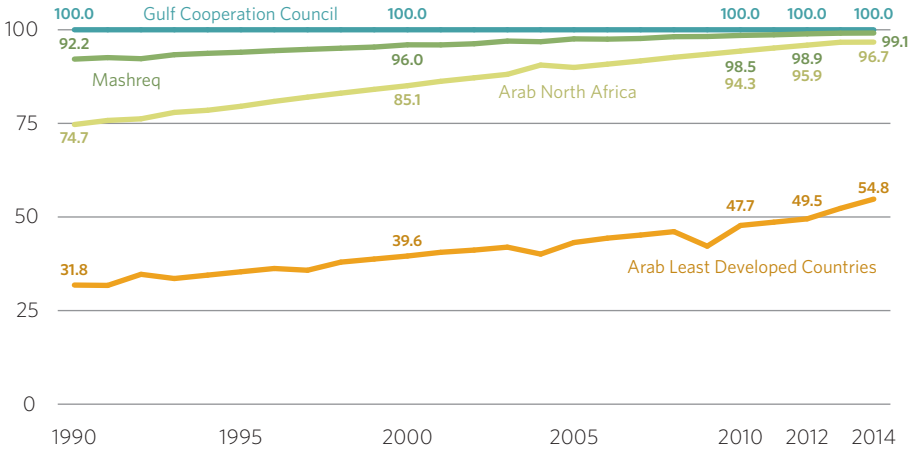
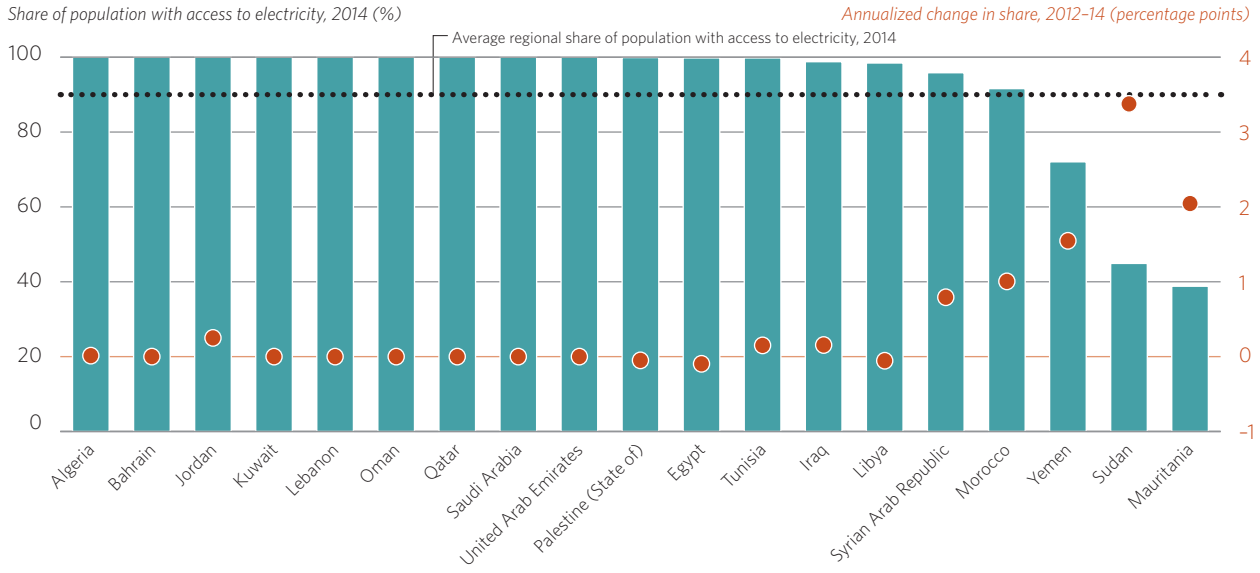


FIGURE 9.4 Arab countries with the lowest electricity access rates expanded access fast



ACCESS TO CLEAN FUELS AND TECHNOLOGIES FOR COOKING

Regional progress

The Arab region's 88% rate of access to clean fuels and technologies for cooking (here "clean cooking") ranked second among all regions in 2014, after the Europe, North America, and Central Asia region and just ahead of the Latin America and Caribbean region. The share had risen from 79.2% in 2000, adding 7.8 million new users a year, equivalent to the population of Jordan (figure 9.5). It is one of the few regions in the world where access to clean cooking is almost on a par with access to electricity.

The drivers of the high access rates to clean cooking in the region are similar to those for electrification. Middle- and high-income countries have historically put considerable gas supply infrastructure in place, enjoying access to technology and low-cost fuels. In addition, a relatively well-educated population has been more disposed to adopt modern fuels, as evidenced by significant use of liquefied petroleum gas (LPG) cookstoves, even in rural areas. Nonetheless, in 2014, 43.4 million people still lacked access to clean cooking, almost equivalent to the population of Yemen and the Syrian Arab Republic combined. The highest deficit was in Sudan, at 30.4 million.

Subregional trends

All subregions reached universal (or at least 99%) access to clean cooking, except for the Arab LDCs where access was severely limited, as was the case for electrification (figure 9.6).

The Arab North Africa subregion closed the gap of access to clean cooking, reaching 99.7% in 2014. The access rate had already been high in 2000 at 91.7%. The Mashreq countries also converged on universal access to clean cooking, reaching 99.5% in 2014, up from 87.4% in 2000. Access in Egypt and Iraq improved considerably. The GCC countries had already reached universal access to clean cooking in 1990, benefiting from their wealthy economies, high urbanization, and domestic supply of fossil fuels.

The three Arab LDCs faced a severe shortage of access to clean cooking, increasing to 38.9% in 2014 from 27.7% in 1990. The Arab LDCs started from that very low rate of access and struggled to narrow the gap with the rest of the region due to highly dispersed populations, low incomes, and lack of infrastructure and institutional capacity. Access is particularly precarious in Sudan and Mauritania despite rising trends. Yemen reached 62.1% access in 2014 (figure 9.7), but that rate had barely budged since 2000. In both Sudan and Yemen, internal conflict and instability limited further progress, particularly in rural areas.

FIGURE 9.5 The Arab region enjoys relatively high access to clean cooking, but the pace of progress slowed notably in recent years

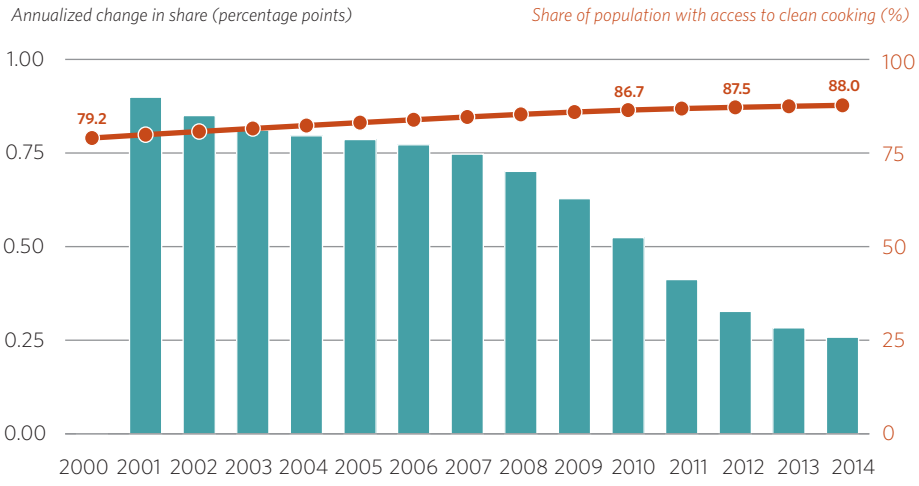
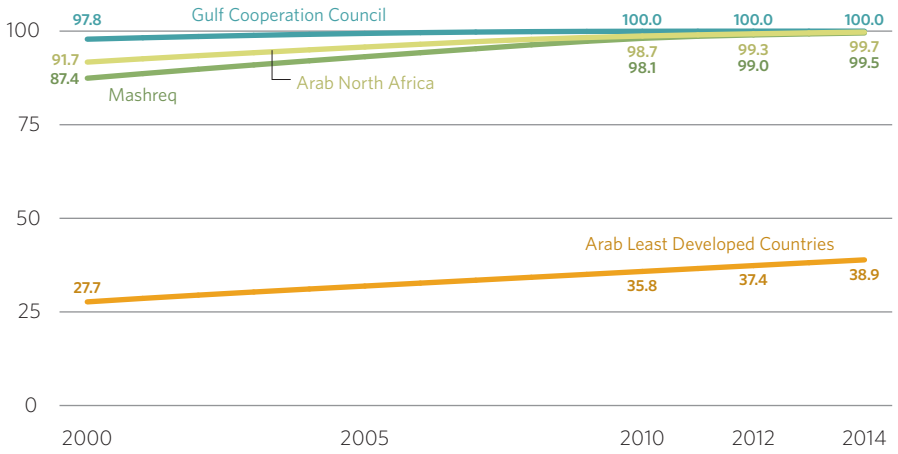


FIGURE 9.6 Most of the region reached universal access to clean cooking in 2014, but a handful of least developed countries lagged a long way behind



ENERGY EFFICIENCY

Regional progress

The Arab region was the region with the second-lowest energy intensity in 2014 (high energy intensity is a proxy for low energy efficiency). The Latin America and Caribbean region was the only one with lower energy intensity. And the Arab region was the only region where energy intensity was rising—from 4.4 MJ/2011 PPP $ (megajoules per 2011 purchasing power parity dollar) in 1990 to 4.9 MJ/2011 PPP $ in 2014—as total energy supply grew faster than GDP (figures 9.8 and 9.9). However, a small decline could be perceived in 2012–14, allowing the region to save about 0.2 EJ (exajoules) of energy, corresponding to 1.3% of global energy savings.

Incentives to improve energy efficiency have been low (with some recent advances) throughout the Arab region for multiple reasons. Abundant fossil fuel is sold at low cost to domestic users, an efficiency disincentive exacerbated by energy subsidies in many countries during global oil price increases in the 2000s. Vertically integrated state-owned electricity utilities have had limited incentives to implement energy efficiency measures and innovative technologies (CCEE 2014). High global oil and natural gas prices from the mid-2000s to June 2014 further reduced the urgency of such measures. Windfall revenues in this period were used largely to expand public spending, particularly in the oil-rich GCC economies (Gause 2013; IMF 2016).

More recently, net-energy-importing countries in the Arab region saw their vulnerability to higher oil prices increase, as well as their bills for fuel and fuel subsidies, spurring them to efficiency measures. Since the 2011 Arab Spring, Egypt, the Islamic Republic of Iran, Jordan, Morocco, and Tunisia have undertaken major energy subsidy reforms and are beginning to let stronger price signals incentivize energy savings (IMF 2014; Sdralevich et al. 2014).

Conflict and political instability have affected the region, particularly Egypt, Iraq, Libya, the Syrian Arab Republic, and Yemen (UN ESCWA 2015b). Data may be misleading in some countries. Fear of conflict contagion has stalled economic reforms and investment programs that could have boosted structural improvement in energy efficiency across the region.

Institutional capacity of governments, regulators, and other public institutions has been weak, as have civil society and consumer interest organizations. Regulatory frameworks and enforcement of technical norms, product labeling, and quality control are also weak, if not absent. Unaffordability of efficient technology prevents household, commercial, and

FIGURE 9.7 Yemen is the only country with low access to clean cooking that is not expanding access at a decent pace

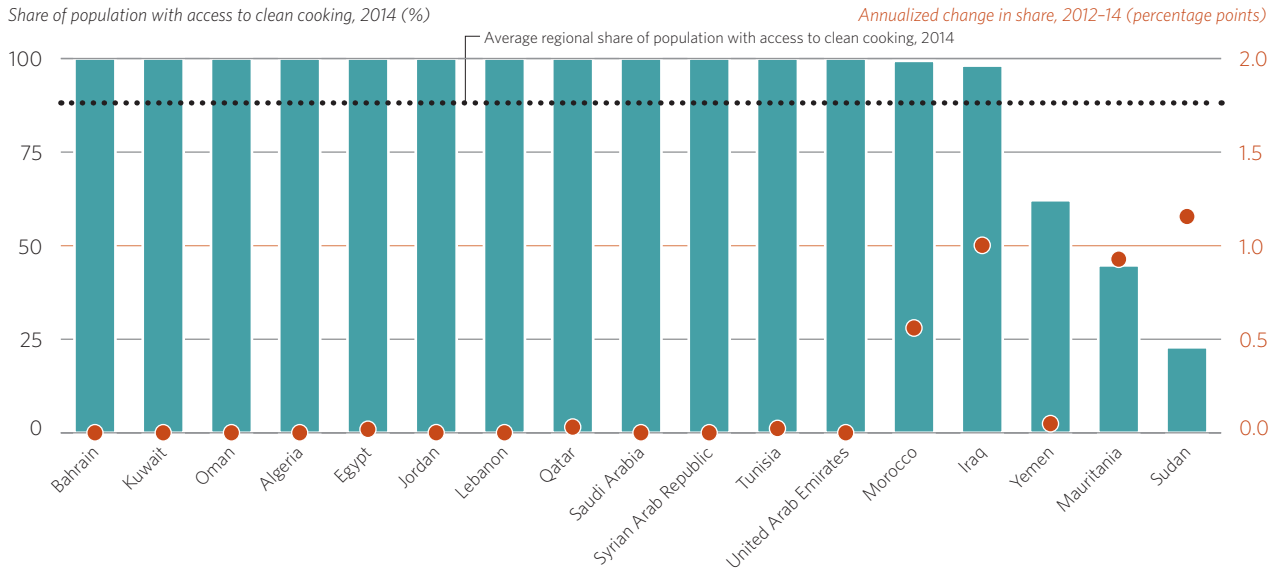


FIGURE 9.8 The Arab region's energy intensity has long been low but has hardly improved in 25 years

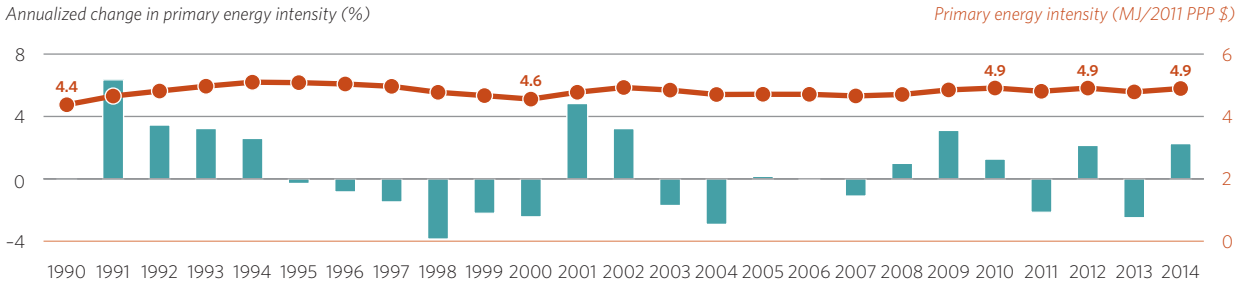


FIGURE 9.9 Following rising energy intensity in the Arab region in 1990–2010, trends started to improve after 2010

Primary energy intensity compound annual growth rate (%)

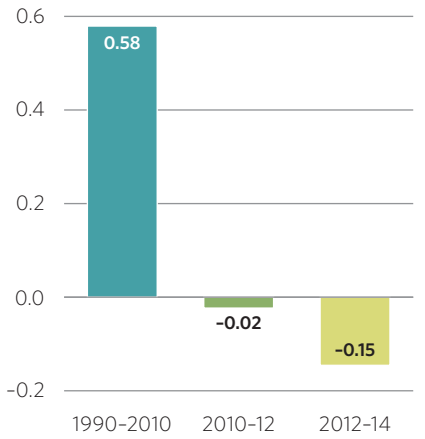


FIGURE 9.10 Trends in energy intensity have generally improved in all economic sectors except services since 1990

Final energy intensity compound annual growth rate (%)

industrial use. Financing mechanisms and dedicated state programs, such as soft loans and banking guarantees for industrial and business investment in energy efficient equipment, are missing in many countries (UN ESCWA 2015c; Ganda and Ngwakwe 2014).

In all economic sectors energy efficiency deteriorated in 1990–2010, and agriculture is the only sector where efficiency has since turned sharply around (figure 9.10). The service sector's energy intensity increased the fastest in 2012–14 after more moderate increases in previous periods.

On the supply side of electricity efficiency, the Arab region showed upward trends. The thermal efficiency of fossil fuel–based power generation rose from 32.9% in 1990 to 35.4% in 2014, driven by a gradual shift from oil-fired generation plants to more efficient gas-fired generation plants. Transmission and distribution losses of electricity increased from 11% in 1990 to 16.6% in 2014, the second highest level after the Latin America and Caribbean region. Natural gas transmission and distribution losses decreased from 0.6% in 1990 to 0.1% in 2014—the lowest rate globally.

The decomposition analysis[3] for the Arab region shows that the decoupling of energy demand from GDP has been widening (figure 9.11).

Subregional trends

Energy intensity trends among subregions differ widely (figure 9.12) due to vastly different industrial profiles, socioeconomic developments, per capita incomes, and government policies and priorities (UN ESCWA 2015c). Energy intensity trends also depend on whether a country is a net energy exporter or importer. Large oil producers, such as Saudi Arabia, Iraq, and other GCC countries, have based their industrial growth on fossil fuels and energy-intensive industries, such as petrochemicals, steel, aluminum, and fertilizer. Energy-importing countries, such as Jordan and Tunisia, and transitional countries such as Egypt, have focused on agriculture and on less energy-intensive manufacturing and services, with some GCC countries having energy intensity around 6 MJ/2011 PPP $ or above, and many countries in the Arab North Africa and Mashreq subregions in the 3–4 MJ/2011 PPP $ range (figure 9.13).

The Arab North Africa subregion's energy intensity worsened to second highest in the region in 2014 at 4.2 MJ/2011 PPP $, despite starting from the lowest rate in 1990. The deterioration was driven by net energy exporters such as Algeria and Libya, even as Morocco and Tunisia were improving. Libya's energy intensity increased steeply in 2012–14 due to hindrance caused by civil conflict, to operating essential infrastructure (oil and gas fields, pipelines, and power plants and transmission lines) and transport (figure 9.13).

The Mashreq subregion's energy intensity improved in 1990–2014 to 3.9 MJ/2011

FIGURE 9.11 Decoupling of energy demand from GDP has been widening in the Arab region since the early 2000s

Index (1990 = 100)

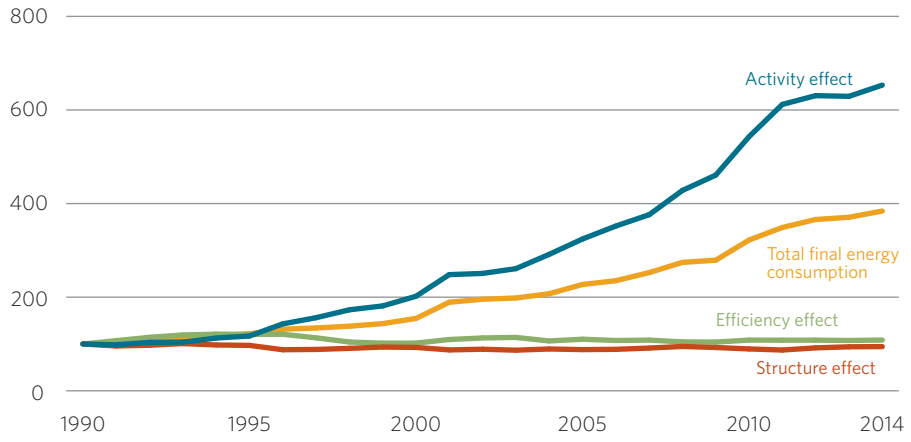
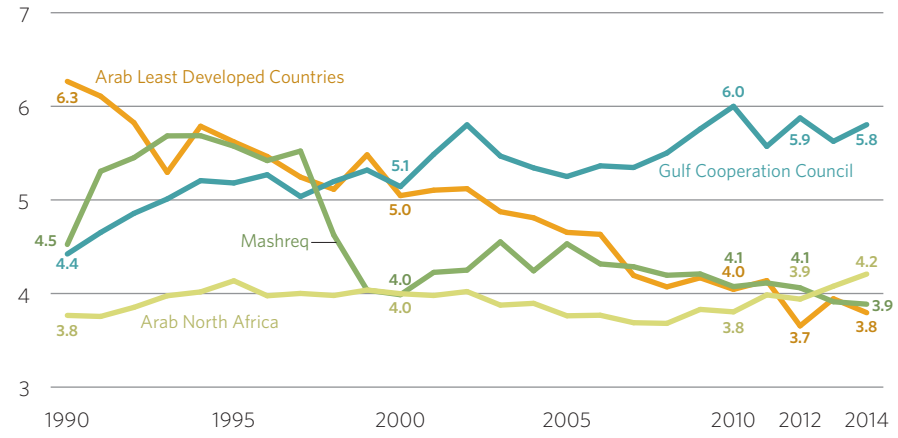


FIGURE 9.12 GCC countries' energy intensity diverged from energy intensity in the rest of the Arab region

Primary energy intensity (MJ/2011 PPP $)



PPP $, with trends in most countries declining. A steep decline in the second part of the 1990s was driven by Iraq, where total primary energy supply dropped faster than GDP due to sanctions' effect of reducing oil production. Recently, Egypt's energy intensity declined most steeply, reaching 3.5 MJ/2011 PPP $ in 2014, because of decreased economic activity and energy intensity in industry, agriculture, and transport (see figure 9.13). However, the State of Palestine's energy intensity grew sharply when the 2013 political crisis created severe infrastructure damage and fuel shortages, increasing the use of typically inefficient backup energy solutions such as kerosene, biomass, and electricity from diesel generators for lighting, heating, and cooking. The Syrian Arab Republic's energy intensity remained the highest in the Mashreq subregion, despite a declining trend, at 6.3 MJ/2011 PPP $ in 2014 due to inefficient energy technology. Many households use diesel or kerosene-fired stoves for space and water heating.

The hydrocarbon-rich GCC subregion had the highest energy intensity in 2014, 5.8 MJ/2011 PPP $. After two decades of increase, though, the trend was reversed in 2012–14, driven by growing GDP in Kuwait, Oman, and United Arab Emirates due to rising oil prices (see figure 9.13). Despite improvements in 2012–14, Bahrain had the highest energy intensity in the whole Arab region due to its highly energy-intensive key industries, such as oil refining and aluminum, with little other economic activity contributing to GDP. The same trend is reflected in Bahrain's per capita energy consumption, which is the highest in the world.

The Arab LDCs subregion had the steepest decline in energy intensity in the Arab region, going from highest in 1990 (6.3 MJ/2011 PPP $) to lowest in 2014 (3.8 MJ/2011 PPP $) (see figure 9.13). This pattern, similar to that in other low-income countries, reflects a structural shift from highly inefficient combustion of traditional biomass toward use of more efficient modern fuels. In 2010–12, declines in the subregion accelerated as total primary energy supply dropped faster than GDP in Sudan and Yemen. When Yemen and Sudan returned to economic growth in 2012–14, energy intensity in the subregion started to increase because Yemen's total primary energy supply increased almost six times faster than GDP.

RENEWABLE ENERGY

Regional progress

The Arab region's share of renewable energy in total final energy consumption (TFEC) was the lowest of any region in 2014 at 3.6% (0.56 EJ), a share that had been declining since 1990 (figure 9.14). The region has been a hydrocarbon producer, and many countries have had low-cost oil and natural gas resources since the 1960s, reducing the need for alternative energy. In most parts of the region, conventional fossil fuels have for many decades underpinned the systematic expansion of modern energy access and higher living standards, leading to near-universal access to electricity and clean cooking. Renewable energy sources have played a marginal and declining role in the region's energy mix.

The dearth of renewable energy, similar to the scantiness of energy efficiency, stems from the absence of targeted policy initiatives, as well as prevalent state-owned energy utilities and widespread fossil fuel subsidies that have discouraged use of new non-fossil fuel–based technologies (UN ESCWA 2015c; Fattouh and El-Katiri 2012). The dominance of fossil fuels in Arab countries' economic development also restricted the sociopolitical discourse on environmental sustainability and domestic energy security that has supported renewable energy deployment elsewhere.

However, discourse about energy has started to change in recent years in some parts of the Arab region, and the share of modern renewable energy stabilized in

FIGURE 9.13 About half the Arab countries' energy intensity worsened in 2012–14, particularly those hit by conflict

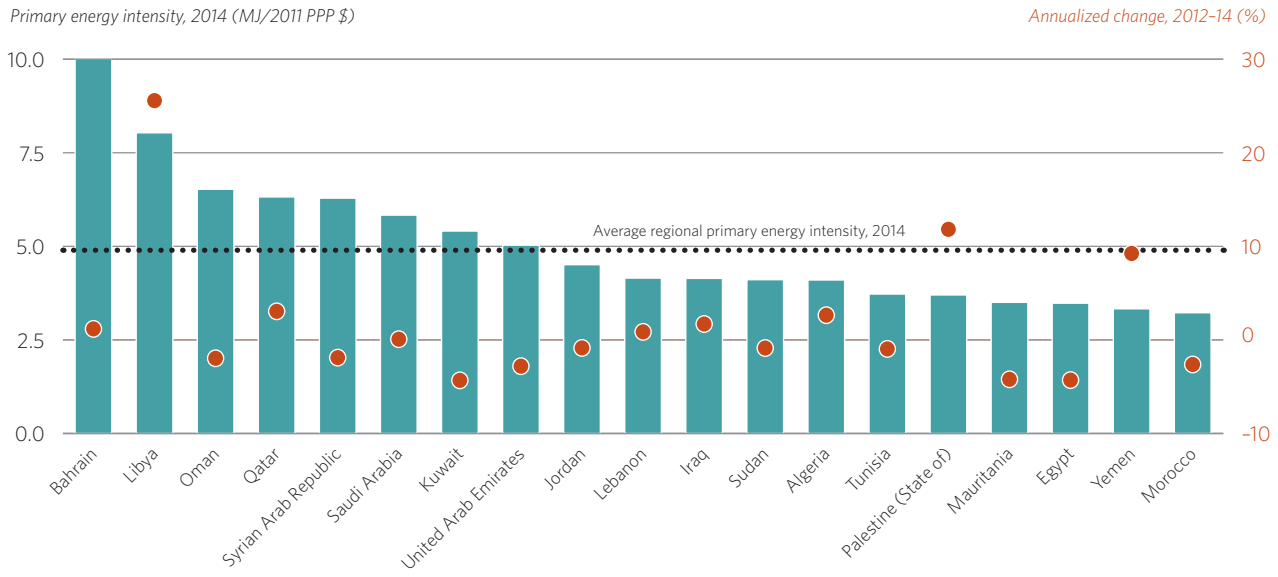
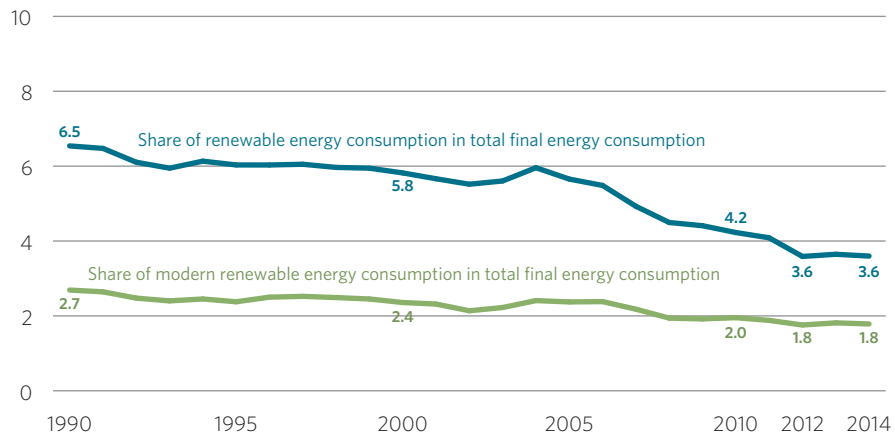


FIGURE 9.14 The Arab region's share of renewable energy consumption in total energy consumption is the lowest in the world and has been declining in 1990–2014

Share (%)



2012–14. Energy demand grew fast during the late 2000s and early 2010s, driven by the economic boom and rising living standards, particularly in the GCC subregion. High oil prices during this period increased energy costs for net importing countries and opportunity costs for exporting countries. Falling costs of renewable energy made investments, particularly in wind and solar power, more attractive.

Although the Arab region is just beginning to invest in renewable energy technologies, strong growth over the next decade is possible, especially in solar energy. Even so, long-term policy obstacles to deploying renewables remain, and while new business models in the energy sector such as competitive auctions and public–private partnerships hold considerable potential for the future, they have not yet proven popular regionally.

About half of renewable energy in the Arab region came from traditional renewable energy sources in 2014. Among modern renewable energy sources, modern solid biofuels had the highest share in 2014 (57.1%), followed by hydropower (33.5%), solar power (4.9%), and wind power (4.5%) (figure 9.15). In 2012–14, consumption of wind power grew the fastest, followed by solar power, while hydropower consumption fell slightly.

Subregional trends

In three of the four subregions, consumption of renewable energy as a share of TFEC was low (figure 9.16). The share in the Arab LDCs was much higher due to their high consumption of traditional renewable energy. In about half the Arab region countries the share of renewable energy is almost negligible and decreasing (figure 9.17).

Arab North Africa's share of both traditional and modern renewable energy consumption in TFEC declined in 1990–2014. In 2014, the share of renewable energy consumption was 4.5%, of which over half was traditional renewable energy. Still, in 2012–14, the decline in renewable energy decelerated and the share of modern renewable energy consumption showed a positive change, driven by wind energy in Morocco and Tunisia and, to less extent, solar energy in Tunisia, stemming from government policies and funding from European and international agencies, such as the Clean Development Mechanism. Morocco, which has some of the world's best sites for wind energy and a record of highly successful wind projects, significantly expanded its capacity, following a long-term plan conceived in the 2000s (IRENA and RCREEE 2013).

The Mashreq subregion's share of renewable energy consumption in TFEC also declined in 1990–2014, reaching 4.5% in 2014. The subregion's share of modern renewable energy consumption in TFEC was about three times as high as traditional renewable energy's share because of hydropower, which supplied more than half of modern renewable energy

FIGURE 9.15 Consumption of modern renewable energy in the Arab region was dominated by solid biofuels and hydropower in 1990–2014

Modern renewable energy consumption (exajoules)

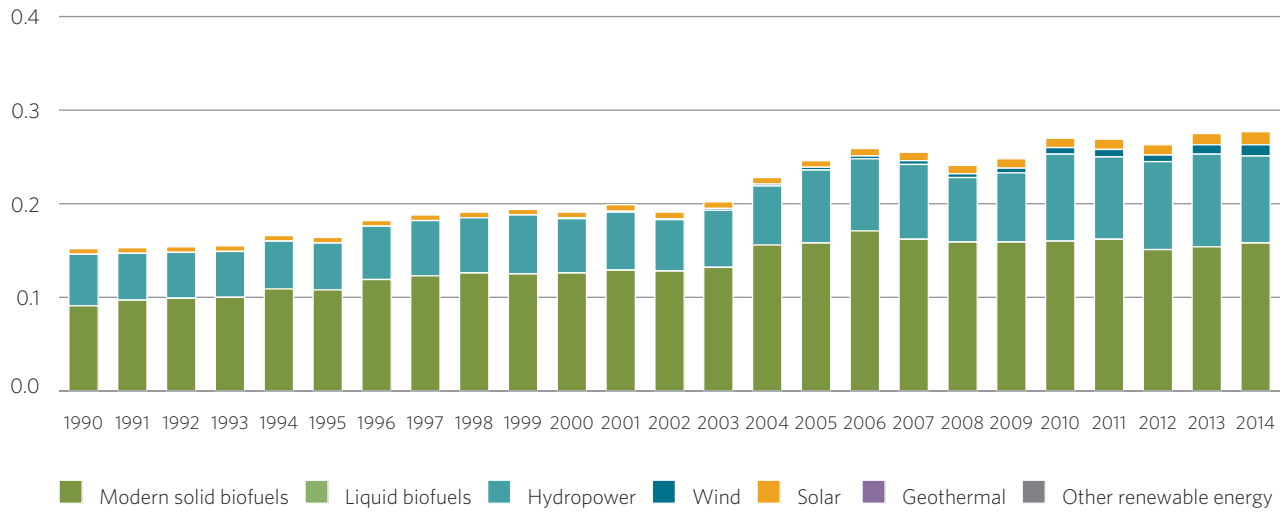
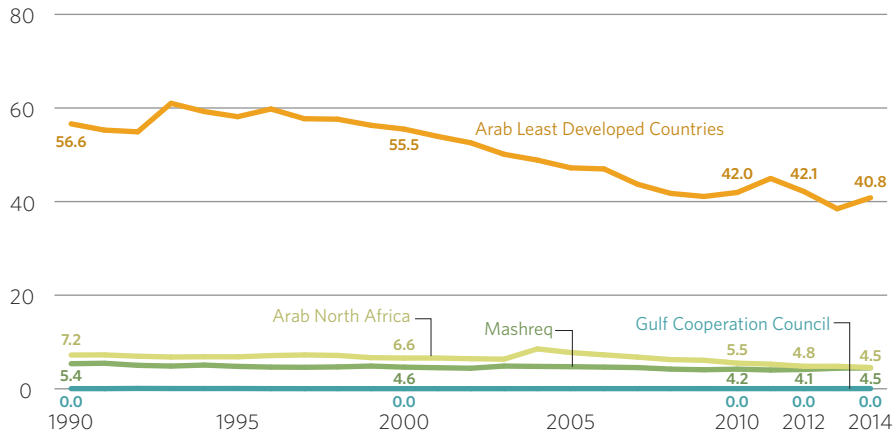


FIGURE 9.16 Only the Arab LDCs have a substantial share of renewable energy, and it has been declining steeply in 1990–2014

Share of renewable energy consumption in total final energy consumption (%)

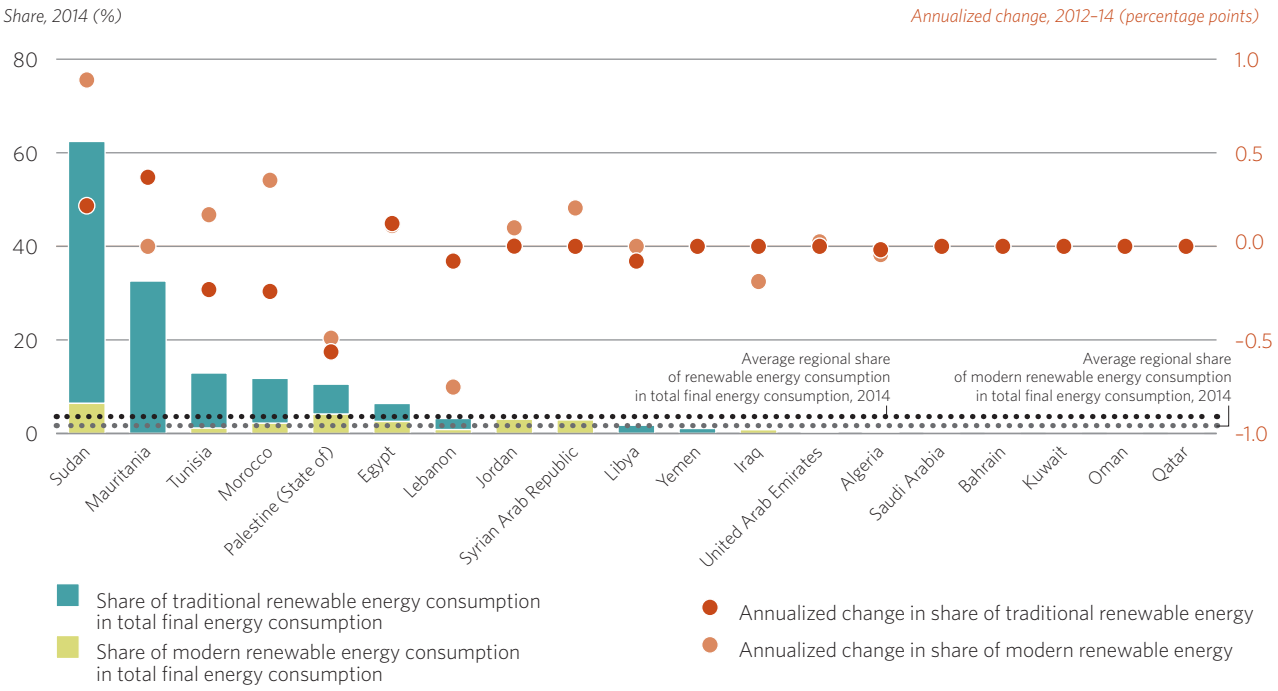


consumption. Hydropower is particularly important in Egypt, Iraq, and the Syrian Arab Republic, with smaller use in Lebanon (UN ESCWA and UNEP 2015b).

In the GCC subregion, renewable energy was almost nonexistent in 1990–2014, reflecting the omnipresence of oil and natural gas. In 2012–14, however, solar power consumption started to tick up, driven by increases in Saudi Arabia, and reached 28.4% of modern renewable energy consumption in the subregion. Falling costs for solar photovoltaic (PV) power, which generated record low prices in bidding for utility-size PV production in Dubai in 2015–16, should further strengthen the commercial case for modern solar energy technologies in the GCC subregion.

In the Arab LDCs, the share of renewable energy consumption in TFEC was 40.8%, the highest in the Arab region, in 2014. The shares of both traditional and modern renewable energy were the highest in the region—24.7% and 16.1%—driven by low costs rather than sustainability. Modern renewable energy consumption was largely modern biomass, and to a lesser extent Sudan's hydropower.

FIGURE 9.17 Few Arab countries have expanded their renewable energy consumption



NOTES

1. For background information on socioeconomic progress in the Arab region, see UN ESCWA and UNEP (2015a), UN ESCWA (2015a), and UN ESCWA (2016a).
2. 2013 data.
3. The decomposition analysis explains the energy consumption trends through three underlying components: activity, efficiency, and structure.

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10

THE ASIA–PACIFIC REGION

The regional profile of the Asia–Pacific region has been written with the United Nations (UN) Economic and Social Commission for Asia and the Pacific (ESCAP) and the Asian Development Bank.

REGIONAL OVERVIEW

Asia–Pacific comprises 58 economies across five subregions, with a population of 4.3 billion, representing 60% of the world's population (table 10.1). The region includes highly industrialized and least developed countries, rapidly growing economies, extreme ranges of population sizes and geographic environments, and an uneven distribution of energy resources. In 2014, it accounted for 45.9% of global gross domestic product (GDP) (2011 PPP $), 51.4% of global energy supply, and 54.3%[1] of the planet's carbon dioxide emissions. The decisions and actions taken by Asia–Pacific economies will profoundly shape the pace of progress to the global sustainable energy goals. Several countries are already exhibiting leadership in shifting toward increasingly sustainable energy supply and use, though the energy challenges remain substantial and markedly diverse.

TABLE 10.1 Asia–Pacific economies by subregion

East and North-East Asia	North and Central Asia	The Pacific	South-East Asia	South and South-West Asia
1. China	1. Armenia	1. American Samoa [a,b,c,e]	1. Brunei Darussalam [e]	1. Afghanistan
2. Hong Kong (SAR, China) [b]	2. Azerbaijan	2. Australia [e]	2. Cambodia	2. Bangladesh
3. Japan [e]	3. Georgia	3. Cook Islands [c,d,e,f]	3. Indonesia	3. Bhutan
4. Korea (Dem. People's Rep. of) [c]	4. Kazakhstan	4. Fiji	4. Lao PDR	4. India
5. Korea (Rep. of) [e]	5. Kyrgyzstan	5. French Polynesia [b,c]	5. Malaysia	5. Iran (Islamic Rep. of)
6. Macao (SAR, China) [b,e]	6. Russian Federation	6. Guam [a,b,c,d,e,f]	6. Myanmar	6. Maldives
7. Mongolia	7. Tajikistan [e]	7. Kiribati [f]	7. Philippines	7. Nepal
	8. Turkmenistan [f]	8. Marshall Islands [e]	8. Singapore [e]	8. Pakistan
	9. Uzbekistan [e]	9. Micronesia (Federated States of)	9. Thailand	9. Sri Lanka
		10. Nauru [c,d]	10. Timor-Leste [f]	10. Turkey [b,e]
		11. New Caledonia [b,c]	11. Viet Nam	
		12. New Zealand [d]		
		13. Niue [a,b,c]		
		14. Northern Mariana Islands [a,b,c,d,e,f]		
		15. Palau [d,e,f]		
		16. Papua New Guinea		
		17. Samoa		
		18. Solomon Islands [f]		
		19. Tonga		
		20. Tuvalu [d,e,f]		
		21. Vanuatu		

a. Data on access to electricity not available.

b. Data on access to clean fuels and technologies for cooking not available.

c. Data on energy intensity not available.[1]

d. Data on total renewable energy consumption either not available or reported being zero.[2]

e. Data on traditional renewable energy consumption either not available or reported being zero.[3]

f. Data on modern renewable energy consumption either not available or reported being zero.[4]

1. In addition, data for energy intensity by sector was not available in 2014 for several countries: energy intensity in agriculture was not available for 26 countries; energy intensity in industry was not available for 21 countries; and energy intensity in services was not available for 17 countries. For more details, see data annex 2.

2. Renewable energy consumption data are based on databases of the International Energy Agency (IEA) Energy Data Center and United Nations Statistics Division (UNSD). When data for total, modern, or traditional renewable energy consumption is not available this may be due to either negligible consumption, or energy balance data not being available at the necessary level of detail, or uses of renewable energy that are not captured by official country statistics as reported to the IEA Energy Data Center and UNSD.

3. Ibid. Also, traditional renewable energy consumption is assumed to be only the consumption of solid biomass in the residential sector of non–Organisation for Economic Co-operation and Development (OECD) countries (that is, no traditional renewable consumption is assumed to occur in OECD countries). This IEA convention has been adopted in the Global Tracking Framework, due to the heavy reliance on the IEA data (see box 5.1 for further details).

4. Ibid.

ACCESS TO ELECTRICITY

Regional progress

Electrification in the Asia–Pacific region grew the fastest compared with other regions in the last quarter-century, with the access rate rising from 70.2% in 1990 to 90.3% in 2014. The growth gave access to 70.7 million people each year—or more than the population of Thailand (figure 10.1). Economies in Asia–Pacific, increasingly motivated by the link between energy and development, have been implementing policies and measures to provide electricity to unserved populations. In 2014, nearly all economies yet to achieve universal access had identified at least one energy access target, a situation in contrast to 2000, when only a few economies had begun to integrate the energy–development link into their national energy policies[2] (figure 10.2).

Still, about 421.4 million people lacked access to electricity in 2014 (more than the population of Bangladesh and Indonesia combined). India had by far the biggest absolute deficit in access: 269.8 million people without electricity in 2014. And in several economies inadequate electricity supply or failing infrastructure caused unplanned outages and regular load shedding. Improving the reliability and quality of electricity is an emerging policy priority, not only for economies with low access rates, but also for more advanced economies.

In urban areas, the access rate increased from 93.0% in 1990 to 98.7% in 2014 (figure 10.3). The share of urban population with access dropped slightly in 2010–12, when electrification was overtaken by urbanization, but picked up again in 2012–14. In 2014, about 27 million people in urban areas remained without access. The speed of urbanization[3] is an important driver of electrification. As cities expand, rural populations move to urban areas already covered by the electricity grid, or to peri-urban areas where it is easier to expand the grid. In 2012–14, China's rural population fell by 13.9 million a year, while its urban population increased by 20.7 million a year. Countries such as Indonesia, Malaysia, Mongolia,

FIGURE 10.1 The Asia–Pacific region grew the fastest in access to electricity in 1990–2014, but the pace slowed in 2012–14

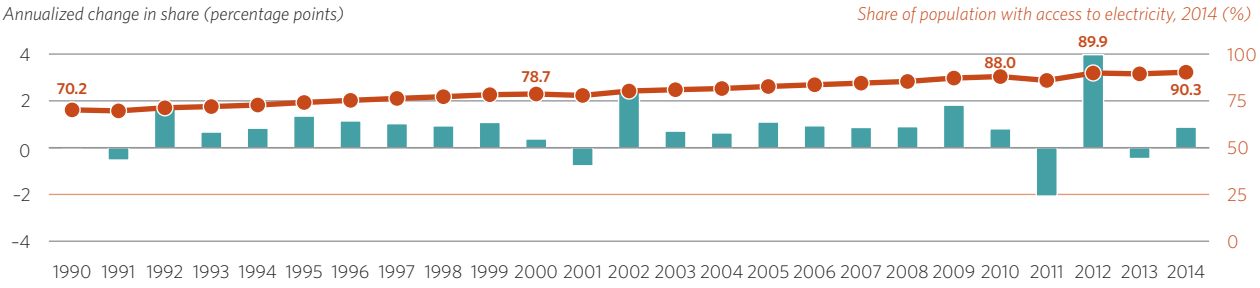
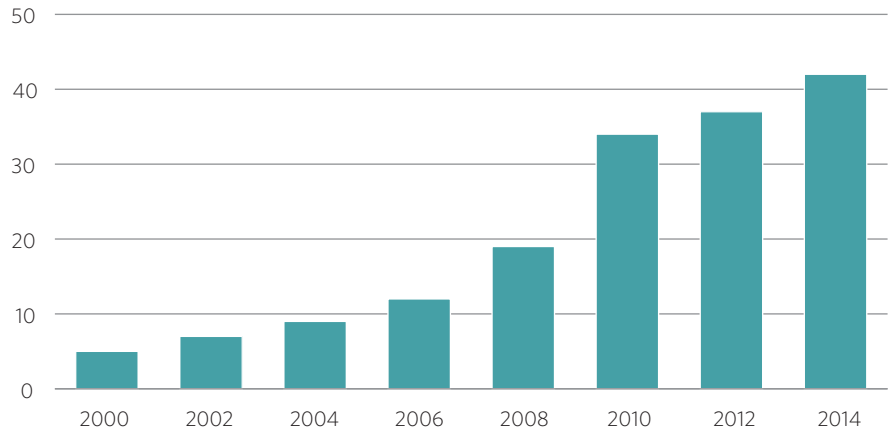


FIGURE 10.2 The number of Asia–Pacific economies with energy access targets climbed sharply in 2000–14

Number of countries



and Thailand also encountered shrinking rural, and growing urban, populations.

The rural rate of access to electricity in Asia–Pacific rose from 63.3% in 1990 to 83.3% in 2014. About 388.7 million rural people were still without electricity in 2014—more than the populations of Indonesia and Japan put together. Electrification in dispersed rural areas remains a challenge, because extending national grids to small numbers of households is often considered economically unviable. Governments are increasingly turning to small, decentralized energy systems relying on renewable energy resources to meet power needs in remote areas. These efforts have had mixed success due to the high upfront costs of renewable energy systems, questionable affordability of service, and difficulties in operating and maintaining decentralized energy equipment. However, costs of solar energy have been coming down, while new business models are emerging, including ownership and operation of decentralized energy systems based on public–private partnerships.

Subregional trends

In most of the subregions in Asia–Pacific, access rates increased, and several approached universal access. Still, the Pacific subregion's rate of access was flat (figure 10.4). The highest gains in electrification are usually seen in countries with the lowest access rates, but as access rates increase, expansion tends to slow, suggesting that providing access to harder-to-reach populations needs stronger efforts. Of 54 economies in the region that reported electricity access rates, 31 had achieved universal access or above 99% access to electricity by 2014, while in the other 23 economies access ranged widely from 20.3% to 98.5% (figure 10.5).

FIGURE 10.3 Access to electricity in Asia–Pacific has increased over the last 25 years, with the gap between urban and rural access gradually narrowing

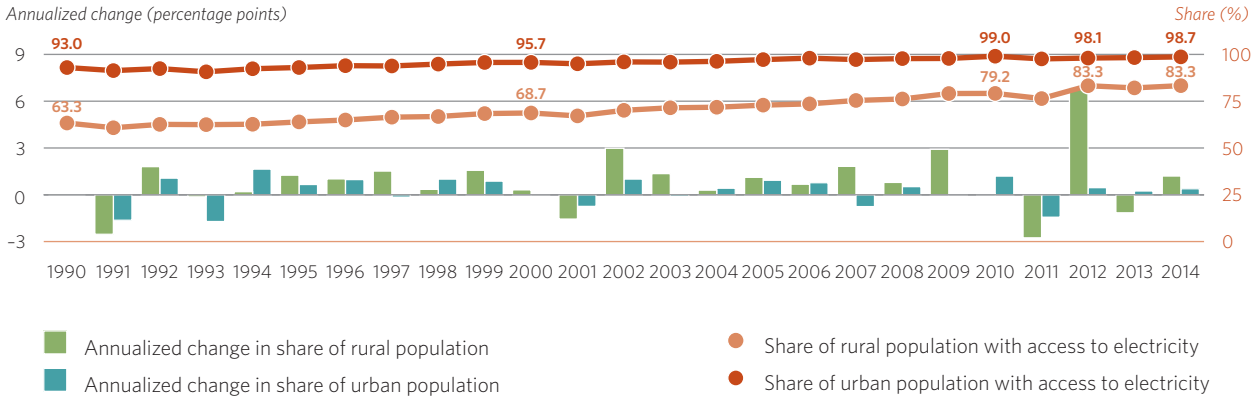
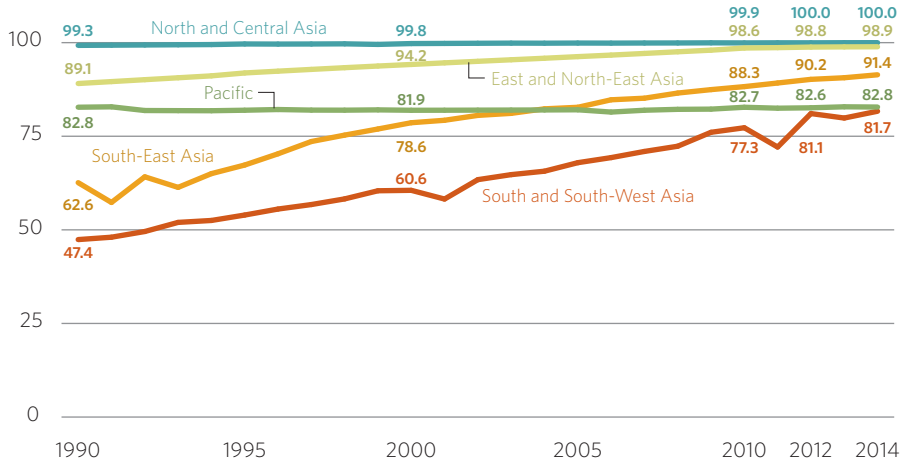


FIGURE 10.4 Access grew steeply across much of Asia–Pacific in 1990–2014, but the trend was flat in the Pacific subregion

Share of population with access to electricity (%)



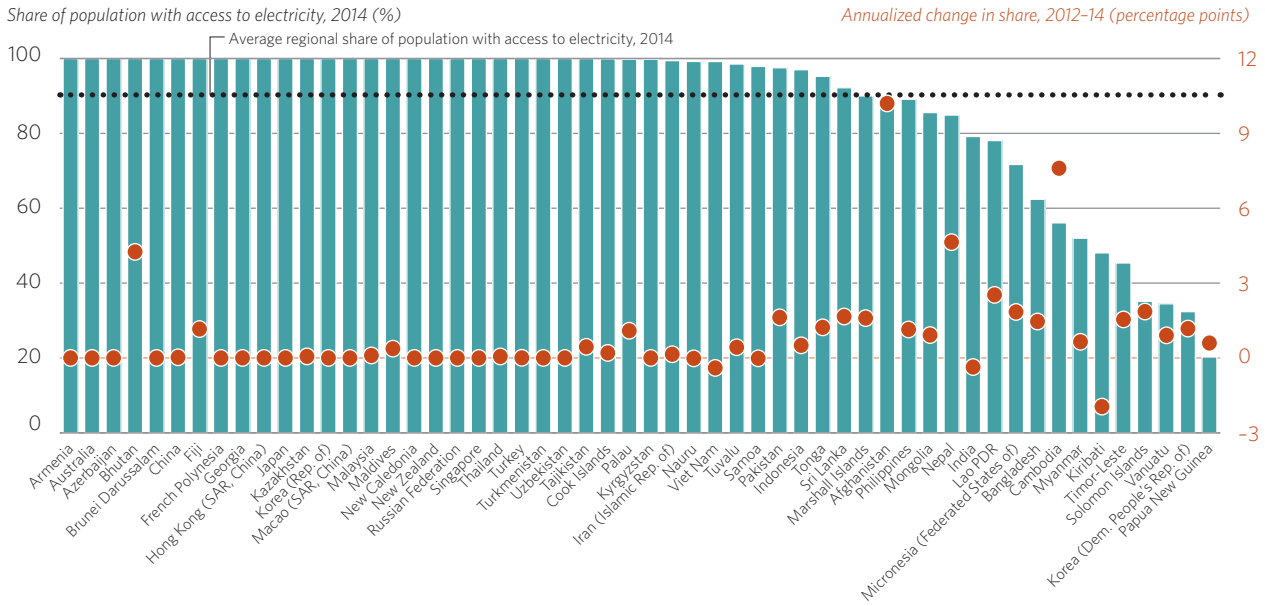
In the East and North-East Asia subregion the rate of access to electricity rose from 89.1% in 1990 to 98.9% in 2014. The increase was impelled by China, which reached universal access in 2014 and has more than 85% of the subregion's population. Two countries suffer from inadequate infrastructure: the Democratic People's Republic of Korea (with an access rate of 32.4%) and Mongolia (85.6%) (see figure 10.5). In Mongolia, the challenge of electrification, given large territory and small, dispersed and often nomadic populations, requires increasing decentralized energy systems.

The North and Central Asia subregion has long had electrification rates of 99% or higher due to energy systems built during the Soviet era, though deteriorating infrastructure threatens power supply in some areas. (Further country-level analysis is in the Europe, North America, and Central Asia regional chapter of this publication.)

In the Pacific subregion, the rate of access to electricity was a stable 82.8% in 1990–2014, but there were large differences among countries. In 2014, 9 countries had universal or above 99% access, and 5 countries had rates between 70% and 99%. But in 4 countries, rates were less than 50%: Kiribati, Papua New Guinea, the Solomon Islands, and Vanuatu. Papua New Guinea, with the second largest population in the subregion, had the lowest access rate, 20.3%, in 2014 (see figure 10.5), but the country aims to increase its access rate to 70% by 2030 (Government of Papua New Guinea 2010). Developing island nations, with small populations scattered, in some cases, across hundreds of islands, are challenged to provide high-quality energy services.

The South-East Asia subregion lifted its rate of access to electricity rapidly from 62.6% in 1990 to 91.4% in 2014. Cambodia and the Lao People's Democratic Republic made the biggest gains in the period. In Lao PDR, the government set clear targets for electricity access to be achieved by 2010 and 2020, through an aggressive grid extension program, backed up by off-grid electrification. Surplus revenues from exporting electricity from hydropower contributed to financing the national power grid expansion and connection program (World Bank 2012). In Cambodia, the access rate accelerated dramatically after 2010, thanks to efforts to expand grid infrastructure and, in rural areas, to disseminate home systems for solar power. The country implemented several programs supporting rural electrification: The Power to the Poor Program (P2P) offered interest-free loans to cover connection fees and wiring costs; the Solar Home System Program provided subsidized systems in rural areas; and the Program for Providing Assistance to Develop Electricity Infrastructure in Rural areas

FIGURE 10.5 In 2014, 31 economies in Asia–Pacific had universal access, while access rates ranged widely over the other 23



helped private suppliers secure investment funds (Electricité du Cambodge 2014).

The South and South-West Asia subregion had Asia–Pacific's fastest growth in the electricity access rate in 1990–2014, from 47.4% to 81.7%. But the subregion also had the largest absolute access deficit in the region, 343.8 million people in 2014. Two-thirds of those without electricity lived in rural India, where electricity grid expansion has been difficult. For the future, India and Bangladesh—the two countries with the largest deficits—have introduced targeted access measures. India has stepped up its projected universal electrification of all villages through joint Ministry of Power and State efforts (Government of India 2017), aiming to electrify all households by 2019. Bangladesh is targeting 96% access by 2020 (Government of Bangladesh 2015). Nepal's rates of access grew at one of the quickest paces in the subregion in 1990–2014, accelerated in recent years by installations of mini- and micro-hydro and solar systems under the Rural Energy for Rural Livelihood Program (RERL 2015), and efforts at grid expansion (NEA 2015). In 2014, Nepal launched the Urban Solar Rooftop Program to mitigate impacts of frequent scheduled load shedding (AEPC 2016).

FIGURE 10.6 In Asia–Pacific, growth of access to clean cooking was slow, and nearly 2.1 billion people were without access in 2014

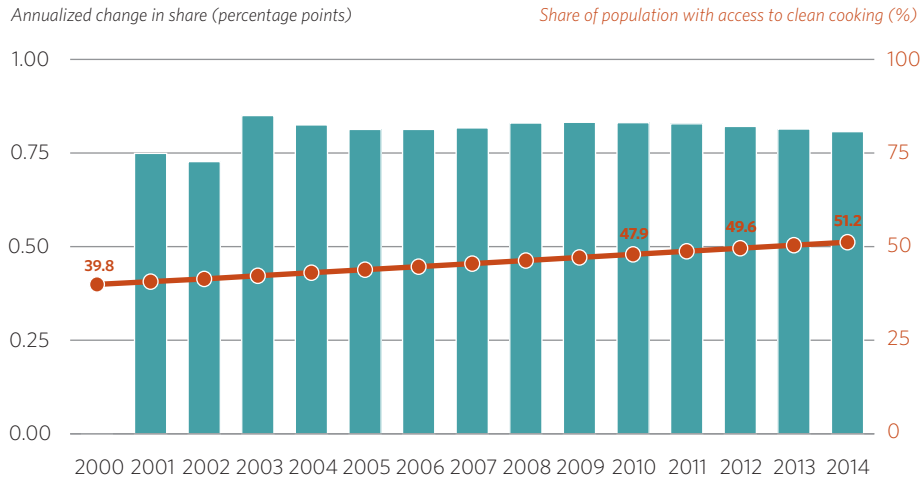
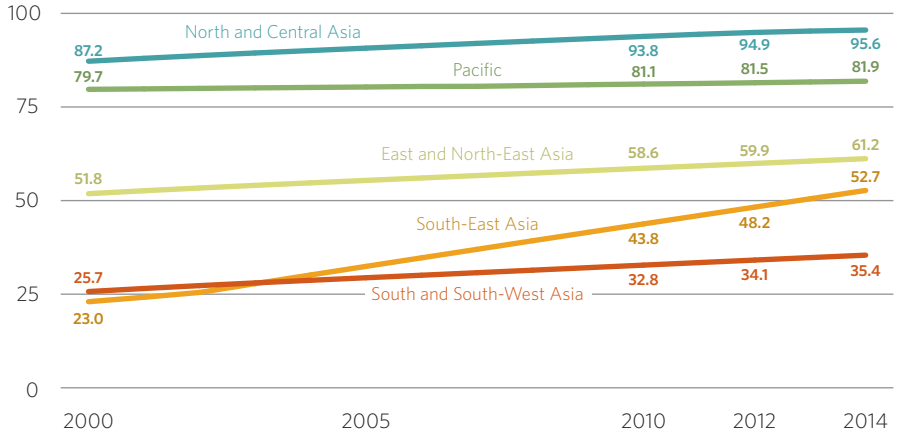


FIGURE 10.7 Though the rate of access to clean cooking in Asia–Pacific improved in 2000–14, it needs to rise much more

Share of population with access to clean cooking (%)



ACCESS TO CLEAN FUELS AND TECHNOLOGIES FOR COOKING

Regional progress

The Asia–Pacific had the second-lowest rate among all regions in 2014 of access to clean fuels and technologies for cooking (here "clean cooking"), and was closer to the worst performer—the Africa region—than to better-performing regions. Asia–Pacific rate of access to clean cooking grew from 39.8% in 2000 to 51.2% in 2014, representing a yearly increase of 51 million new users, equivalent to the population of the Republic of Korea (figure 10.6).

Nearly 2.1 billion people in the Asia–Pacific region—28.8% of the global population—relied on traditional fuels and technologies for cooking in 2014. India and China accounted for over two-thirds of Asia–Pacific's population without access to clean cooking. The unserved population was concentrated in rural areas, where traditional solid biomass, in the form of wood, dung, and charcoal, is easily accessible at little or no monetary cost. In urban areas, modern cooking options such as liquefied petroleum gas (LPG) stoves are more readily available, fuel supply chains better established, and electricity to power induction stoves more affordable.

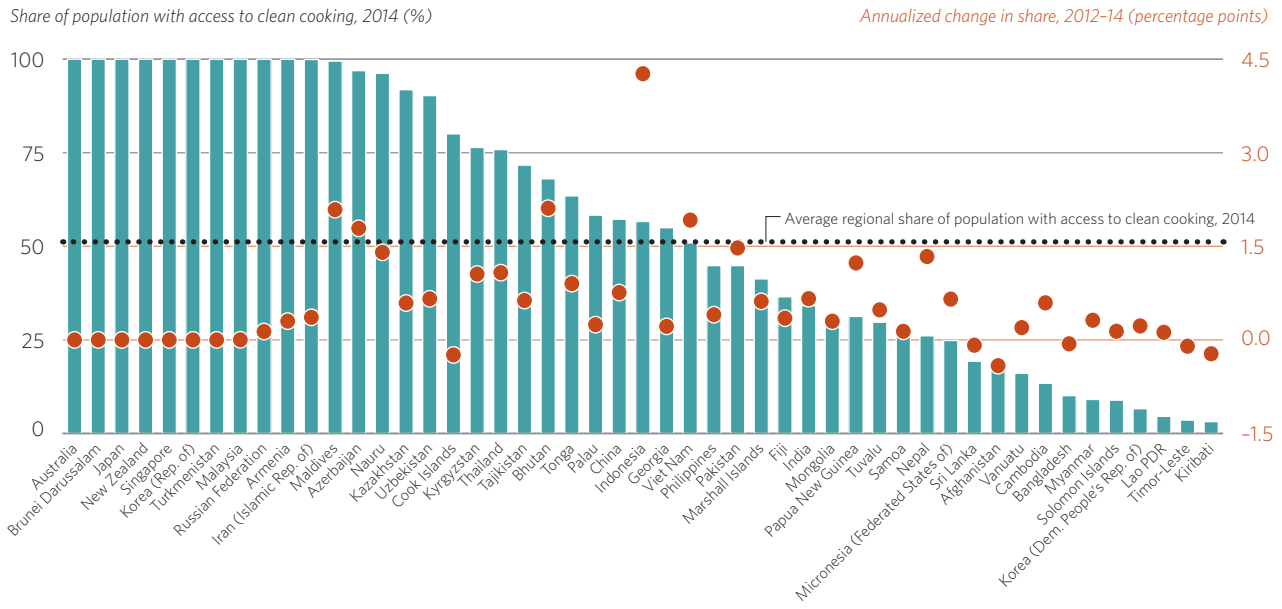
Few governments have emphasized clean cooking, in contrast to electrification, and until recently, nongovernmental organizations provided much of the impetus. But in recent years a few countries, such as India and Indonesia, have started to promote LPG through large-scale fuel and appliance programs to extend the market reach of fuel distribution and supplies. And a number of countries, such as Bangladesh, Kiribati, and Tuvalu have begun to promote clean cookstoves. Even when clean cooking is adopted in households, fuel stacking (use of mixed fuels for various cooking purposes) remains common, and ascertaining that clean cooking is being used appropriately is difficult. To support adoption of clean cooking, strong government policies are needed to expand distribution networks and to ensure their affordability.

Subregional trends

All subregions in Asia–Pacific showed rising trends in access to clean cooking, but the pace is lagging across the region (figure 10.7). Out of 49 economies that reported clean cooking access rates, only 12 had achieved universal or above 99% access by 2014. Twenty-three countries had access rates below 50% (figure 10.8).

In the East and North-East Asia subregion, the rate of access to clean cooking reached 61.2% in 2014. China, with over 85% of the subregion's population, had a rate of 57.2%, following a stable increase of 0.8 percentage

FIGURE 10.8 In 2014, 12 countries in Asia-Pacific had universal access to clean cooking



points in 2000–14 (see figure 10.8). Cost of clean cooking remained a barrier for low-income households in China: in rural areas, coal is cheap and other biomass is nearly free. Unreliability of the supply of commercial clean fuels also impeded adoption, while spread of biogas faced unreliability of feedstock supply and shortfalls in labor for maintaining production. Cookstove production ramped up after 2005, but standardization was weak. Local governments promoted improved cookstoves through demonstrations and awareness campaigns but were not entirely successful. To support faster adoption of clean cooking, better pricing and subsidy models are required (Shen et al. 2014). Two other countries had low rates of access to clean cooking and, as their governments put little emphasis on improvement, even lower annual increases than China—the Democratic People's Republic of Korea gained 0.2 percentage points a year, and Mongolia 0.3 percentage points a year in 2000–14.

The North and Central Asia subregion, with abundant gas supplies, had the highest rate of access to clean cooking in Asia-Pacific, with most countries having 90% access or more. (Further country-level analysis is in the Europe, North America, and Central Asia regional chapter in this publication.)

In the Pacific subregion, rates of access to clean cooking in small island states varied. The tiny nation of Nauru's access rate grew the fastest in the subregion, from 76.1% in 2000 to 96.2% in 2014, due to heavily subsidized electricity, which boosted use of electric cookers (IRENA 2013). Papua New Guinea's increase was also strong, from 13.5% to 31.3% in 2000–14. In other nations access was very low in 2014, as in Kiribati (3.2%) and the Solomon Islands (8.9%), and rates of change were very low and even negative in 2012–14 (see figure 10.8). Small island states lack domestic gas supplies and, often, adequate power infrastructure, so fuel and technology options are limited, particularly for rural populations.

The South and South-West Asia subregion had the Asia-Pacific region's lowest rate of access to clean cooking in 2014, 35.4%. The Maldives shot up to 99.5% in 2014 from 40.7% in 2000 (an increase of 4.2 percentage points a year) due to rapid urbanization, the lack of traditional biomass (only about 3% of the Maldives is forested), and a well-established network of LPG distribution centers, enabling widespread use of LPG for cooking (Maldive Gas 2017). Bhutan's growth was second fastest after the Maldives—2.1 percentage points a year—supported by awareness campaigns and promotion of fuel-efficient cookstoves and biogas (Government of Bhutan 2013), so that the rate of access reached 68.0% in 2014, up from 38.0% in 2000. Progress in Nepal and Pakistan was strong as well. Nepal conducted programs for improved cookstove distribution and offered subsidies for solar cookers (AEPC 2013). Pakistan supported development of biogas (RSPN 2014).

Afghanistan, Bangladesh, and Sri Lanka had access rates below 20%, which fell in 2012–14 (see figure 10.8). Afghanistan and Sri Lanka have no government policy on clean cooking. Bangladesh had comprehensive clean cookstove policies but poor uptake of clean fuels and technologies. Cookstove design did not always meet user needs or preferences, pricing was a major obstacle, and willingness to pay remained low (Arif et al. 2011). Strong cultural preferences and lack of buy-in from the male population, which makes household financial decisions, further inhibited adoption (Miller and Mobarak 2011). In response, the government adopted the Country Action Plan for Clean Cookstoves in 2013 to develop a national network of improved cookstove suppliers and get non-cooking product distribution and wholesale chains, such as grocery shops, to add improved cookstoves, fuels, and other clean cooking appliances to their businesses.

Access to clean cooking in India, with 72% of the subregion's population, improved moderately (0.7 percentage point change a year in 2000–14) and reached 34.2% in 2014. In 2016, to expand LPG use beyond urban areas, the government introduced the Pradhan Mantri Ujjwala Yojana program for replacing traditional cooking fuels with LPG by adding 50 million LPG connections to households below the poverty line and lending funds to women to buy LPG cookstoves.[4] It is the world's largest cash transfer program, reaching 150 million people. To subsidize household fuels but prevent funding leakage to other sectors, India is transferring benefits directly to household bank accounts.

The South-East Asia subregion had the fastest growth in Asia-Pacific of access to clean

FIGURE 10.9 Asia–Pacific's energy intensity declined sharply over the last 25 years

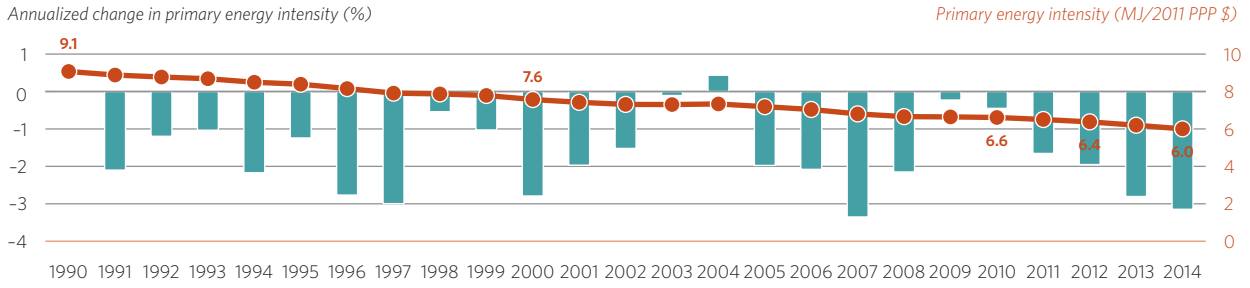


FIGURE 10.10 Energy intensity decline in Asia–Pacific accelerated in recent years

Primary energy intensity compound annual growth rate (%)

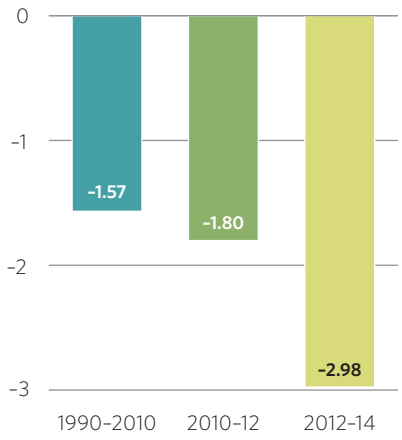


FIGURE 10.11 In all sectors in Asia–Pacific, except residential, energy intensity declined in 1990–2014

Final energy intensity compound annual growth rate (%)

cooking, with a rate that more than doubled from 23% to 52.7% in 2000–14. Growth was led by Indonesia (the most populous country in the subregion), whose rate of access increased from 2.4% to 56.6% in 2000–14. Indonesia's government and state oil and gas company started a massive program in 2007 to switch from kerosene to LPG in cooking, distributing free of charge an initial LPG stove (including the cylinder, regulator, and hose) and then subsidizing purchase of small LPG containers. Viet Nam's results were also strong, reaching 50.9% access to clean cooking in 2014, driven by rapid GDP growth, urban population growth, and a national policy adopted in 2007 setting targets—50% access by 2010, 80% by 2020. Viet Nam also publicized heavily the risks of indoor cooking with coal (Accenture 2012).

Several countries had access rates below 10% in 2014, and their progress was slow. Myanmar and Timor-Leste had no policy on clean cooking. In Lao PDR, clean cooking programs supported by aid agencies have yet to bear fruit.

ENERGY EFFICIENCY

Regional progress

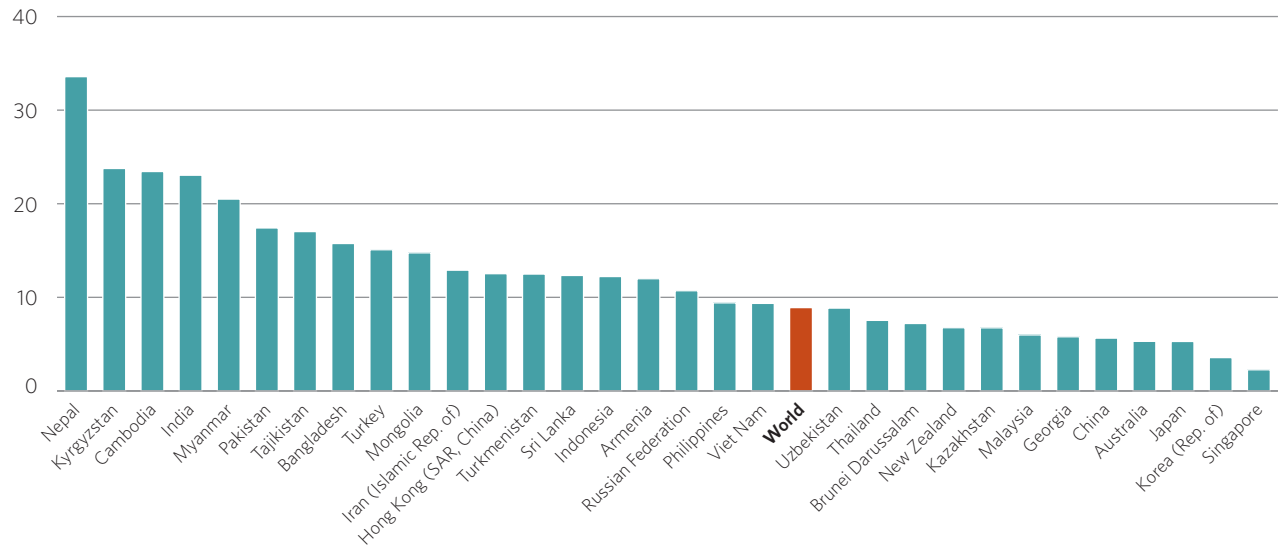
Asia–Pacific had the highest energy intensity among all regions in 2014 (high energy intensity serves as a measurable proxy for low energy efficiency). Energy intensity declined steeply, however, from 9.1 MJ/2011 PPP $ (megajoules per 2011 purchasing power parity dollar) in 1990 to 6.0 MJ/2011 PPP $ in 2014 (figures 10.9 and 10.10), converging rapidly on the world average of 5.5 MJ/2011 PPP $. From 2012 to 2014, the region avoided 8.2 exajoules (EJ) of total final energy consumption (TFEC), representing 69% of global avoided energy, equivalent to the 2014 TFEC of the Republic of Korea and Thailand combined. Countries across the region adopted energy efficiency targets, including more aggressive commitments under the Nationally Determined Contributions of the Paris climate agreement (COP 21). Legislative frameworks increasingly identified energy efficiency priorities and plans, introduced standards and regulations across sectors, and set up financial mechanisms and incentives.

Energy intensity in all productive sectors—industry, agriculture, and services—declined (figure 10.11). The decline in industry was driven by China, accounting for 55.3% of the region's industrial energy consumption in 2014, which continued to adopt aggressive measures to eliminate outdated technologies and establish energy consumption standards. By contrast, energy intensity in the residential sector rose as higher standards of living relying on increased energy consumption became more widely affordable with rising per capita GDP.

Real estate development is being driven by rapid economic growth across the Asia–Pacific region. Green building standards amid growing housing development are key for future gains in energy intensity, as current methods of construction will largely determine residential

FIGURE 10.12 Most countries in Asia-Pacific had electricity losses above the global average in 2014

Electricity transmission and distribution losses (%)



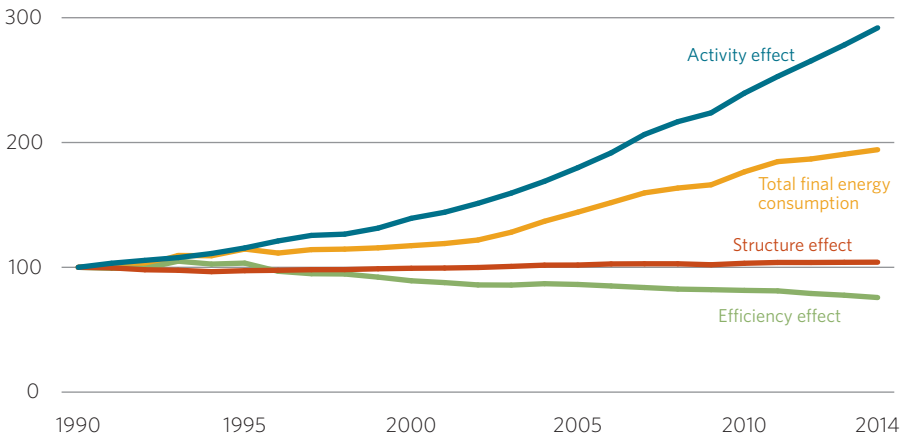
energy consumption for decades to come. With standards and regulations underdeveloped, energy efficiency has often been left behind in a rush to meet the requirements of physical space. Even when standards and regulations exist for "green buildings," they may be weak and poorly enforced. Still, building energy efficiency policies have spread across Asia-Pacific over the past decade. In many countries, public buildings are the starting place for energy efficiency codes, later expanded to other building sectors.

In transport, modern urban infrastructure is being rolled out to efficiently move growing populations, though road traffic has reached critical conditions in many large cities. Some countries, including China, the Republic of Korea, and Viet Nam, are pushing fuel switching from petroleum to gas and electricity, to increase efficiency and reduce pollution. Countries such as Australia, Bangladesh, Fiji, Malaysia, and Tonga are running campaigns on energy efficiency information for electricity, such as labeling appliances to raise awareness and promote energy efficiency.

Supply-side efficiency in electricity generation showed upward trends in the region. The efficiency of thermal power generation rose from 33.4% in 1990 to 38.8% in 2014, driven by the gradual shift from oil-fired generation plants to coal-fired generation plants, whose efficiency increased. Transmission and distribution losses of electricity remained stable in 1990–2014 at the regional level, 8.6% in 2014, but many countries are saddled with outdated and inefficient infrastructure (figure 10.12). Most countries in Asia-Pacific have electricity losses above the global average, indicating the weakness of transmission and distribution networks. Enhancing power supplies and grids, which could provide huge efficiency improvements, remains a planning and financial challenge in many countries.

FIGURE 10.13 Asia-Pacific has decoupled energy consumption from GDP growth

Index (1990 = 100)



A decomposition analysis[5] of trends in TFEC shows that Asia-Pacific has decoupled energy consumption from GDP growth (figure 10.13). Even though regional energy consumption has increased rapidly since the early 2000s, chiefly due to industry in China and, to a lesser extent, India, the effect has been partly mitigated by increased productivity in energy use coming from energy efficiency policies and measures.

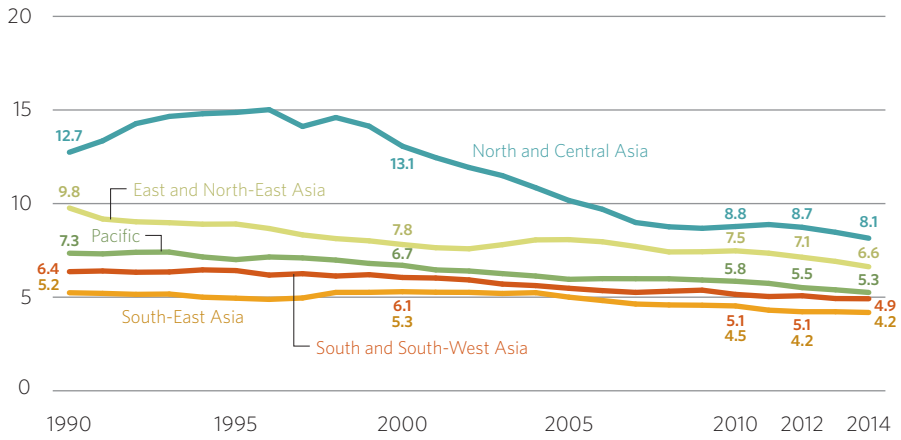
Subregional trends

Energy intensity in all subregions of Asia-Pacific declined in 1990–2014—in some cases considerably—despite starting from very different levels (figure 10.14). Energy intensities ranged from 14 MJ/2011 PPP $ (megajoules per purchasing power parity dollar) in Turkmenistan to about 2 MJ/2011 PPP$ in Sri Lanka and even lower in Hong Kong (SAR, China) and Macao (SAR, China) (figure 10.15).

The East and North-East Asia subregion started in 1990 with energy intensity at 9.8 MJ/2011 PPP $ and reached 6.6 MJ/2011 PPP $ in 2014, a reduction of 1.6% a year at the compound annual growth rate (CAGR). The fall was driven by China where energy intensity

FIGURE 10.14 All subregions of Asia–Pacific had declining energy intensities in 1990–2014, narrowing the gaps between them

Primary energy intensity (MJ/2011 PPP $)



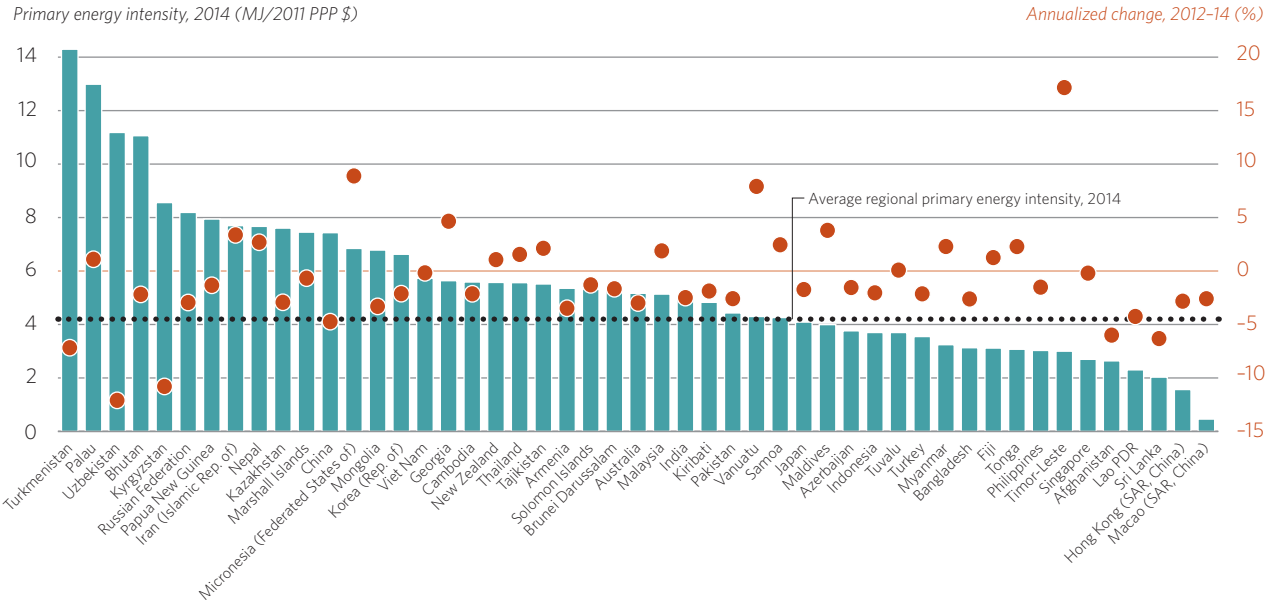
declined from 21.2 MJ/2011 PPP $ in 1990 to 7.4 MJ/2011 PPP $ in 2014, at −4.3% per year, CAGR. China aimed to mitigate increasing energy consumption in industry with aggressive energy efficiency measures. Its government established mandatory quotas for energy consumption per unit of product in key industries, and strengthened evaluation and supervision of energy savings. China took up many energy-saving projects, including simultaneous generation of heat and power, and recycling of industrial by-product gas (Government of China 2012). As cities in China continue to grow, the country promotes eco-cities, where green buildings account for 50% of the building stock (Government of China 2014). The most advanced energy efficiency policies in the East and North-East Asia subregion, such as in the Republic of Korea, aim for "net zero" buildings.

The North and Central Asia subregion had the highest energy intensity in Asia–Pacific in 1990, 12.7 MJ/2011 PPP $, and despite increasing in the early 1990s, energy intensity fell fast after the fall of the Soviet Union. More recently, improvements in the agricultural and industrial sectors drove further declines. Although the subregion remained the most energy intensive in the world at 8.1 MJ/2011 PPP $ in 2014, the gap with the second most energy intensive—East and North-East Asia—narrowed sharply. (Further country-level analysis is presented in the Europe, North America, and Central Asia regional chapter.)

Energy intensity in the Pacific subregion fell from 7.3 MJ/2011 PPP $ in 1990 to 5.3 MJ/2011 PPP $ in 2014. The transport sector consumed the largest share of energy, reflecting reliance on road networks and the large size of Australia, which accounts for 83% of the subregion's TFEC. In Papua New Guinea and the Solomon Islands energy intensity declined the fastest in the subregion, while it rose in Kiribati, Marshall Islands, the Federated States of Micronesia, and Vanuatu.

The South and South-West Asia subregion had the second lowest energy intensity, which decreased from 6.4 MJ/ 2011 PPP $ in 1990 to 4.9 MJ/2011 PPP $ in 2014. Bhutan's energy intensity fell impressively in 1990–2014 from 30.0 MJ/2011 PPP $ to 11.1 MJ/2011 PPP $, at a −4.1% CAGR, driven by fast-growing GDP resulting from hydropower exports.[6] In India, accounting for over two-thirds of the subregion's total primary energy supply, energy intensity declined. Upgrading of existing urban environments is a promising development. In 2015, India launched its Smart Cities Mission, which will cover 100 cities in five years, for retrofitting, redeveloping, and expanding cities using integrated, smart solutions to improve city infrastructure.

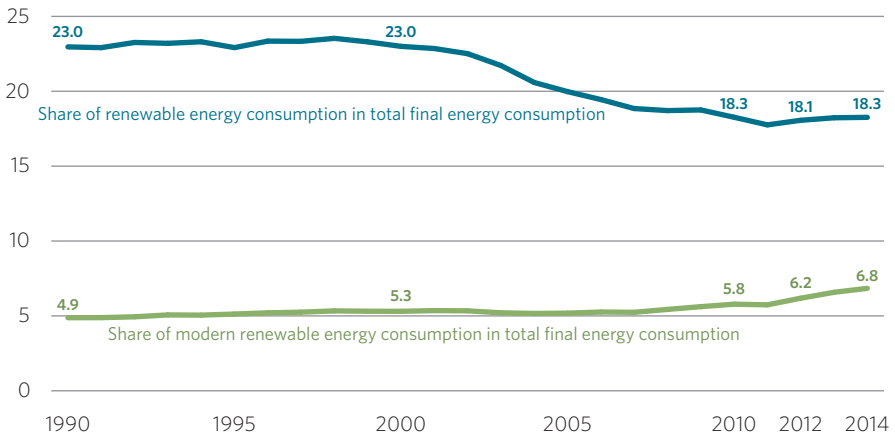
FIGURE 10.15 Energy intensity varied widely across economies in Asia–Pacific in 2014



The South-East Asia subregion's energy intensity was the lowest in Asia–Pacific, beginning at 5.2 MJ/2011 PPP $ in 1990, and slowly decreasing to 4.2 MJ/2011 PPP $ in 2014. Declines in energy intensity in Cambodia, Lao PDR, and Myanmar were the strongest in the subregion.

FIGURE 10.16 Close to one fifth of Asia–Pacific's energy consumption came from renewable energy sources in 2014

Share (%)



RENEWABLE ENERGY

Regional progress

Asia–Pacific has emerged as the global leader in renewable energy, with more investment and installed capacity than any other region.[7] In 2014, its renewable energy consumption was the highest in the world, at 31.1 EJ, double the consumption of the second-ranking Europe, North America, and Central Asia region. China led in new renewable energy investments (excluding large hydropower), which nearly doubled from $84 billion in 2011 to $161 billion in 2015, representing over half of the region's investments (Frankfurt School-UNEP Centre/BNEF 2016).

Yet the energy-hungry region's consumption of fossil fuels also rose dramatically, reducing the share of renewable energy in TFEC to 18.3% in 2014 (figure 10.16). The share of traditional biomass has been falling steadily, from 18.1% of TFEC in 1990 to 11.4% in 2014. Conversely, the share of modern renewable energy consumption increased from 4.9% in 1990 to 6.8% in 2014, with the pace accelerating over recent years.

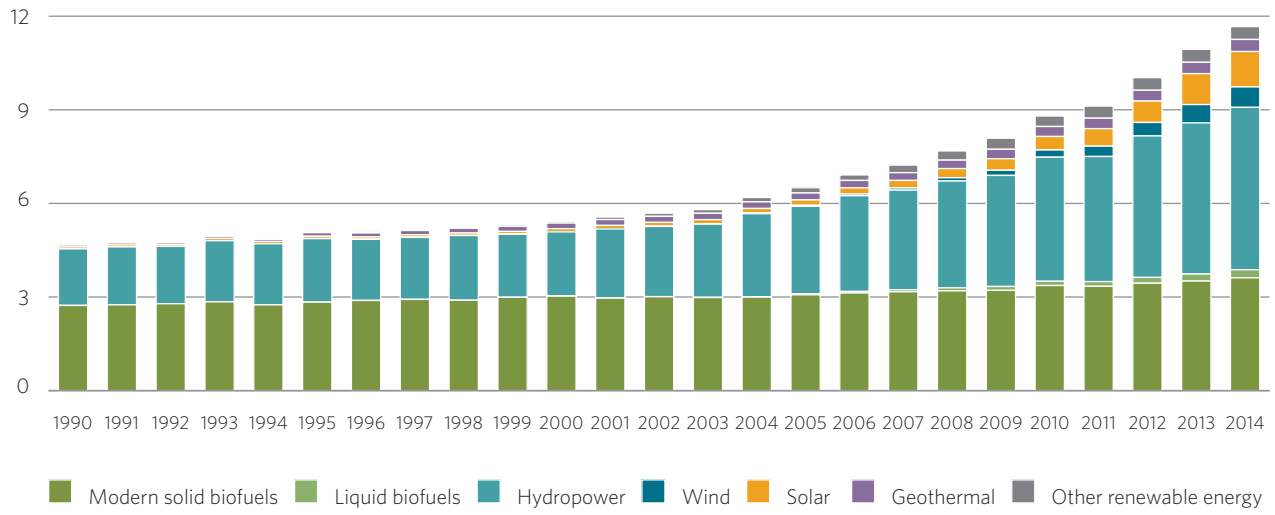
Among modern renewable energy sources, hydropower had the largest share (44.6%) in 2014, followed by modern biofuels (31.0%), solar (9.7%), and wind power (5.6%), the last two reporting double-digit growth in 2012–14 (figure 10.17).

Government policies adopted since 2000 to promote renewable energy investment growth include renewable energy targets,[8] feed-in tariffs, and other measures. New commitments and targets, combined with a shift from coal, portend a growing role for renewable energy. COP 21 was for many countries a turning point, renewing and broadening commitments to expanding use of renewable energy.

New models for decentralized energy applications are emerging. Micro-hydro has been a key decentralized power application in China, Indonesia, and Nepal. Solar micro-grids have attracted interest across Asia–Pacific due to high solar irradiation, low environmental impacts, and increasingly affordable pricing. Solar micro-grids are still high-risk investments in many countries, but private actors are entering the market as lenders become more receptive and governments develop subsidy models to support wider use. Distributed energy, which comes from small-scale generators connected to the grid, is proliferating with government support to diversify the energy mix and strengthen grids. For some countries use of distributed energy aims to reduce dependence

FIGURE 10.17 Asia–Pacific consumption of modern renewable energy was dominated by hydropower and modern biofuels in 1990–2014

Modern renewable energy consumption (exajoules)

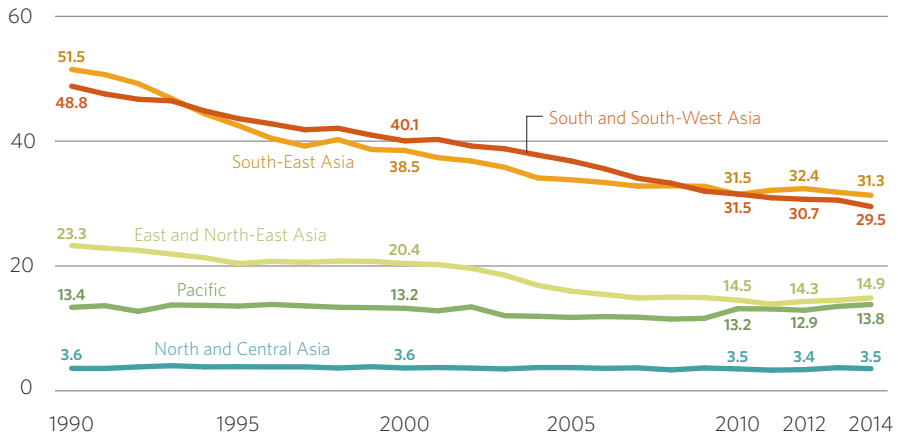


on imports and mitigate the risks from volatile energy markets.

Expanding renewable energy's share requires upgrading and expanding transmission infrastructure to ensure full use of current installed renewable capacity and promote an increase in variable renewable energy supplies. Growing support for regional connectivity suggests that the share of renewable energy consumption will grow, facilitated by expanded, cross-border power grid systems that could accommodate higher shares of variable renewable energy, if technical and political conditions for market integration can be agreed. Current power trade agreements are mostly bilateral, though some regional initiatives envisage multilateral market integration, which would widen areas for electricity balance and allow greater renewable energy uptake.

FIGURE 10.18 The share of renewable energy consumption in total final energy consumption fell in most subregions of Asia-Pacific in 1990-2014

Share of renewable energy consumption in total final energy consumption (%)

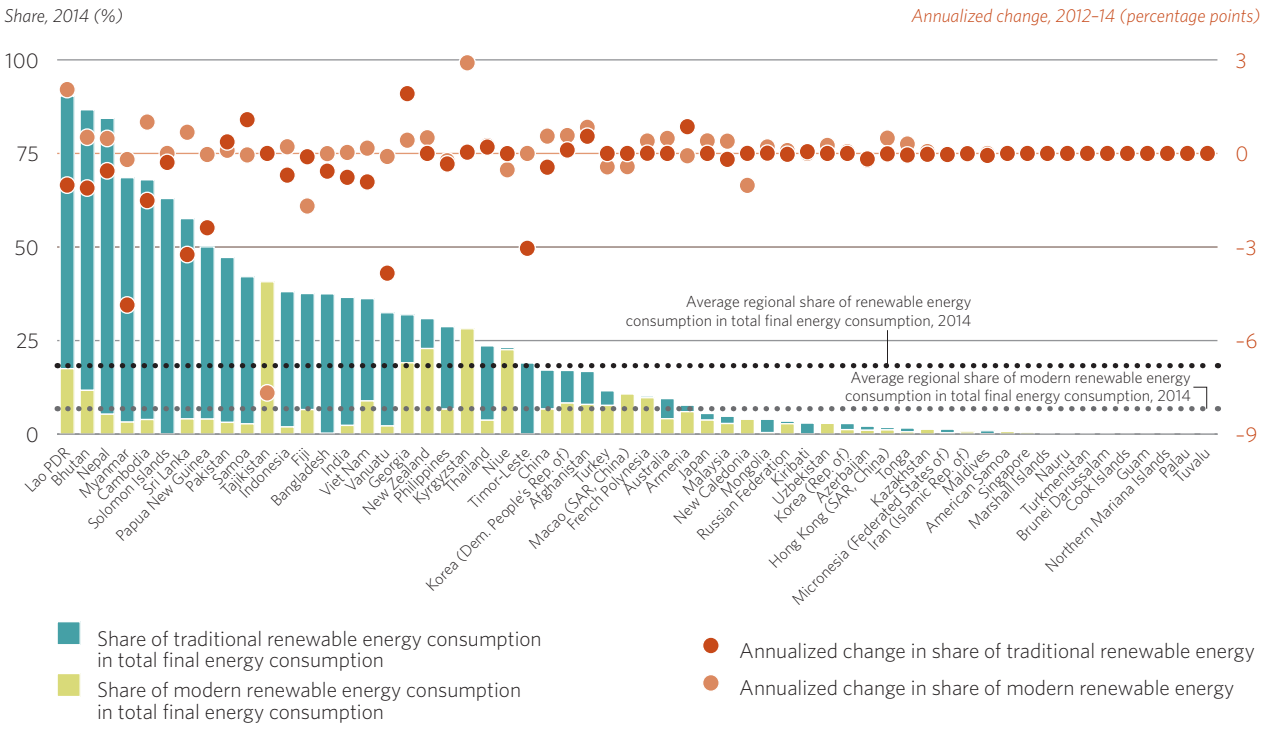


Subregional trends

In three of the five subregions in Asia-Pacific the share of renewable energy consumption in TFEC declined (figure 10.18). Shares varied hugely, from around 90% in Lao PDR to negligible numbers in some economies (figure 10.19).

In the East and North-East Asia subregion, the share of renewable energy consumption in TFEC fell from 23.3% in 1990 to 14.9% in 2014, as consumption of renewable energy was outpaced by consumption of fossil fuels, especially coal in China (in 2014 China's coal supply accounted for nearly 30% of the region's total primary energy supply). New renewable energy capacity installations have, however, gained momentum, with hydro and solar power making the largest contribution. Rising modern energy use, coupled with a falling traditional renewable energy consumption, raised the subregion's share of modern renewable energy in TFEC to 6.5% in 2014 from 2.3% in 1990. China pledged to install 200 GW of wind and 100 GW of solar capacity under its Nationally Determined Contribution commitment in COP 21 and under its Energy Development Strategic Action Plan, and the installed capacity of China's hydropower generation is expected to reach about 340 GW by 2020.

FIGURE 10.19 Share of renewable energy consumption varied dramatically by country in Asia-Pacific in 2014



In the North and Central Asia subregion, the share of renewable energy consumption in TFEC was the lowest in Asia–Pacific—3.5% in 2014—a share that was flat in 1990–2014. Hydropower's share has been the largest, driven by Tajikistan. (Further country-level analysis is in the Europe, North America, and Central Asia regional chapter.)

The Pacific subregion's share of renewable energy in TFEC was 13.8% in 2014, and it had the highest share of modern renewable energy in the region, 12.4%, driven by modern solid biofuels and hydropower. The share of wind was 7.9%, and solar power 5.9% in 2014, driven by Australia and New Zealand. Several Pacific Island nations, including the Cook Islands, Fiji, Samoa, Tuvalu, and Vanuatu, aim to generate 100% of their electricity with renewable energy, and some have already made good progress. Fiji's modern renewable energy share of 6.6% in 2014 is largely based on modern solid biofuels.

In the South and South-West Asia subregion the share of renewable energy consumption in TFEC also declined, sinking to 29.5% in 2014, as fossil fuel consumption increased faster than renewable energy consumption. The share of traditional renewable energy declined to 21.4% in 2014, from 36.6% in 1990, and the share of modern renewable energy dropped to 8.1% in 2014, from 12.3% in 1990. Modern solid biofuels consumption accounted for over two-thirds of the modern renewable energy consumption in 2014, followed by hydropower (about one-fifth). India increased its renewable energy consumption, particularly liquid biofuels, solar and wind power, in 2012–14, driven by initiatives setting renewable energy targets.[9] India aims to increase its installed renewable energy capacity to five times 2015 levels by 2022, to 175 GW, by adding 100 GW of solar. The country will also explore new wind–solar hybrid models. Bangladesh's solar power consumption rose in 2012–14, reaching 19.7% of modern renewable energy, on the back of its 500 MW solar program for 2012–16.

Although South-East Asia's share of renewable energy consumption in TFEC declined, it was the highest in the Asia–Pacific region, 31.3%, in 2014, including the highest share of traditional renewable energy consumption, 22.4%. More recently, the share of modern renewable energy consumption started to rise, and traditional renewable energy consumption continued to fall. Several countries of the South-East Asia subregion are pursuing hydropower development, and energy generation from modern solid biofuels in the form of agricultural waste is rising in Indonesia, Malaysia, the Philippines, and Thailand. Geothermal resources are abundant and initial efforts have begun in the Philippines and Indonesia, but use of geothermal power has yet to increase significantly due to technical and financial barriers. Solar is increasingly used in on- and off-grid applications in several countries.

NOTES

1. 2013 data.
2. According to authors' review of national policies contained within the Asia Pacific Energy Portal, available at asiapacificenergy.org.
3. In 2014, 47.5% of the population lived in urban areas, up from 38.1% in 2000.
4. Connections under this program, run by the Ministry of Petroleum and Natural Gas, will be in the name of the female head of household.
5. Decomposition analysis explains energy consumption trends through three underlying components: activity, efficiency, and structural.
6. The trade value of Bhutan's electricity exports grew from $18.5 million in 1993 to $174.8 million in 2014 (based on UN Comtrade 2017).
7. Excluding large hydro, in 2015 regional countries invested more than $160 billion in renewable energy, with China spending $102.9 billion (36% of the global total), Japan $36.2 billion, and India $10.2 billion, with the rest of Asia accounting for $11.4 billion (Frankfurt School–UNEP Centre/BNEF 2016).
8. Targets are defined as share, added capacity, or output goals identified within a policy or program document.
9. Initiatives include the Jawaharlal Nehru National Solar Mission launched in 2010, and the 2011 Strategic Plan for New and Renewable Energy Sector for 2011–2017 (Government of India 2010; Government of India 2011).

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11

THE EUROPE, NORTH AMERICA, AND CENTRAL ASIA REGION

The regional profile of the Europe, North America, and Central Asia region has been written with the UN Economic Commission for Europe (UNECE).

REGIONAL OVERVIEW

The region comprises 56 countries with a population of 1.3 billion in 2014, representing 17% of the world's population. The region has four subregions: North America; Western and Central Europe; Southeast Europe; and Eastern Europe, Caucasus, and Central Asia (table 11.1). It is diverse, with high- and low-income countries, countries in economic transition, some energy-rich countries, and others with few indigenous energy resources. In 2014, the region accounted for 42% of global gross domestic product (GDP) (2011 PPP $), 40% of the world's total primary energy supply, and 34%[1] of the planet's carbon dioxide emissions.

TABLE 11.1 Countries by subregion

North America	Western and Central Europe		Southeast Europe	Eastern Europe, Caucasus, and Central Asia
1. Canada	1. Andorra [b]	18. Lithuania	1. Albania	1. Armenia
2. United States of America	2. Austria	19. Luxembourg	2. Bosnia and Herzegovina	2. Azerbaijan
	3. Belgium	20. Malta	3. Bulgaria	3. Belarus
	4. Cyprus	21. Monaco [b,c,e]	4. Croatia	4. Georgia
	5. Czech Republic	22. Norway	5. Montenegro	5. Israel
	6. Denmark	23. Netherlands	6. Romania	6. Kazakhstan
	7. Estonia	24. Poland	7. Serbia	7. Kyrgyzstan
	8. Finland	25. Portugal	8. Macedonia (The former Yugoslav Rep. of)	8. Moldova (Rep. of)
	9. France	26. San Marino [b,c,e]		9. Russian Federation
	10. Germany	27. Slovak Republic		10. Tajikistan [d]
	11. Greece	28. Slovenia		11. Turkey [a,d]
	12. Hungary	29. Spain		12. Turkmenistan [e]
	13. Iceland	30. Sweden		13. Ukraine
	14. Ireland	31. Switzerland		14. Uzbekistan [d]
	15. Italy	32. United Kingdom of Great Britain and Northern Ireland		
	16. Latvia			
	17. Liechtenstein [a,b]			

a. Data on access to clean fuels and technologies for cooking not available.

b. Data on energy intensity not available.[1]

c. Data on total renewable energy consumption either not available or reported being zero.[2]

d. Data on traditional renewable energy consumption either not available or reported being zero.[3]

e. Data on modern renewable energy consumption either not available or reported being zero.[4]

1. In addition, data for energy intensity by sector was not available in 2014 for several countries: energy intensity in agriculture was not available for 7 countries; energy intensity in industry was not available for 6 countries; energy intensity in services was not available for 7 countries; and residential energy intensity was not available for one country. For more details, see data annex 2.

2. Renewable energy consumption data are based on databases of the International Energy Agency (IEA) Energy Data Center and United Nations Statistics Division (UNSD). When data for total, modern, traditional renewable energy consumption is not available this may be due to either negligible consumption, energy balance data not being available at the necessary level of detail, or uses of renewable energy that are not captured by official country statistics as reported to the IEA Energy Data Center and UNSD.

3. Ibid. Also, traditional renewable energy consumption is assumed to be only the consumption of solid biomass in the residential sector of non-Organisation for Economic Co-operation and Development (OECD) countries (that is, no traditional renewable consumption is assumed to occur in OECD countries). This IEA convention has been adopted in the Global Tracking Framework, due to the heavy reliance on the IEA data (see box 5.1 for further details).

4. Ibid.

ACCESS TO ELECTRICITY

Regional progress

The Europe, North America, and Central Asia region is the only region to achieve universal access to electricity. High levels of industrialization provided a high rate of electricity access in all countries. The regional access rate was already 98.8% in 1990 and reached 100% in 2009, with about 6.5 million more people a year getting access (figure 11.1). In all countries access was above 99% in 2014.

Urban areas throughout the region reached universal access to electricity in 2009 and continued to have an access rate above 99.9% in 2014. Rural areas throughout the region achieved universal access in 2010 and continued to have access above 99% in 2014 (figure 11.2).

Subregional progress

All subregions have universal access to electricity. North America, and Western and Central Europe had already achieved universal access in 1990, Southeast Europe achieved it in 2007, and Eastern Europe, Caucasus, and Central Asia in 2010 (figure 11.3).

In 2014, only some 12,520 people in rural Kyrgyzstan and Tajikistan did not have access to electricity (figure 11.4).

Despite 100% access to electricity, several countries in the Eastern Europe, Caucasus, and Central Asia subregion face problems of affordability, quality of access, and quality of service. Much infrastructure outside North America and Western Europe—a legacy of post–World War II industrialization—is now old and requires substantial renewal and redevelopment to improve reliability and quality of supply. In Tajikistan, for example, power shortages of 2,700 gigawatt-hours a year, equal to 25% of winter power needs, create estimated economic losses of $200 million, or 3% of GDP (REN21 2015). These outages represent 4.4% of electricity sales—against average outages of 0.1% in countries of the Organisation for Economic Co-operation and Development (OECD) (REN21 2015). In 2013, five countries in the region had isolated settlements that had lost grid access, in some cases due to recent conflicts, and efforts to restore access were under way (REN21 2015).[2]

Upgrading or replacing infrastructure to improve service quality across the Eastern Europe, Caucasus, and Central Asia subregion is a much larger task than providing access to the remaining areas. Affordability of electricity service to low-income households is another important challenge.

FIGURE 11.1 The Europe, North America, and Central Asia region was the only region with universal access to electricity by 2014

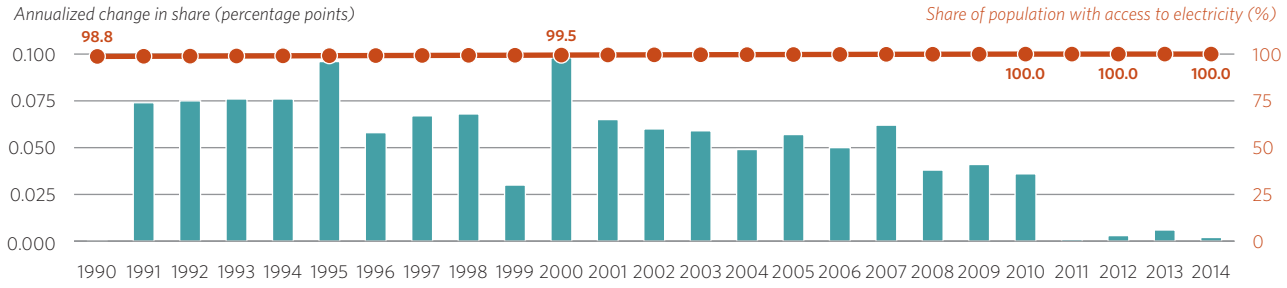


FIGURE 11.2 All countries in the Europe, North America, and Central Asia region achieved universal access to electricity in both urban and rural areas

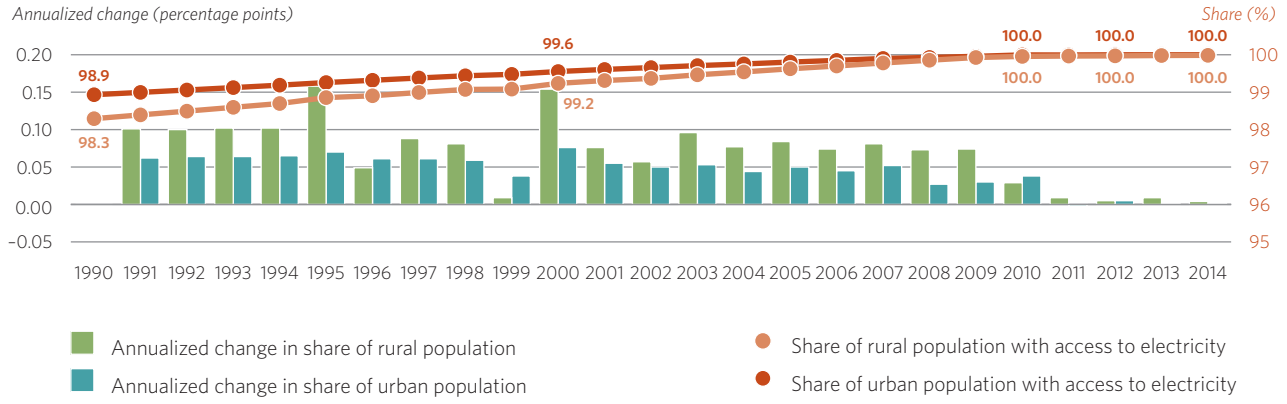
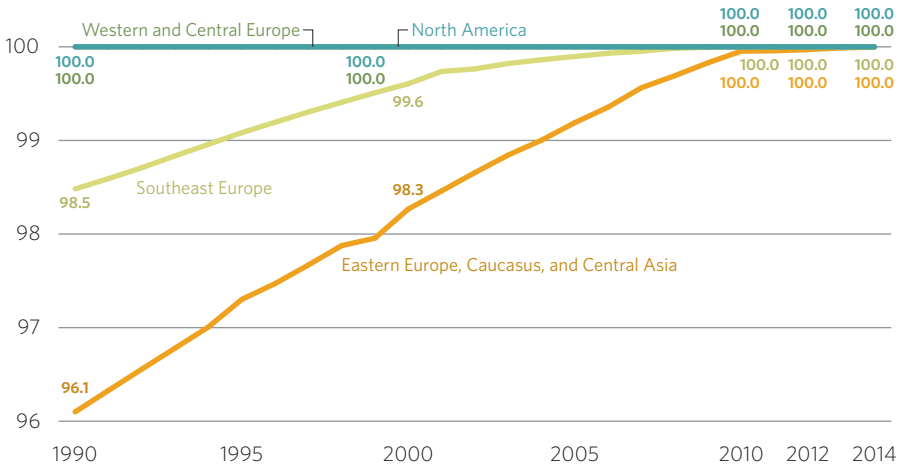


FIGURE 11.3 All subregions in the Europe, North America, and Central Asia region had achieved universal access to electricity in 2014

Share of population with access to electricity (%)



ACCESS TO CLEAN FUELS AND TECHNOLOGIES FOR COOKING

Regional progress

The Europe, North America, and Central Asia region ranked first among global regions on access to clean fuels and technologies for cooking (here "clean cooking"), with 98% of the population having access in 2014 (figure 11.5). The region already had a 95.3% access rate in 2000. In 2000–14, about 7.2 million more people a year got access to clean cooking (figure 11.5).

However, 23.3 million people still relied on traditional fuels for cooking in 2014 in the Europe, North America, and Central Asia region, roughly the combined population of Kazakhstan and Kyrgyzstan. Most lived in remote areas and used locally gathered fuelwood. The fuel is typically burned in a controlled combustion woodstove or a traditional high-mass space heater or cooking oven. Compared with stoves used in other regions, these traditional stoves offer users reliable heat from low- or no-cost local resources at reasonable efficiencies[3] and are therefore preferred where access to commercial energy sources is impractical or expensive.

Subregional progress

All subregions except Southeast Europe achieved access that was universal or above 95% (figure 11.6).

Developed countries in North America and Western and Central Europe have universal access to clean cooking, mainly using electricity and natural gas. In some remote areas in Scandinavian countries where access to commercial energy sources is impractical or expensive, many households use wood fuel in modern woodstoves with high efficiency for cooking (and heating).

FIGURE 11.4 All countries in the Europe, North America, and Central Asia region had achieved universal access to electricity in 2014

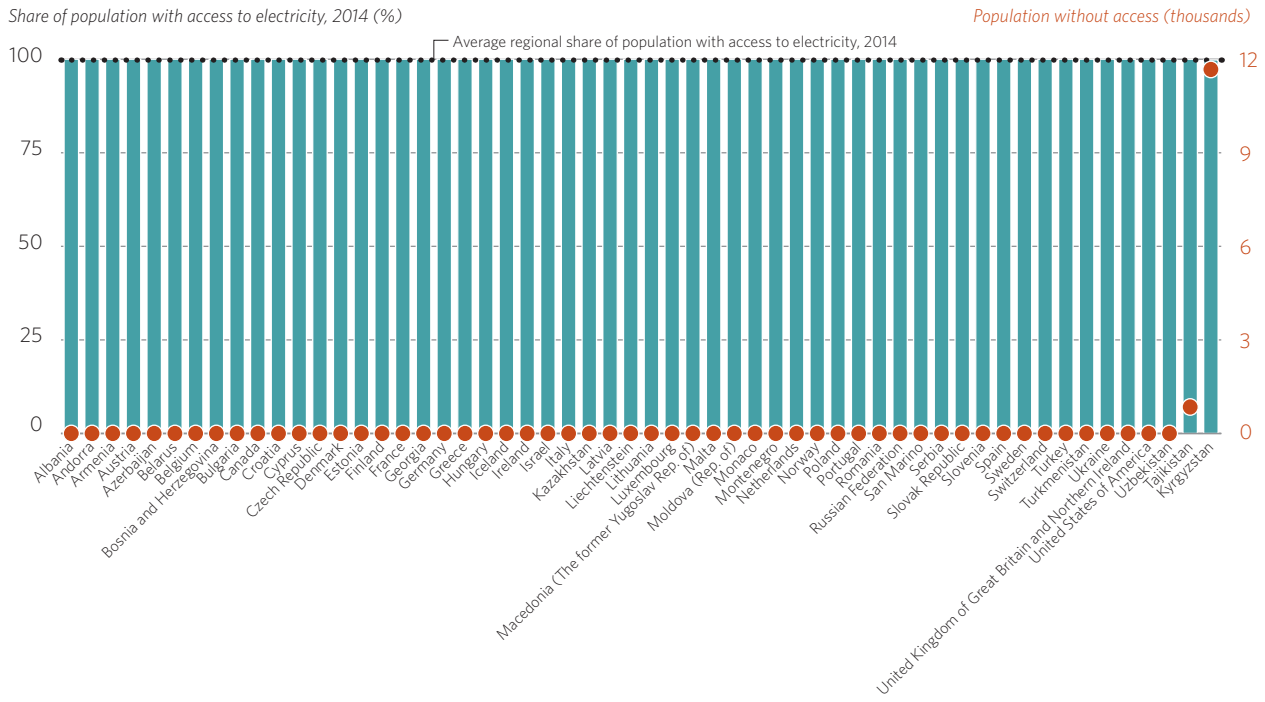
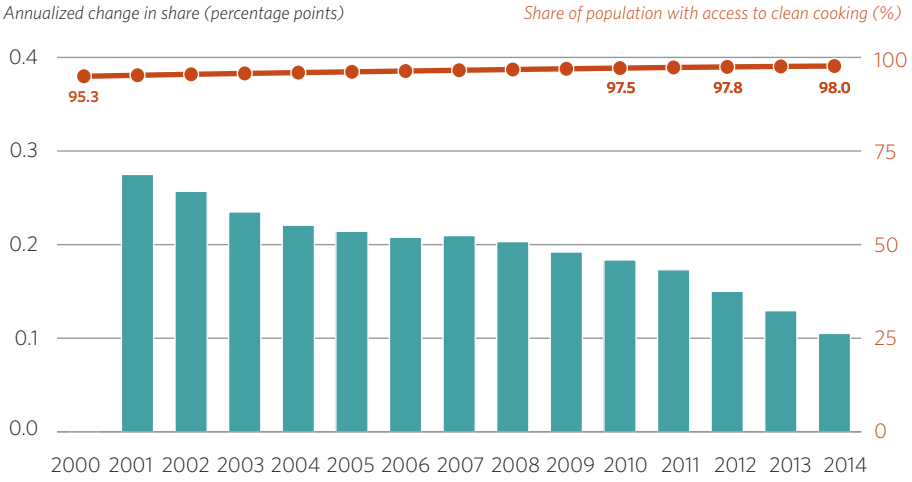


FIGURE 11.5 The rate of access to clean cooking in the Europe, North America, and Central Asia region ranked first in the world



In Southeast Europe, access to clean cooking reached 75.8% in 2014, up from 67.9% in 2000. Albania had the fastest growth in the subregion and reached 67.1% access, while Bosnia and Herzegovina reported the lowest access, 39.8%, and the slowest growth in 2012–14 (figure 11.7).

Access to clean cooking in the Eastern Europe, Caucasus, and Central Asia subregion grew and reached a rate of 96.1% in 2014, up from 88.1% in 2000. All countries but three—Georgia, Kyrgyzstan, and Tajikistan—reported either universal access or a rate above 90%. Azerbaijan had the fastest-growing access rate and reached 96.9% access in 2014, while Georgia's access was lowest, 55.0%.

Access to clean fuels and technologies for heating

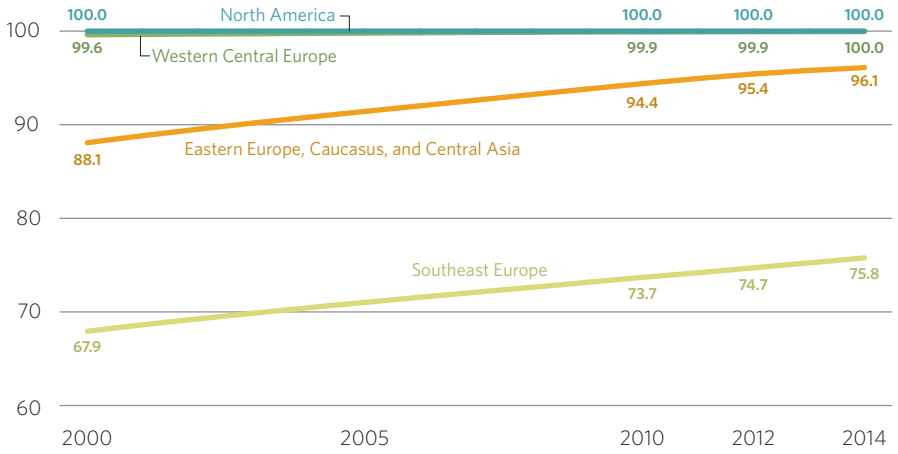
The Europe, North America, and Central Asia region's countries circle the arctic, and cold climates across much of the region create the highest demand for heating services in the world. The region has a legacy of older, often poorly insulated buildings with old, inefficient central or unitary heating systems. Affordability and quality of heating services are particular challenges where reliance on older, fossil-based heat infrastructure is locked in. Poor insulation is an important issue in all countries.

In all countries, at least part of their household population is in energy poverty, which is generally recognized as spending more than 10% of household income on energy. For example, in the Russian Federation, 29% of households spend more than 10% of income on energy, while in four other countries more than 40% of households spend more than 10% of their income on energy—Albania, 46%; Republic of Moldova, 52%; Serbia, 49%; and Tajikistan, 60% (REN21 2015).

Improving end-use efficiency is not only cheaper than providing new energy supply, it also delivers large social and economic benefits (IEA 2014). These benefits occur particularly in countries where heating services are inefficient or unaffordable, where the value of improved comfort and reduced health care costs exceed the value of reduced energy demand costs. Investments in energy efficiency also reduce upstream costs for power and heat supply systems. A shift from the current focus on lifecycle cost of supply to an approach maximizing system value will improve multiple benefits and energy resilience across the energy system.

FIGURE 11.6 Southeast Europe did not achieve universal access to clean cooking by 2014

Share of population with access to clean cooking (%)



ENERGY EFFICIENCY

Regional progress

Decreasing energy intensity, a measurable proxy for increasing energy efficiency, has improved over the long term in the Europe, North America, and Central Asia region, which ranked third among all regions in 2014 (after the Latin America and Caribbean region, and the Arab region). In 1990–2014, the region's energy intensity declined the fastest among all regions at a –1.9% compound annual growth rate (CAGR) from 8.0 MJ/2011 PPP $ (megajoules per 2011 purchasing power parity dollar) to 5.1 MJ/2011 PPP $ (figures 11.8 and 11.9). In 2012–14, through declining energy intensity, the region avoided 3.9 exajoules (EJ) of total final energy consumption (TFEC), 32.9% of avoided energy worldwide, almost equivalent to the 2014 TFEC of Spain and the Czech Republic combined.

Key drivers of improved energy efficiency in North America and elsewhere include cost-reflective prices and consistent energy efficiency policies. Long-running energy efficiency policies like MEPS (Minimum Energy Performance Standards),[4] CAFE (Corporate Average Fuel Economy) standards,[5] and building codes work together with competitive pressures in these economies to improve productivity, displace inefficient production, and encourage energy efficiency innovations such as electric vehicles and intelligent production systems applying advanced information and communications technology.

Energy intensity changes differed in various economic sectors. In industry and agriculture, energy intensity declined throughout the entire period (figure 11.10). In the services and residential sectors energy intensity fell sharply in 2010–12 but returned to more modest declines in 2012–14.

Supply-side efficiency in electricity generation increased from 36.4% in 1990 to 40.7% in 2014, driven by the gradual shift away from oil- and coal-fired generation plants toward more efficient gas-fired generation plants. In addition, gas-fired generation plants efficiency climbed from 37.1% in 1990 to 49.4% in 2014—the highest among regions. Losses in electricity transmission and distribution declined from 8.2% in 1990 to 7.2% in 2014, the lowest among all regions, while natural gas transmission and distribution losses fell by half, from 1.2% to 0.6%.

FIGURE 11.7 In 2014, 35 countries in the Europe, North America, and Central Asia region reached universal access to clean cooking, and 9 more had a rate above 90%

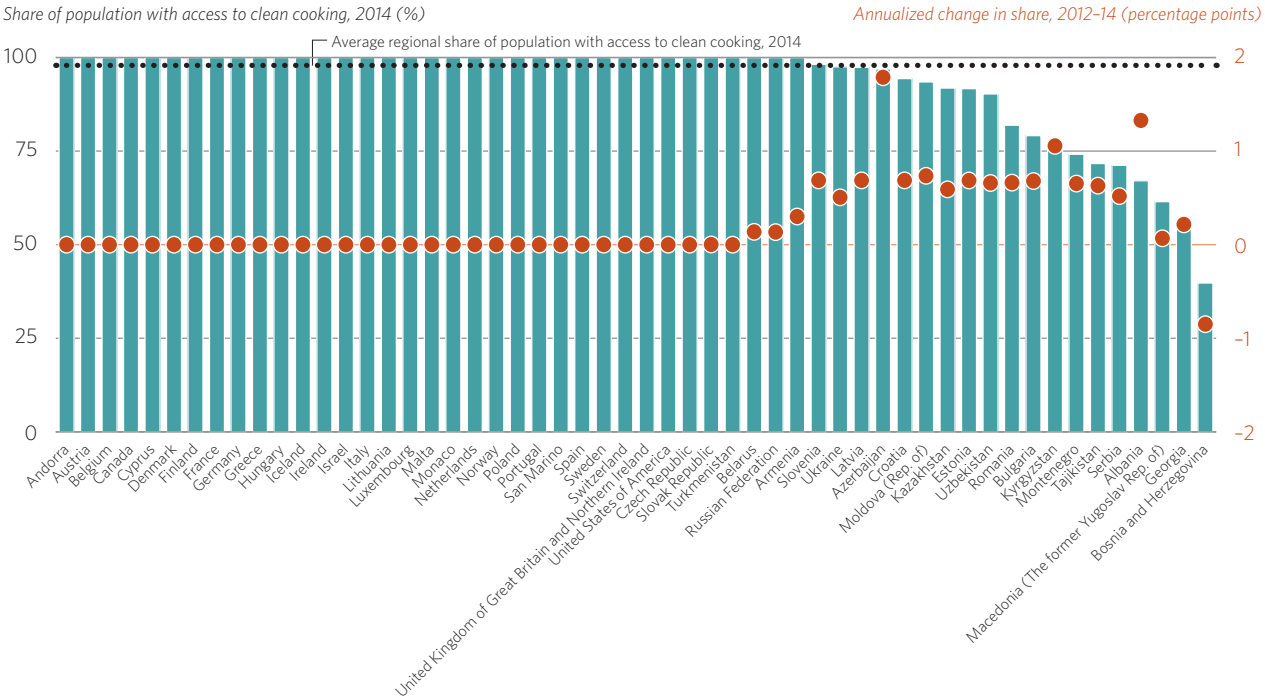


FIGURE 11.8 The Europe, North America, and Central Asia region reported the fastest decreasing energy intensity rate in 1990–2014

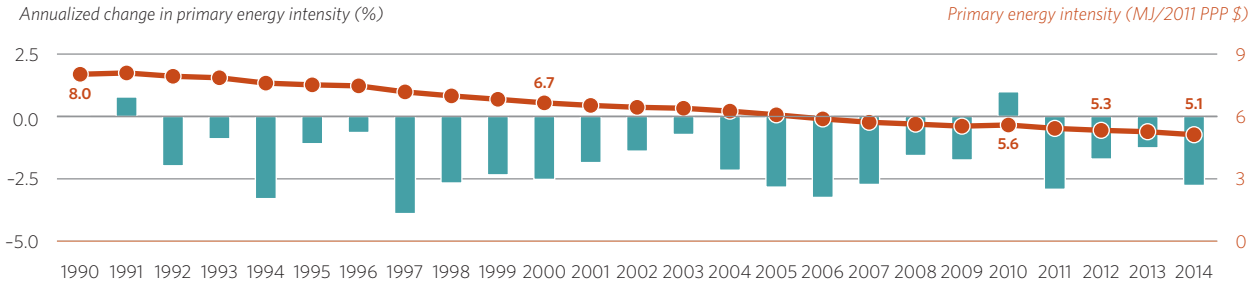


FIGURE 11.9 The energy intensity decline in the Europe, North America, and Central Asia region accelerated slightly in 2010–14

Primary energy intensity compound annual growth rate (%)

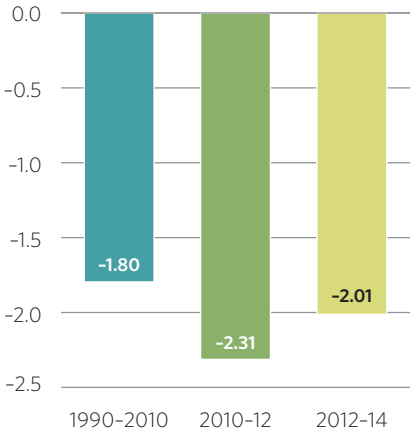
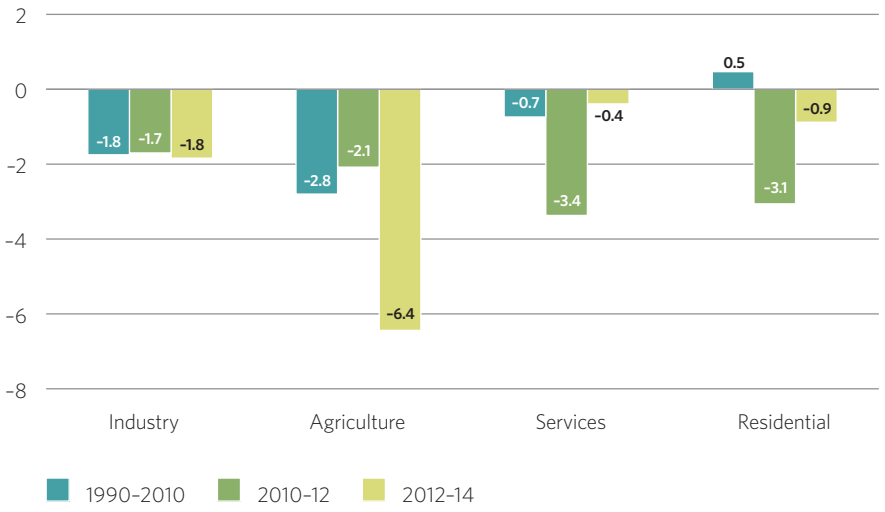


FIGURE 11.10 Energy intensity in industry and agriculture in the Europe, North America, and Central Asia region declined continuously in 1990–2014

Final energy intensity compound annual growth rate (%)

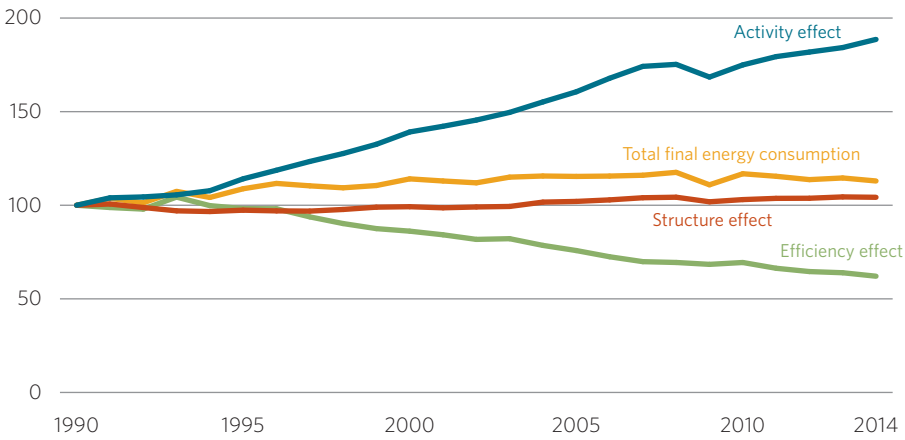


Decomposition analysis[6] shows that changes in energy intensity are due to the decoupling of energy consumption from GDP growth, driven by efficiency gains. Decoupling started in the mid-1990s and accelerated gradually until 2014, with GDP increasing as energy demand remained stable, and even decreased in more recent years (figure 11.11).

Absolute energy efficiency improvements require prices and policies that treat the energy system as an interconnected cost-reflective system, rather than a supply-dominated system. An "end-use energy efficiency first," demand-side approach also minimizes claims on upstream production systems and fossil-fuel transition costs, enhances the contribution of renewable energy investments, and optimizes socioeconomic and environmental outcomes.

FIGURE 11.11 Decoupling accelerated sharply in the mid-1990s in the Europe, North America, and Central Asia region and continued unabated until 2014

Decomposition of trends in global total final energy consumption: Activity, structure, and efficiency effects, 1990–2014 (index, 1990 = 100)

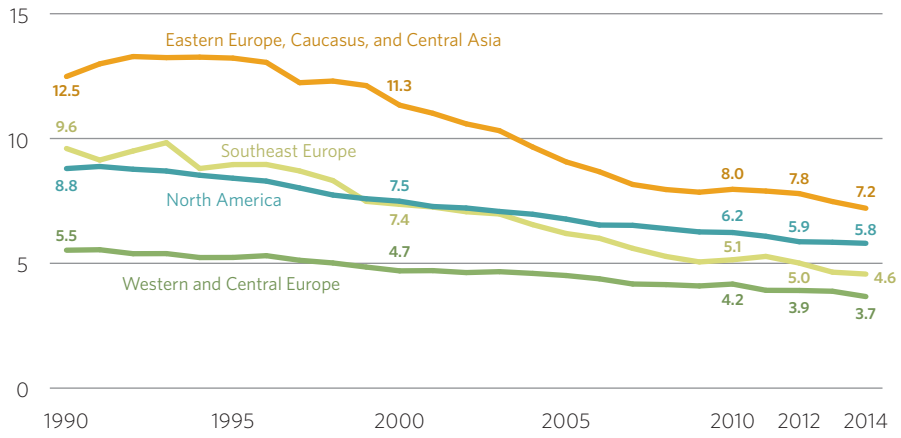


Subregional progress

In all four subregions, energy intensity declined in 1990–2014, and the decline accelerated in 2012–14 except in the North America subregion

FIGURE 11.12 All subregions of the Europe, North America, and Central Asia region cut their energy intensity, sharply narrowing the absolute gaps between them

Primary energy intensity (MJ/2011 PPP $)



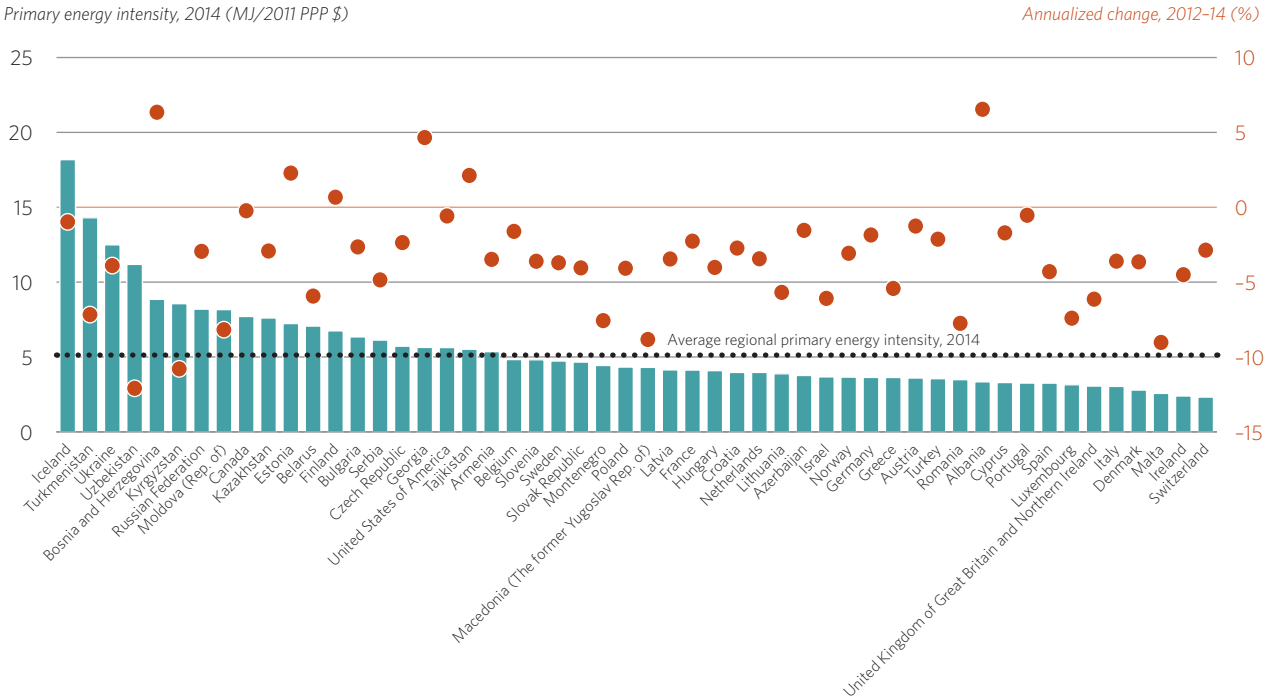
(figure 11.12). The Europe, North America, and Central Asia region has a huge range of energy intensities, from 18 MJ/2011 PPP $ in Iceland to about 2 MJ/2011 PPP $ in Switzerland (figure 11.13).

North America had the third highest energy intensity in 1990 at 8.8 MJ/2011 PPP $, which fell to 5.8 MJ/2011 PPP $ by 2014 as economic growth decoupled from energy demand. In 2010–12, the pace of improvement accelerated, driven by cost-reflective energy prices and energy efficiency policies. In the power sector, the shift to natural gas enabled efficiencies in new electricity and heat plants that displaced older coal-fired plants. Yet activity in energy-extractive industries recorded significant growth. Canada's cold climate and mineral extraction industry resulted in energy intensity of 7.7 MJ/2011 PPP $, higher than the United States of America's 5.6 MJ/2011 PPP $ (see figure 11.13).

In Western and Central Europe, energy intensity declined continuously in 1990–2014, from 5.5 MJ/2011 PPP $, the lowest in the region, to 3.7 MJ/2011 PPP $, driven by a combination of cost-reflective energy prices and consistent, comprehensive, and aggressive energy efficiency policies and commitments. The European Union (EU) Renewable Energy Directive 2009 set an energy efficiency target for 2020—a 20% reduction in energy demand relative to a business-as-usual projection. All EU countries were mandated to shape National Energy Efficiency Action Plans requiring durable efficiency improvements along the whole energy value chain. The plans should largely achieve the 2020 targets, in part due to the global financial crisis (Economidou et al. 2016). The EU 2020 target was originally set at 18.6% below projected primary energy consumption of 1,542 Mtoe (million tonnes of oil equivalent), or 64EJ (exajoules), but primary energy consumption was revised downward to 1,527 Mtoe (63EJ), a 17.6% reduction (Economidou et al. 2016).

Higher-productivity countries in the Western and Central Europe subregion reported very low energy intensity (see figure 11.13), but Iceland's was the highest in 2014 as its economy featured high energy-intensive aluminum smelters and a primary energy resource of low-grade geothermal energy with high transformation losses. Of the cold-climate Baltic countries, Estonia's energy intensity was the highest, 7.2MJ/2011 PPP $, due to high dependence on

FIGURE 11.13 Energy intensity varies significantly with climate, economic structure, and underlying efficiency in each country



low-quality indigenous oil shale,[7] and Latvia's was the lowest, 4.1MJ/2011 PPP $.

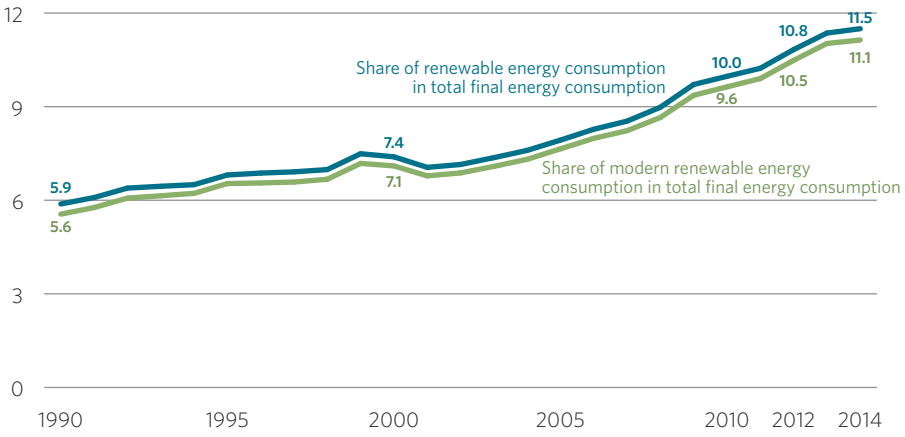
In Southeast Europe, sharp improvements in energy intensity were made in the 1990s when conflict in Croatia, and Bosnia and Herzegovina caused energy demand to drop faster than economic output. During the 2000s, innovations in productivity contributed to further improvements.

The pace of energy intensity improvements in Southeast Europe picked up in 2012–14, and energy intensity reached 4.6 MJ/2011 PPP $ in 2014, on the back of underlying structural shifts to lower-intensity services and recovery of GDP to 2008 levels. Still, significant annual variations in energy intensity suggest that the subregion has yet to implement firm policies on cost-reflective energy prices and energy efficiency. The subregion's northern neighbors have more challenging climates but often have lower energy intensity, pointing to further scope for energy efficiency action in Southeast Europe. Energy intensity in Southeast Europe is converging slowly toward the levels in the rest of Europe.

In Eastern Europe, Caucasus, and Central Asia energy intensity declined in 1990–2014 from 12.5 MJ/2011 PPP $—the highest in the region—to 7.2 MJ/2011 PPP $. As in Southeast Europe, variations suggest that prices and policies have still to mature into durable drivers. Changes in structure lie beneath the reported changes in energy intensity in many countries. In Tajikistan, for example, the declining trend was interrupted in 2011, and energy intensity increased as industries grew following long stagnation after the 1992–97 civil war. Israel's energy intensity was low in 2014, 3.7 MJ/2011 PPP $, as was Turkey's, 3.5 MJ/2011 PPP $ (see figure 11.13); both benefited from low-energy-intensity industries and mild climates. Most countries in the subregion still have energy intensities above 5 MJ/2011 PPP $. Limited policy action, monitoring and evaluation, and data and compliance, coupled with energy price subsidies, slowed gains after 1998.

FIGURE 11.14 The Europe, North America, and Central Asia region was the only region where the share of renewable energy consumption in total final energy consumption grew in 1990–2014

Share (%)



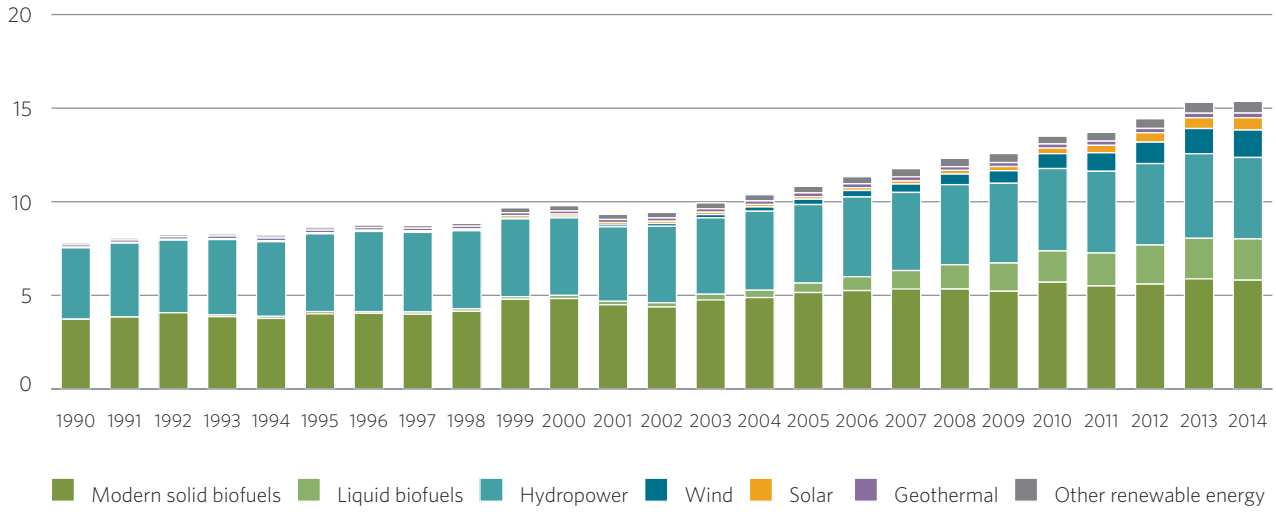
RENEWABLE ENERGY

Regional progress

The Europe, North America, and Central Asia region was the only one to increase its share of renewable energy consumption in TFEC in 1990–2014, with improvement accelerating after 2000. The region was also the only one with flat TFEC in 1990—2014. Both factors contributed to a marked increase in the share of renewable energy consumption from 5.9% in 1990 to 11.5% in 2014 (figure 11.14). The share

FIGURE 11.15 In the Europe, North America, and Central Asia region, liquid biofuel, wind, and solar power consumption grew in 1990–2014

Modern renewable energy consumption (exajoules)



of modern renewable energy in TFEC was 11.1% in 2014, the second highest among all regions, as use of traditional biomass is negligible in the region.

In modern renewable energy sources, the share of modern solid biofuels consumption was the largest in 2014 at 37.8%, followed by hydropower at 28.3%, and modern liquid biofuels at 14.3% (figure 11.15). In 2012–14, the fastest growth was reported for wind and solar power consumption, reaching shares of 9.5% and 4.3%.

The use of local hydro resources in the Europe, North America, and Central Asia region's industrialization developed its substantial renewable electricity system and underpinned the high rate of electricity access. More recently, decentralized forms of renewable energy (such as wind farms and solar farms) have played an increasing role. However, local feed-in tariffs look increasingly unsustainable. Most renewable energy investments were in Western Europe and North America, where price support and policies provided a strong foundation.

Challenges to increasing the share of renewable energy consumption include the lack of foundational long-term energy policies, geopolitical factors that maintain conventional energy subsidies and constrain trade, and locked-in reliance on older, inefficient infrastructure. Further growth depends on renewable energy possibilities that vary considerably according to climate, energy market and policy contexts, and socioeconomic drivers. Efficient deployment of renewable energy capacity requires reinventing the energy system as an interconnected whole to improve service quality while reinforcing energy efficiency policy and employing alternative sources of energy.

Subregional progress

In all subregions of the Europe, North America, and Central Asia region, the share of renewable energy in TFEC increased in 1990–2014 (figure 11.16).

North America's share of renewable energy consumption was the second lowest in the region in 2014, 10.4%, despite a rising trend in 1990–2014. In 2014, over half of modern renewable energy consumption in North America came from modern biofuels, and another 26.5% from hydropower. In 2012–14, wind and solar power grew most strongly, reaching shares of 9.2% and 2.5%. Cost-reflective energy pricing and regulatory policies in this subregion drive investments in renewables. The life-cycle cost of electricity from combined-cycle gas turbine gas power plants (56$/MWh) ensures a dominant role for gas, but costs from onshore wind (58$/MWh), solar (74$/MWh), and hydroelectricity (68$/MWh) enable renewables to compete, especially in distributed, or onsite, generation (USEIA 2016). In 2014, investments in solar capacity represented 32% of all new electric generating capacity in North America, more than wind and coal for the second year in a row (SEIA 2016). Solar power system prices fell by nearly 30% in 2015, and wind and solar power are increasingly able to compete with fossil fuels without subsidies.

In Western and Central Europe, the share of renewable energy consumption in TFEC more than doubled from 7.3% in 1990 to 16.8% in 2014. Consistent growth in installed renewable energy capacity has been driven by committed policy action to comply with the EU's Renewable Energy Directive 2009, which set a binding target that 20% of overall energy use, and 10% of energy use in transport, be provided from renewable energy sources by 2020. The EU objectives are to be met through national measurable targets and policies set by each country according to its renewable energy resource potentials. Similar to North America, over half of Western and Central Europe's modern renewable energy consumption came from modern biofuels and another 23.2% from hydropower in 2014. Since 2010, the strongest growth was in wind and solar power, reaching a share of 11.1%, and 5.6% in 2014. Shares of renewable energy consumption in TFEC were highest in Iceland, 76.4%, Norway, 62.2%, and Liechtenstein, 57.1% (figure 11.17). Iceland and Norway have a long history in hydropower and geothermal energy. Liechtenstein took the world lead in solar photovoltaic energy per capita. In each country, the high share of renewable energy reflects substantial renewable resources and government commitment to use them.

Southeast Europe achieved a share of 26% of renewable energy consumption in TFEC, the largest in the Europe, North America, and Central Asia region, in 2014. Over half of the subregion's renewable energy consumption is traditional renewable energy, in contrast to the other subregions, where the share of traditional renewable energy consumption in TFEC is negligible. In 2014, the highest shares of renewable energy consumption were in Montenegro, 46%, Bosnia and Herzegovina, 41.7%, and Albania, 38.7% (see figure 11.17), driven by indigenous resources. The subregion also has the region's largest share of hydropower in modern renewable energy, led by Albania, Croatia, and Montenegro. Wind power, reaching an 8% share, and solar power, 3.3%, were the fastest-growing sources of modern renewable energy in 2012–14.

Some Southeast Europe countries have renewable energy policies. In Bulgaria, for example, the 2011 Energy from Renewable Sources Act and the 2015 update of the Energy Act enabled preferential prices for electricity from renewable sources (Government of Bulgaria 2011). Under these Acts, the regulator set feed-in tariffs for electricity produced by new renewable energy electricity installations and for biomass.

In the Eastern Europe, Caucasus, and Central Asia subregion, the share of renewable

FIGURE 11.16 All subregions in the Europe, North America, and Central Asia region, Southeast Europe the fastest, increased the share of renewable energy consumption in total final energy consumption in 1990–2014

Share of renewable energy consumption in total final energy consumption (%)

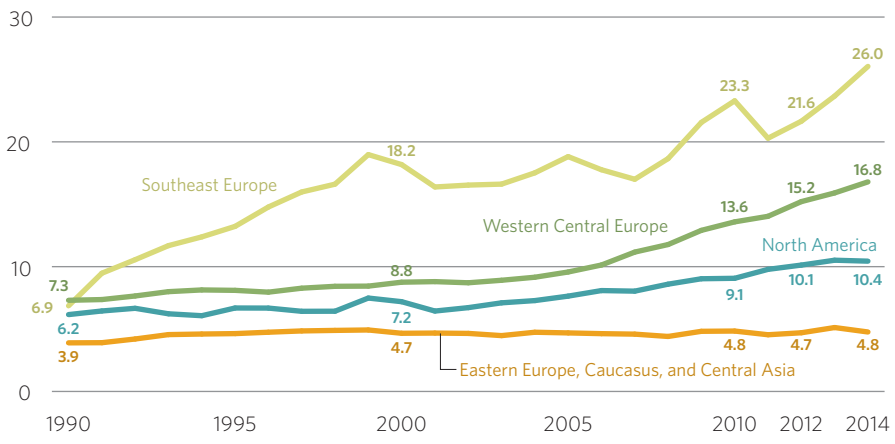
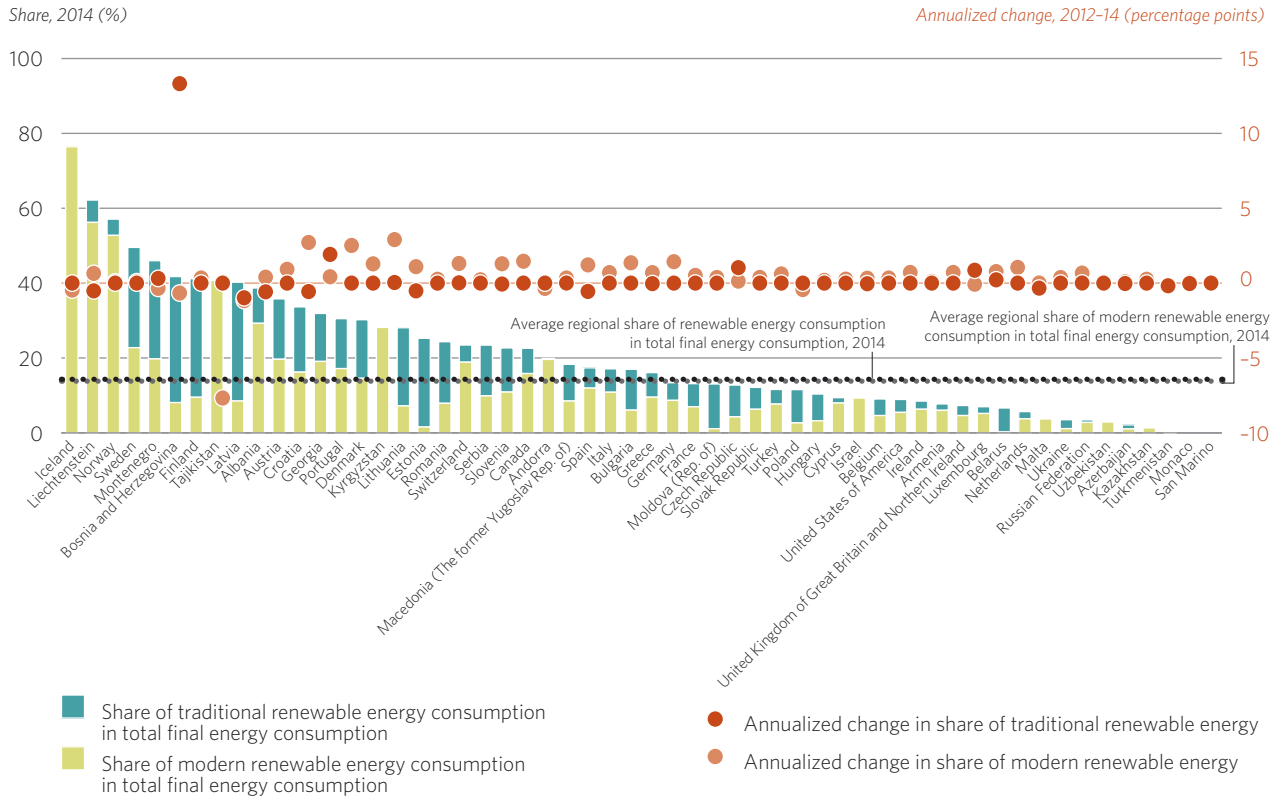


FIGURE 11.17 Some countries in the Europe, North America, and Central Asia region have the world's highest shares of modern renewable energy, while others have barely begun to adopt it



energy consumption in TFEC was 4.8% in 2014, the lowest in the Europe, North America, and Central Asia region, and the pace of increase was the slowest, as subsidies for conventional energy have constrained investment. Renewable energy spending has focused largely on hydropower, but the improving cost-effectiveness of solar photovoltaic, wind, and bioenergy is creating investment opportunities. The role that distributed renewables can play in enhancing system resilience makes them an important contributor to improving access to electricity in the Caucasus region. Hydropower dominated the Eastern Europe, Caucasus, and Central Asia subregion's modern renewable energy mix with a 61.9% share in 2014, led by Tajikistan. Modern solid biofuels accounted for 21%, following a steep decrease in 1990–2014. Growth of the share of liquid biofuels consumption in modern renewable energy consumption, reaching 0.8%, was the strongest in 2012–14. Ukraine's wind power consumption increased by 100% in 2012–14, to 7.2% share in modern renewable energy consumption in 2014 from 1.8% in 2012. That trend is expected to continue as Ukraine's 2014 National Renewable Energy Action Plan carries energy policies such as preferential loans for alternative energy production, tax exemptions, accelerated depreciation, and import duty waivers, as well as initiatives eliminating fossil fuel energy subsidies for residential users. Ukraine's policies are motivated by the political and economic need to increase energy security and decrease reliance on energy imports (Government of Ukraine 2014). In Belarus a program with performance targets adopted in 2007 aimed to increase biodiesel production through domestic resources in 2007–10 (IEA 2013), and liquid biofuels consumption grew from zero in 2007 to 3.3% of modern renewable energy consumption in 2014.

NOTES

1. 2013 data.
2. Areas include villages in Bosnia and Herzegovina affected by conflict, 8 villages in Georgia, 20 settlements in Kyrgyzstan, 1,500 communities in Uzbekistan, and Tajikistan (where the power grid covers 96% of the country) (REN21 2015).
3. The traditional masonry fuelwood stoves and cookers in the Europe, North America, and Central Asia region generally use a distributed sustainable fuelwood resource efficiently. They differ significantly from the poor efficiency and high emissions of cooking stoves used in other regions of the world, and for many communities using them costs less than gas or fossil-fueled district heat. A limited number of combustion tests of traditional and modern masonry stoves points to efficiencies that are similar to efficiencies of other controlled combustion woodstoves—generally above 60% and up to 72%—despite local variations in testing procedures and actual performance that is subject to operator skill (Lopez Labs 2010).
4. Minimum Energy Performance Standards (MEPS) and related mandatory and voluntary energy performance labeling policies have been in place in the United States of America since the 1987 National Appliance Energy Conservation Act (4E 2012).
5. Corporate Average Fuel Economy (CAFE) standards have required manufacturers of vehicles for sale in the United States of America to improve the fuel economy of their production fleet since 1978 (NHTSA 2017).
6. The decomposition analysis explains the energy consumption trends through three underlying forces: the activity component, the efficiency component, and the structural component.
7. Oil shale is an organic-rich fine-grained sedimentary rock containing kerogen (a solid mixture of organic chemical compounds) from which liquid hydrocarbons called shale oil (not to be confused with tight oil—crude oil occurring naturally in shales) can be produced. Although unusual globally, oil shale is a significant primary energy resource in Estonia and China.

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12

THE LATIN AMERICA AND CARIBBEAN REGION

This regional profile has been written with the UN Economic Commission for Latin America and the Caribbean (ECLAC).

REGIONAL OVERVIEW

The Latin America and Caribbean region comprises 33 countries, with a population of 662.2 million in 2014, representing 8.6% of the world's population. The region has two subregions: Latin America—with around 95% of the region's gross domestic product (GDP) and population—and the Caribbean (table 12.1). Countries vary in size, economic development, energy resources, and demographic aspects. In 2014, the region accounted for 6.5% of the world's primary energy consumption, 8.8% of GDP (2011 PPP $), and 5.2%[1] of carbon dioxide emissions. In 2000–12, the region's economic growth was strong, with GDP expanding at a compound annual growth rate (CAGR) of 3.4%, but in 2012–14, the rate slowed to 1.8%. The poverty rate in the region, calculated as percentage of population with income less than $3.10 a day (in 2011 PPP $), fell from 26.2% in 1999 to 11.3% in 2013.

TABLE 12.1 Countries by subregion

Latin America		Caribbean
1. Argentina	11. Honduras	1. Antigua and Barbuda [b,c,d]
2. Belize	12. Mexico [c]	2. Bahamas [c,d]
3. Bolivia (Plurinational State of)	13. Nicaragua	3. Barbados [d]
4. Brazil	14. Panama	4. Cuba
5. Chile [c]	15. Paraguay	5. Dominica
6. Colombia	16. Peru	6. Dominican Republic
7. Costa Rica	17. Suriname	7. Grenada [d]
8. Ecuador	18. Uruguay	8. Guyana [d]
9. El Salvador	19. Venezuela (Bolivarian Rep. of)	9. Haiti
10. Guatemala		10. Jamaica
		11. Saint Kitts and Nevis
		12. Saint Lucia [d]
		13. Saint Vincent and the Grenadines
		14. Trinidad and Tobago [d]

a. Data on energy intensity not available.[1]

b. Data on total renewable energy consumption either not available or reported being zero.[2]

c. Data on traditional renewable energy consumption either not available or reported being zero.[3]

d. Data on modern renewable energy consumption either not available or reported being zero.[4]

1. Although all countries reported overall energy intensity, data for energy intensity by sector was not available in 2014 for several countries: energy intensity in agriculture was not available for 12 countries; energy intensity in industry was not available for 2 countries; and energy intensity in services was not available for 2 countries. For more details, see data annex 2.

2. Renewable energy consumption data are based on databases of the International Energy Agency (IEA) Energy Data Center and United Nations Statistics Division (UNSD). When data for total, modern, or traditional renewable energy consumption is not available this may be due to either negligible consumption, energy balance data not being available at the necessary level of detail, or uses of renewable energy that are not captured by official country statistics as reported to the IEA Energy Data Center and UNSD.

3. Ibid. Also, traditional renewable energy consumption is assumed to be only the consumption of solid biomass in the residential sector of non–Organisation for Economic Co-operation and Development (OECD) countries (that is, no traditional renewable consumption is assumed to occur in OECD countries). This IEA convention has been adopted in the Global Tracking Framework, due to the heavy reliance on the IEA data (see box 5.1 for further details).

4. Ibid.

ACCESS TO ELECTRICITY

Regional progress

The Latin America and Caribbean region is the only developing region that brought its electricity access rate close to 100% in 2014, closing the gap with the Europe, North America, and Central Asia region. The Latin American and Caribbean region's access rate had started in 1990 at 85.5% (figure 12.1). In 1990–2014, the region provided electricity to an additional 9.4 million people a year (equivalent to the combined populations of Nicaragua and Uruguay). The pace of expansion has slowed as the region approaches universal access and the yet-unserved population becomes harder to reach. In 2014, about 18.5 million people still lacked access to electricity (equivalent to the population of Chile).

In urban areas, the access rate was already high in 1990, 97.9%, and by 2014 it reached 99.0%. About 4.6 million urban dwellers remained without access in 2014. The urban–rural gap narrowed sharply as rural areas' access rate rose from 56.4% in 1990 to 88.6% in 2014, but 14.1 million people still lacked electricity in rural areas in 2014 (figure 12.2).

Affordability of electricity also challenges the region. Many households spend a large share of their income on electricity. A 2009 ECLAC regional study showed that households in the poorest quintile consume less energy than households in other quintiles but still spend a greater share of their income on energy. Often, the price of energy is high due to lack of access to grid electricity (UN ECLAC 2009). Argentina, the Plurinational State of Bolivia, Brazil, the Dominican Republic, Ecuador, El Salvador, Honduras, and Jamaica have launched initiatives to boost acquisition of energy-efficient appliances, or else offer subsidies, discounts, and social tariffs (OLADE 2013).

Electricity theft and illegal connections are widespread, particularly in slums and peri-urban areas, exacerbating trouble for the economic viability of utilities. Losses from electricity theft started to grow during the 1980s, alongside increases in the number of poor in urban areas, and accidents, insecurity, violence, and energy waste soared (CAF 2013). In the last 20 years, almost all countries in the region have adopted programs to regularize illegal connections. But nontechnical losses are still high, despite some encouraging results, as in Ecuador.[2] In the Dominican Republic, Honduras, and the Bolivarian Republic of Venezuela, electricity losses in 2015 stood at around 33%, of which over half, it is estimated, represent electricity theft (UN ECLAC 2017).

Subregional trends

The Caribbean subregion's electricity access rates were far lower than the Latin America subregion's, and the gap did not narrow in 1990–2014 (figure 12.3).

Latin America's access rate rose from 86.5% in 1990 to 98% in 2014. Of 19 countries in the region, 10 had achieved universal or above 99% access; 6 more, above 90%; and the other 3, above 80%. The countries with the fastest-growing access rates in 2012–14 were Honduras and Nicaragua (figure 12.4), where investment efforts expanded electricity coverage and legal obligations were imposed on distribution companies to provide service everywhere within a certain distance of the grid. Guatemala's access rate fell. Ecuador, starting with a high access rate, continued to increase coverage in 2012–14, reflecting

FIGURE 12.1 The Latin America and Caribbean region edged close to universal electricity access in 2014

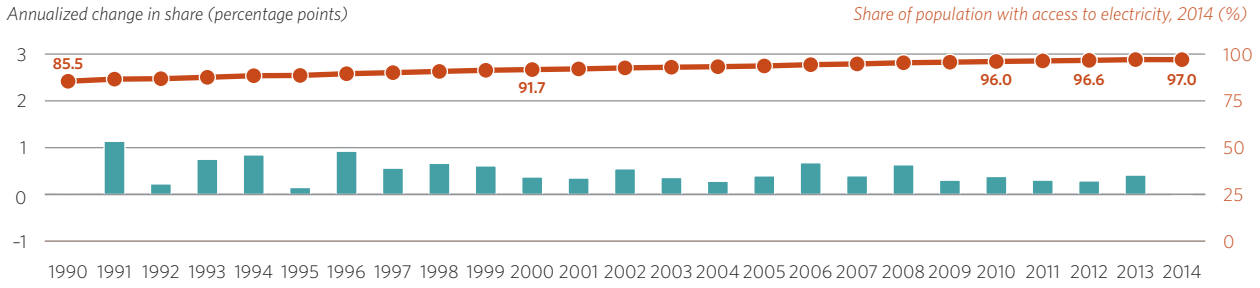


FIGURE 12.2 The Latin America and Caribbean region made rapid progress providing electricity access to rural areas in 1990–2014

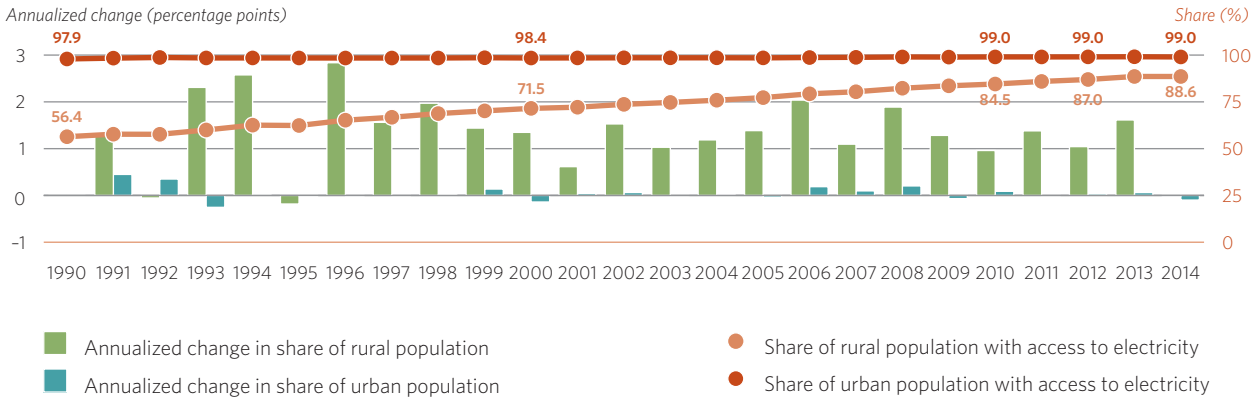
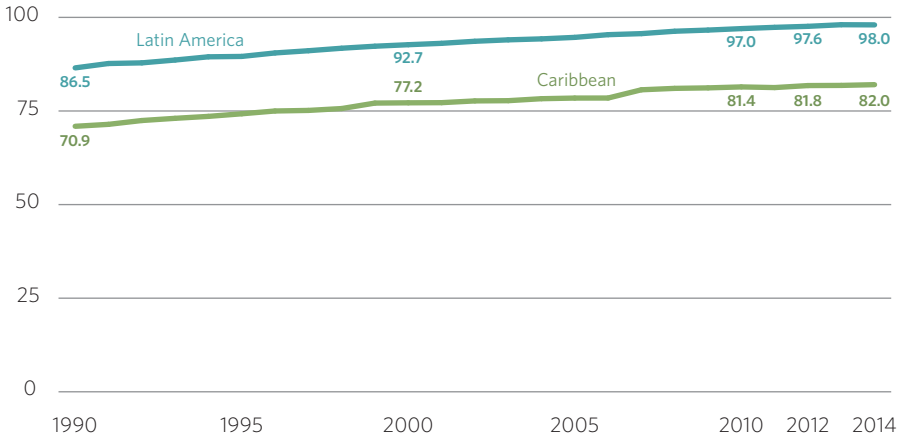


FIGURE 12.3 The Caribbean subregion's rate of access to electricity still lagged behind Latin America's in 2014

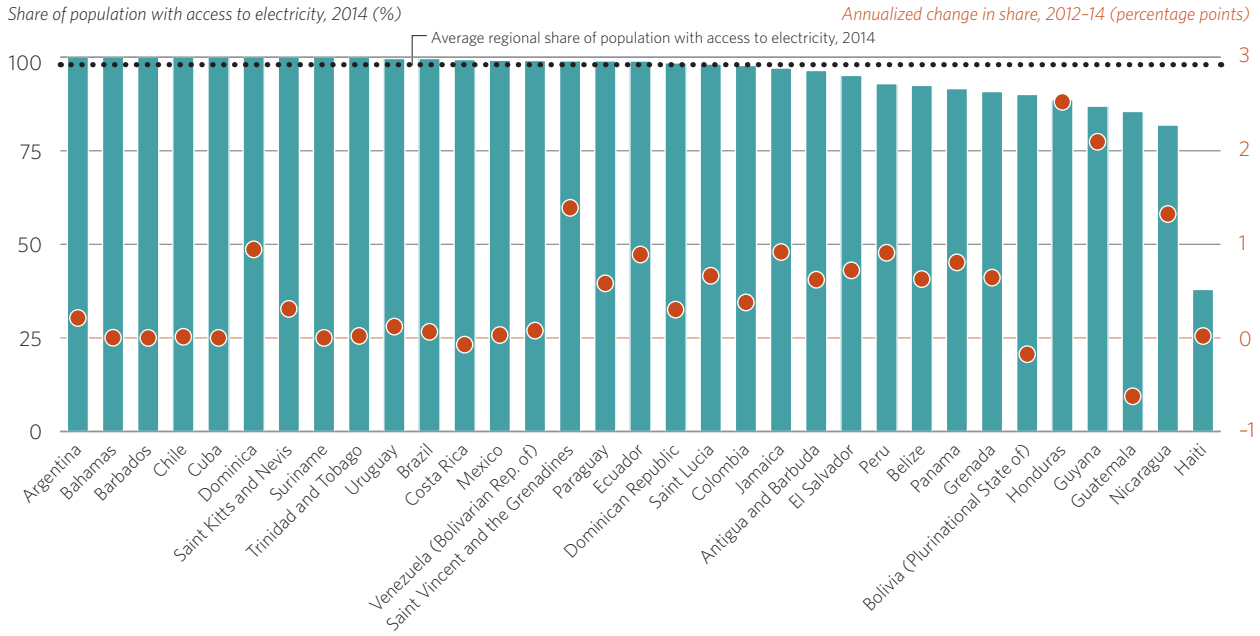
Share of population with access to electricity (%)



ambitious state-funded programs (MICSE 2016). Peru's and Panama's access rates also grew rapidly in 2012–14 due to electrification programs (mainly in rural areas), heavily supported by multilateral banks.

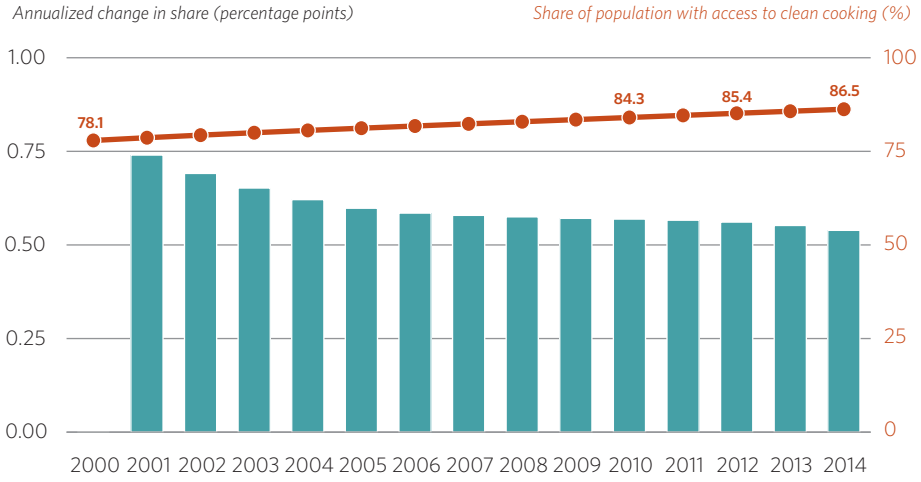
The Caribbean subregion's access rate increased from 70.9% in 1990 to 82% in 2014. Of 14 countries, 6 reached universal access and 8 more had access above 85%. Haiti stands out with only 37.9% access in 2014 (up from 28.4% in 1990) (see figure 12.4). About 6.9 million people remained unserved in the Caribbean subregion in 2014, of whom 6.6 million lived in Haiti. By far the worst performer, Haiti faced multiple challenges, including political instability, weak institutions, strong population growth, a high rural population, and natural disasters in 2008, 2010, and 2012 that devastated much of its infrastructure. Guyana, and Saint Vincent and the Grenadines had the fastest-growing access rates in 2012–14.

FIGURE 12.4 Haiti's electricity access rate was far behind rates of the other countries in the Latin America and Caribbean region in 2014



ACCESS TO CLEAN FUELS AND TECHNOLOGIES FOR COOKING

FIGURE 12.5 The increase of access to clean cooking in Latin America and Caribbean was not fast enough in 2000–14 to provide universal access



Regional progress

The Latin America and Caribbean region had the third-highest rate among all regions of access to clean fuels and technologies for cooking (here "clean cooking") in 2014, closely following the Arab region. Latin America and Caribbean's access rate grew from 78.1% in 2000 to 86.5% in 2014, for a yearly increase of 9.3 million new users (almost matching the population of the Dominican Republic) (figure 12.5). Even so, 84 million people still lacked such access in 2014 (similar to the populations of Colombia, Nicaragua, and Peru combined).

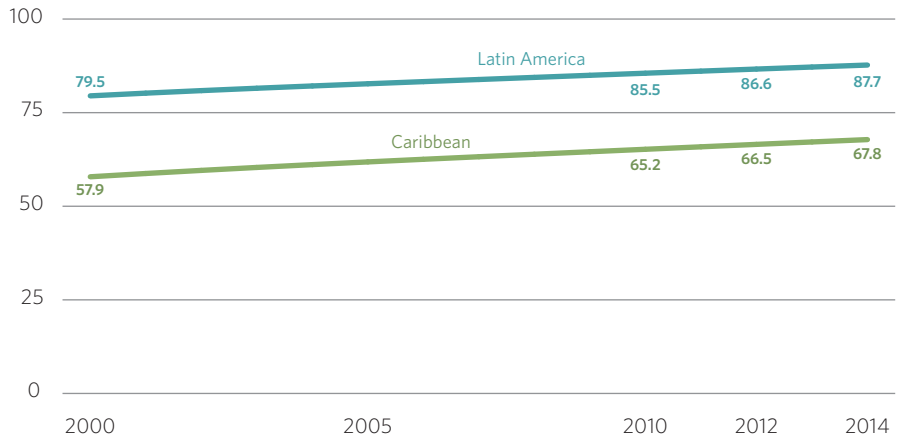
Subregional trends

As with electrification, the Caribbean subregion's rate of access to clean cooking was lower than Latin America's (figure 12.6).

The Latin America subregion reached a rate of access to clean cooking of 87.7% in 2014. Of 19 countries in 2014, only 2 (Argentina and Uruguay) achieved an access rate above 99%, 7 more had a rate above 90%, and 7 had rates of 60–90% (figure 12.7). High access rates are often driven by urbanization, progressive substitution of traditional solid fuels with liquefied petroleum gas (LPG), strong electrification rates, and, in countries such as Argentina, extensive use of natural gas in domestic consumption. Three Central American countries' (Guatemala, Honduras, and Nicaragua) access rates were under 50%. In 2012–14, El Salvador, Paraguay, and Peru had the fastest-growing rates of access to clean cooking, propelled by

FIGURE 12.6 The Caribbean remained far behind Latin America in access to clean cooking in 1990–2014

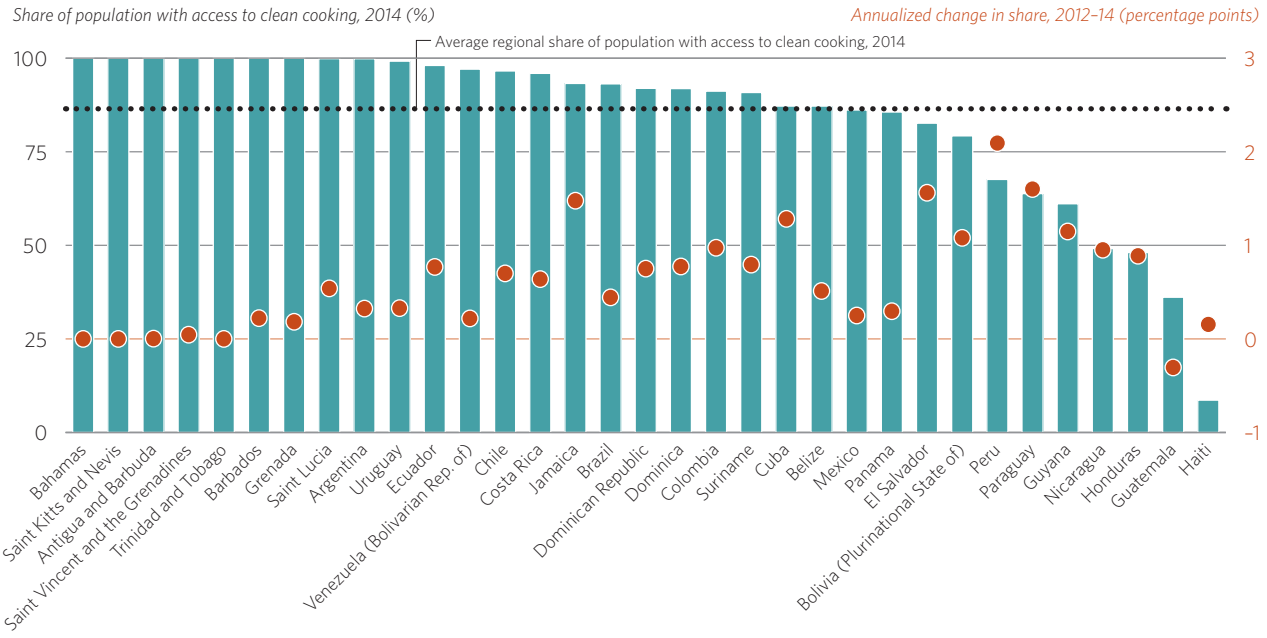
Share of population with access to clean cooking (%)



programs for replacing woodstoves with LPG. As with electricity access, Guatemala's share of the population with access to clean cooking fell.

The Caribbean subregion's rate of access to clean cooking was 67.8% in 2014, up from 57.9% in 2000. Of 14 countries, 9 achieved universal or above 98% access in 2014, and 4 more had rates of around 90%. As for electrification, the worst-performing country was Haiti where the share of population with access to clean cooking was just 8.6%, as most of the population is very poor. In Haiti, the extensive use of traditional biomass for cooking increases the country's vulnerability to devastating erosion and flooding. In 2012–14, Cuba and Jamaica were the countries with the fastest-rising rates of access to clean cooking (see figure 12.7).

FIGURE 12.7 Access to clean cooking was low in Haiti and some Central American countries in 2014



ENERGY EFFICIENCY

Regional progress

Since 1990, the Latin America and Caribbean region has consistently been the world's least energy intensive (a decrease in energy intensity is a measurable proxy for an increase in energy efficiency). Energy intensity was only 4.0 MJ/2011 PPP $ in 2014, compared with 5.5 MJ/2011 PPP $ globally. But reflecting its stronger starting point, the region also had the lowest rate of decrease in energy intensity (figures 12.8 and 12.9). In 2012–14, the region avoided 0.4 exajoules (EJ) of total final energy consumption (TFEC), 3.6% of energy avoided globally, equivalent to the 2014 TFEC of Guatemala. Declining energy intensity frequently reflects a decrease in the use of fuelwood and its replacement by more energy efficient sources, such as gas, and adoption of demand-management programs.

Energy intensity changes varied by economic sector. In industry, energy intensity has declined steeply since 2010 (figure 12.10). In agriculture, it rose in 2010–12 before returning to decreasing trends in 2012–14. In services, energy intensity increased across the period and further deteriorated in 2012–14. The residential sector, long unchanging, began to improve in 2012–14.

On supply-side efficiency in electricity generation, the Latin America and Caribbean region's efficiency accelerated sharply from 33.3% in 1990 to 40.7% in 2014, reflecting the gradual shift away from oil-fired generation plants toward more efficient gas-fired generation plants. Transmission and distribution losses of electricity, however, rose from 14.7% to 17.0%, the highest rate among all regions. Natural gas transmission and distribution losses also moved up, from 0.3% to 0.6% in 1990–2014.

The region has shown modest decoupling of its energy consumption from its GDP, starting in 2004, as appears in the decomposition analysis (figure 12.11).[3] Shifts in economic structure have been small.

Subregional trends

The Caribbean subregion's energy intensity, starting higher than Latin America's, declined

FIGURE 12.8 Remaining the lowest globally, the Latin America and Caribbean region's energy intensity declined slightly in 1990–2014

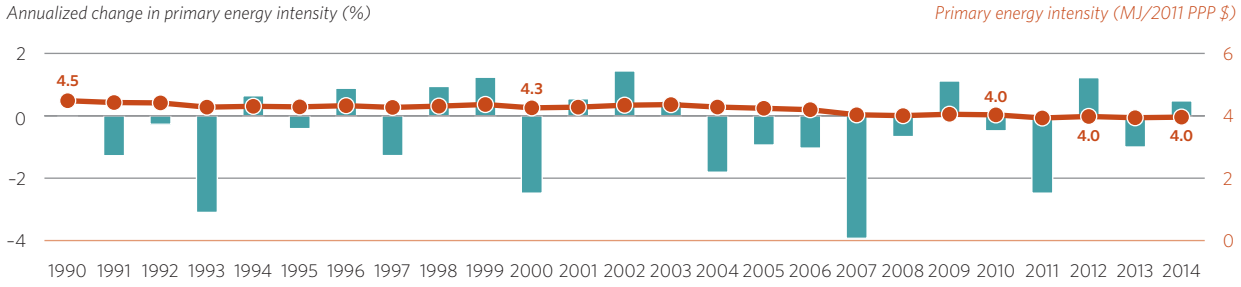


FIGURE 12.9 Energy intensity in the Latin America and Caribbean region declined slowly in 1990–2014, reflecting low starting levels

Primary energy intensity compound annual growth rate (%)

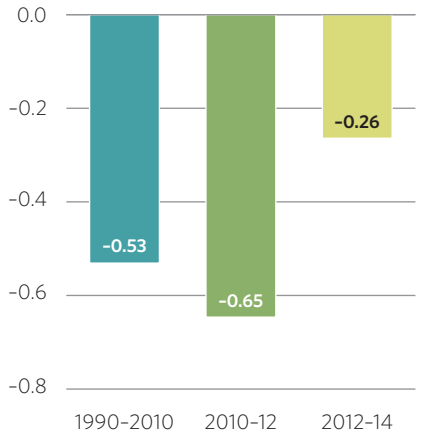


FIGURE 12.10 Industry led in reducing energy intensity among the Latin American and Caribbean region's economic sectors in 1990–2014

Final energy intensity compound annual growth rate (%)

faster, sharply narrowing the gap between the two subregions (figure 12.12).

Energy intensity in Latin America decreased very slightly in 1990–2014, reaching 3.9 MJ/2011 PPP $ in 2014. Latin America's energy intensity ranges from 2.3 MJ/2011 PPP $ in Panama to 6 MJ/2011 PPP $ in Honduras (figure 12.13). The fastest improvements in 1990–2014 were in Belize and Colombia.

The Caribbean subregion reached an energy intensity of 4.3 MJ/2011 PPP $ in 2014, with energy intensity very low in the wide majority of countries (see figure 12.13). Trinidad and Tobago's energy intensity was the highest, 19.8 MJ/2011 PPP $, due to its large gas and petrochemical industry. Haiti's was second highest, 9.9 MJ/2011 PPP $, reflecting its reliance on use of traditional biomass, a highly inefficient energy source, and also extensive losses in electricity transmission and distribution. The fastest improvements in energy intensity in 1990–2014 were in Cuba and the Dominican Republic, countries that also reported some of the fastest gains in access to clean cooking over the period.

FIGURE 12.11 The decoupling of GDP growth from energy consumption in Latin America and Caribbean accelerated in 1990–2014

Index (1990 = 100)

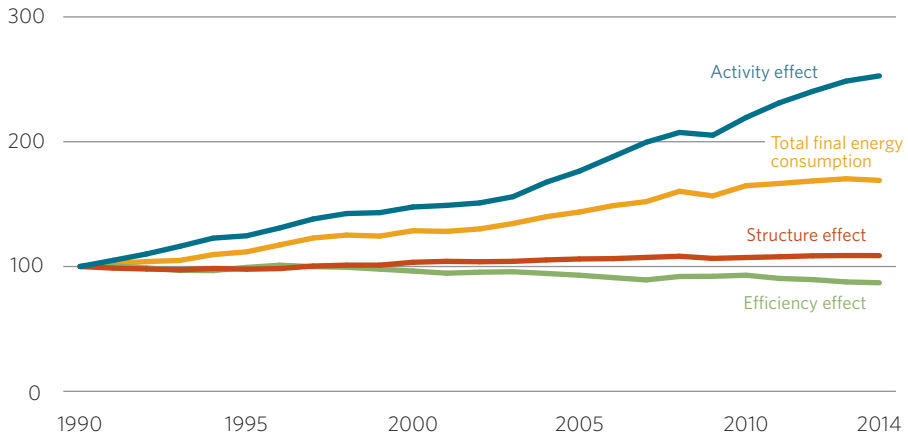


FIGURE 12.12 Energy intensity in the Caribbean almost converged with Latin America's in 1990–2014

Primary energy intensity (MJ/2011 PPP $)

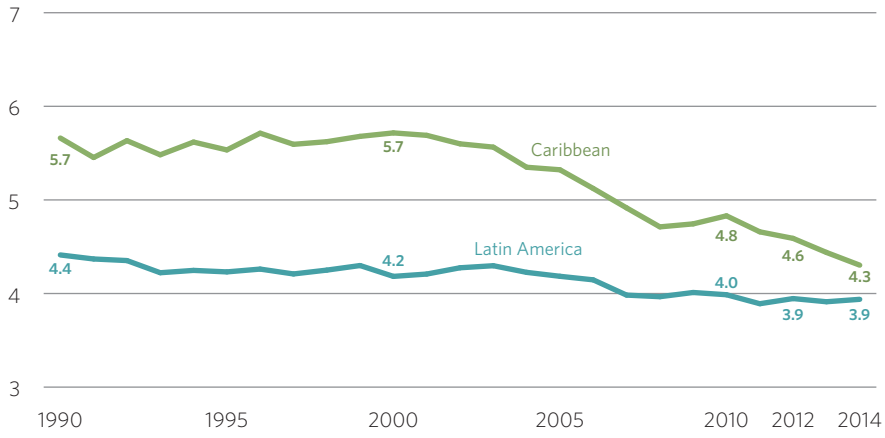
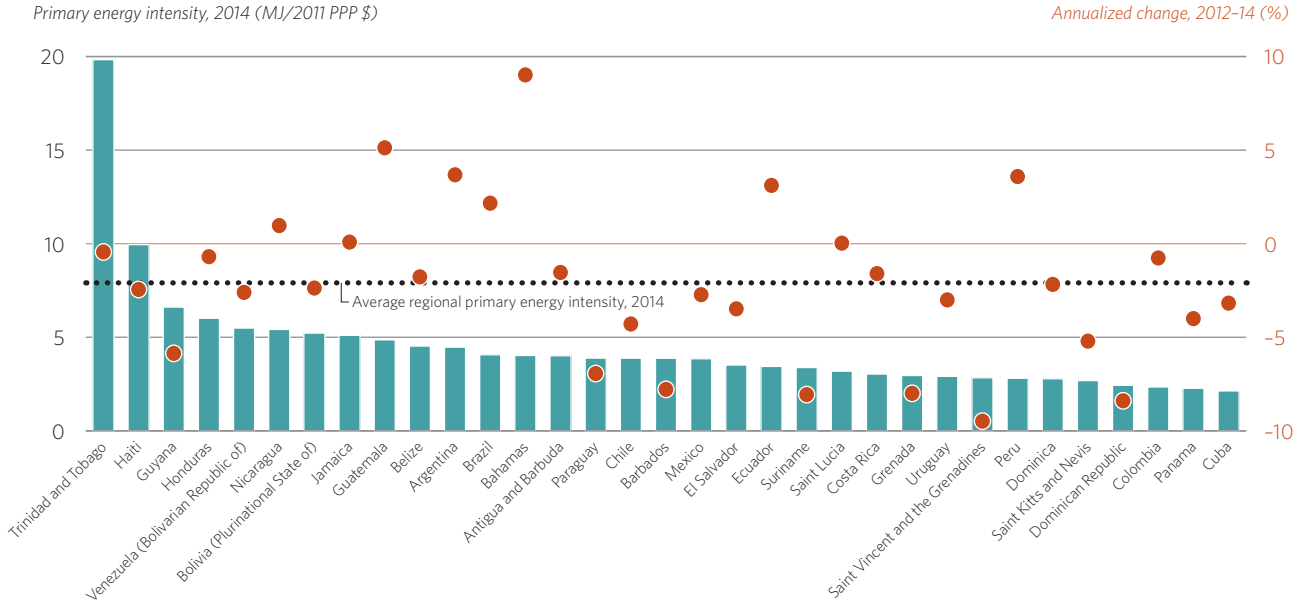


FIGURE 12.13 Energy intensity was high in only a handful of countries in the Latin America and Caribbean region and declined in the large majority in 2012–14



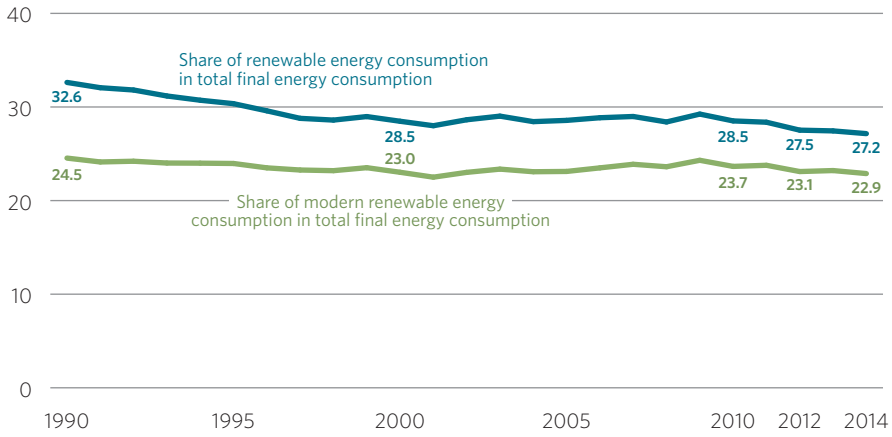
RENEWABLE ENERGY

Regional progress

Despite declines in 1990–2014, the share of renewable energy consumption in total final energy consumption (TFEC) in the Latin America and Caribbean region in 2014 remained the second largest among all regions, and its share of modern renewable energy in TFEC was the largest. The region's traditionally high modern renewable energy share comes from heavy reliance on hydropower, abundant forestry resources (supplying widespread use of modern solid biofuel), and Brazil's strong biofuel program. The share of renewable energy in TFEC declined from 32.6% in 1990 to 27.2% in 2014 (figure 12.14), as total energy consumption grew faster than renewable energy consumption. The share of modern renewable energy fell to 22.9%, and of traditional renewable energy to 4.3% in 2014.

FIGURE 12.14 The share of modern renewable energy in total final energy consumption was stable in 1990–2014 in the Latin America and Caribbean region

Share (%)



Among modern renewable energy sources, modern solid biofuels had the largest share, 47%, in the Latin America and Caribbean region in 2014, followed by hydropower, 37.1%, and modern liquid biofuels, 13.2% (figure 12.15). In 2012–14, wind power consumption grew by 50.6%—faster than any other modern renewable energy source—thanks to strong advancement in Brazil. Wind power accounted for a mere 1.4% of modern renewable energy consumption in 2014, but even this was double 2013's rate.

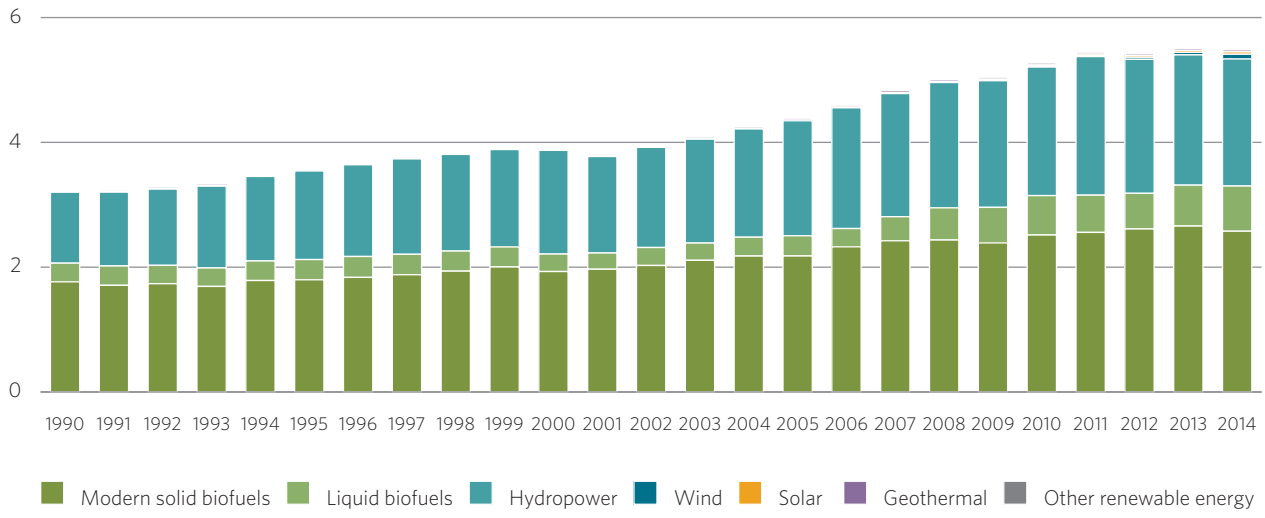
Policies promoting new renewable energy sources, such as wind and solar power, have spread. Investments have picked up in, for instance, Brazil, Chile, and Mexico. Most countries have set targets and passed laws on renewable energy, and introduced instruments such as renewable energy auctions and tax incentives in the electricity sector. In transport, policies focus on biofuels, usually setting targets and fiscal incentives (IRENA 2015).

Subregional trends

In both subregions the shares of renewable energy consumption in TFEC declined. The Caribbean subregion's share declined faster,

FIGURE 12.15 Modern solid biofuels and hydropower dominated modern renewable energy consumption in Latin America and Caribbean in 1990–2014

Modern renewable energy consumption (exajoules)

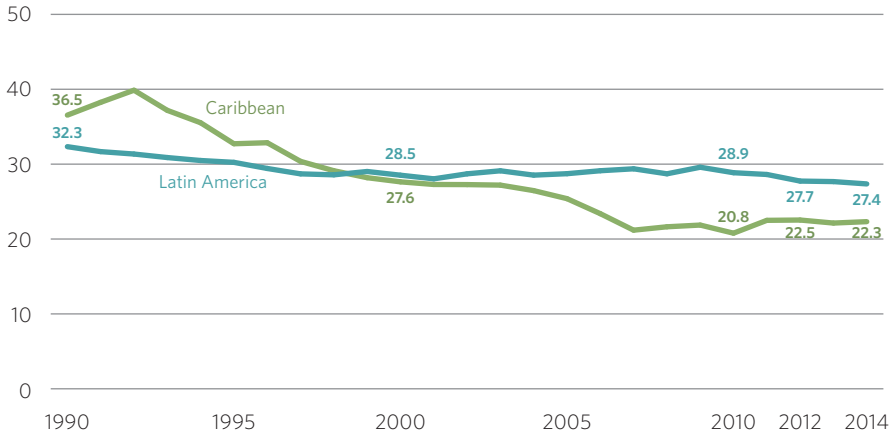


although the trend began to reverse a little after 2010 (figure 12.16).

Latin America's share of overall renewable energy consumption in TFEC declined to 27.4% in 2014, and the share of modern renewable energy consumption in TFEC fell slightly to 23.5%. In five countries (Guatemala, Honduras, Nicaragua, Paraguay, and Uruguay) the share of renewable energy consumption in TFEC surpassed 50% in 2014 (figure 12.17). In Guatemala, Honduras, and Nicaragua, the share was driven by high continuing penetration of traditional biomass consumption. In Paraguay and Uruguay, the share reflected the importance of modern solid biofuels and hydropower. The Latin America subregion's highest shares of liquid biofuels in modern renewable energy consumption in 2014 were in Argentina, 18.4%; Brazil, 14.3%; and Peru, 15.1%. Mandates supporting liquid biofuels consumption required a proportion of liquid biofuels in transport fuel and offered fiscal incentives, some for flexible-fuel vehicles using both gasoline and bioethanol. Mexico, whose share of renewable energy in TFEC was the lowest in the subregion, still has substantial untapped potential for hydropower, solar and geothermal energy, and modern biofuels.

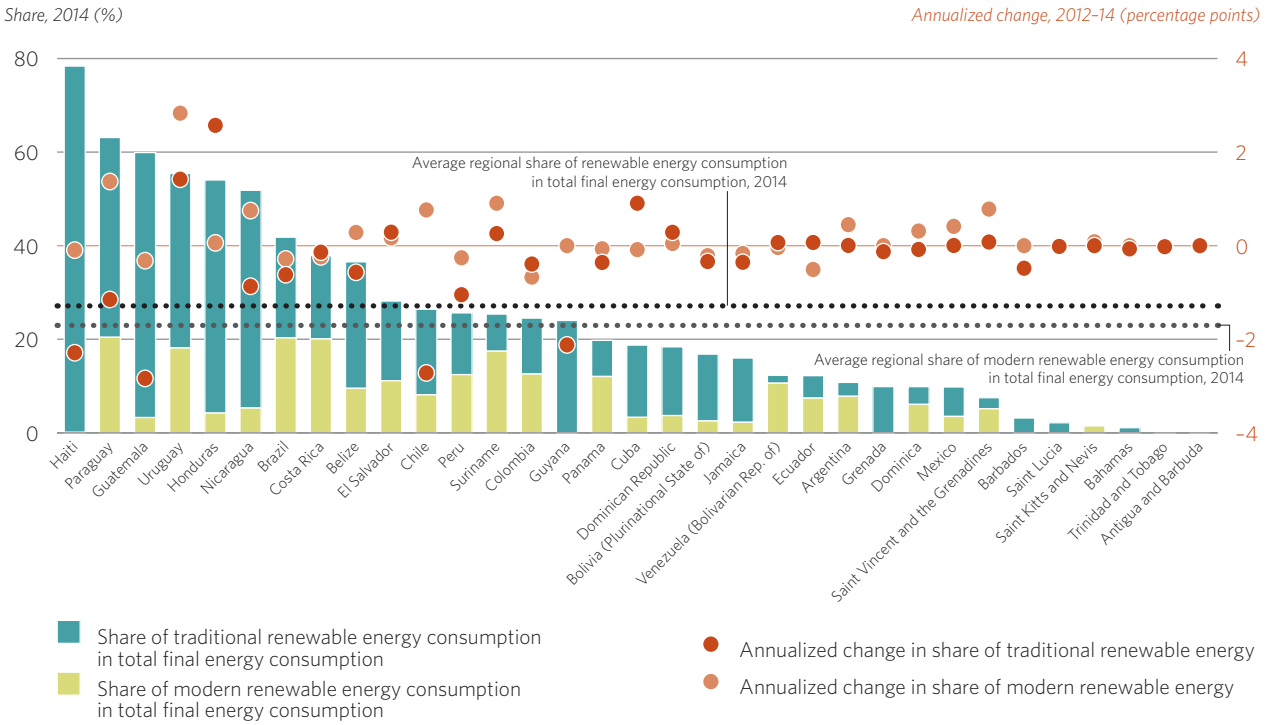
FIGURE 12.16 The Caribbean's share of renewable energy consumption in total final energy consumption fell faster than Latin America's in 1990–2014

Share of renewable energy consumption in total final energy consumption (%)



In the Caribbean subregion, the share of renewable energy in TFEC fell sharply in 1990–2014, from 36.5% to 22.3%, as the share of modern solid biofuels tumbled and nonrenewable sources took over. The trend seemed to stabilize after 2010, with solar and wind power consumption emerging. Haiti's share of renewable energy consumption was by far the highest—consisting mainly of traditional biomass. Dominica reached the highest share of modern renewable energy consumption, driven by hydropower. Nine of the 10 countries in the region with the lowest renewable energy shares—below 10%—were in the Caribbean (see figure 12.17). The potential for hydropower is limited in the Caribbean, so any increase in its share of renewable energy in TFEC has to come primarily from wind and solar power and modern biofuels.

FIGURE 12.17 The share of renewable energy consumption in total final energy consumption varied hugely among countries in the Latin America and Caribbean region in 2014



NOTES

1. 2013 data.
2. Between 2006 and 2014, Ecuador reduced total electricity losses from 22.3% to 12.3% (MICSE 2016).
3. The decomposition analysis explains the energy consumption trends through three underlying components: activity, efficiency, and structure.

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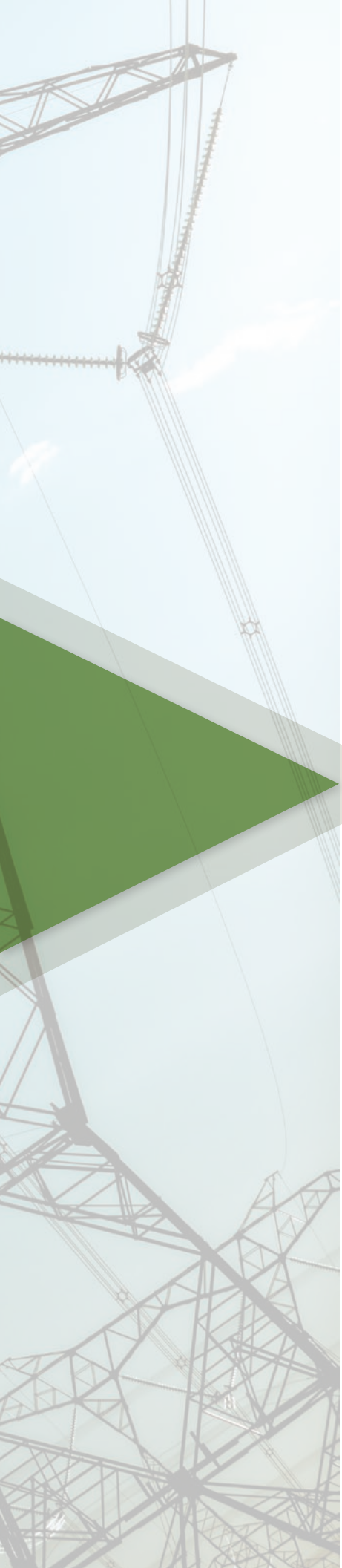

DATA ANNEX

1 ACCESS TO ELECTRICITY AND CLEAN COOKING

	Access to electricity (% of population[a])							Access to clean fuels and technologies for cooking[c] (% of population)			
			Total			Urban[b]	Rural	Total			
	1990	2000	2010	2012	2014	2014	2014	2000	2010	2012	2014[c]
Afghanistan			43[d]	69[d]	90[d]	99[d]	88[d]	23	19	18	17
Albania	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	48	62	64	67
Algeria			100	100	100	100	100	93	100	100	100
American Samoa											
Andorra	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100	100	100	100
Angola			35	34	32[f]	51[f]	3[f]	18	39	44	48
Anguilla		96	100	100	100						
Antigua and Barbuda				95	96	85	100[e]	94	100	100	100
Argentina			99[g]	100	100			92	98	99	100
Armenia		99[g]	100[g]	100	100	100	100	80	97	99	100
Aruba		92[g]	93	94	94	87	100[e]				
Australia	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100	100	100	100
Austria	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100	100	100	100
Azerbaijan		98	100	100	100	100	100	71	90	93	97
Bahamas			100[e]	100[e]	100[e]	100[e]	100[e]	100	100	100	100
Bahrain			100[e]	100[e]	100[e]	100[e]	100[e]	100	100	100	100
Bangladesh		32[h]	55[h]	59	62[h]	91[h]	51[h]	11	10	10	10
Barbados		100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	87	98	100	100
Belarus	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	92	99	100	100
Belgium	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100	100	100	100
Belize			90[g]	91	92	100	86	80	85	86	87
Benin		21	34[i]	38[i]	34[i]	58	16	2	5	6	7
Bermuda	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]				
BES Islands											
Bhutan			82	92[g]	100	100	96	38	60	64	68
Bolivia (Plurinational State of)		70[j]	84	90[j]	90[j]	99[j]	71[j]	64	75	77	79
Bosnia and Herzegovina			100[e]	100[e]	100[e]	100[e]	100[e]	51	43	41	40
Botswana		27	48	52	56	71	38	46	58	60	63
Brazil	87[j]	94	99	100[j]	100[j]	100[j]	98[j]	86	91	92	93
British Virgin Islands	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]				
Brunei Darussalam	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100	100	100	100
Bulgaria	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	69	76	78	79
Burkina Faso		9	13[h]	16	19[h]	58[h]	3[h]	3	6	6	7
Burundi		4	5[k]	7[k]	7[k]	52[k]	2[k]	2	2	2	2
Cabo Verde			81[g]	85	90	96	79	58	67	69	71
Cambodia		17[h]	31[h]	41	56[h]	97[h]	49[h]	5	11	12	13
Cameroon		41[i]	53	55	57[i]	87	22	14	17	17	18
Canada	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100	100	100	100
Cayman Islands	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]				
Central African Republic		6[g]	10[g]	11	12	26	3	2	2	2	2
Chad		3	6[g]	7	8	20	5	2	3	3	4
Chile	92[g]	98[g]	100	100	100	100	100	86	94	95	97
China			100[g]	100	100	100	100	46	54	56	57
Chinese Taipei											
Colombia	90[j]	95[j]	97[j]	97[j]	98[j]	100[j]	90[j]	77	87	89	91
Comoros		39	64	69[g]	74	96	65	2	5	6	7
Congo (Dem. Rep. of)		7[h]	13	15[h]	14[h]	42[h]	0[h]	2	5	5	6
Congo (Rep. of)			39	42[g]	43	61	10	11	16	17	18
Cook Islands			99	100	100	100	100	83	81	81	80
Costa Rica			99[j]	100[j]	99[j]	100[j]	98[j]	87	93	95	96
Côte d'Ivoire		48	58	56[f]	62[f]	84	37	18	19	19	18
Croatia	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	84	92	93	94
Cuba		97[g]	100	100	100	100	98	69	82	85	87
Curacao	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]				
Cyprus	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100	100	100	100
Czech Republic	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	94	100	100	100
Denmark	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100	100	100	100
Djibouti		57	49	48	47	57	10	2	7	9	10
Dominica		81	95	98	100			81	89	90	92
Dominican Republic		89[j]	98[j]	98[j]	98[j]	100[j]	96[j]	81	89	90	92
Ecuador		93	97[j]	97[j]	99[j]	100[j]	97[j]	87	95	97	98
Egypt		98[h]	100	100	100[h]	100[h]	100[h]	88	99	100	100
El Salvador		85[j]	92[j]	94[j]	95[j]	98[j]	90[j]	60	76	80	83
Equatorial Guinea				66	68	100	45	14	19	20	22
Eritrea		29	41	43	46	100	7	4	11	12	14
Estonia	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	82	89	90	92
Ethiopia		13[l]	22	24	27[l]	92[l]	12[l]	3	2	2	2
Faeroe Islands	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]				

	Access to electricity (% of population[a])							Access to clean fuels and technologies for cooking[c] (% of population)			
	Total					Urban[b]	Rural	Total			
	1990	2000	2010	2012	2014	2014	2014	2000	2010	2012	2014[c]
Falkland Islands (Malvinas)											
Fiji		75	94	98	100	100	76	31	35	36	37
Finland	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100	100	100	100
France	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100	100	100	100
French Guiana											
French Polynesia	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]				
Gabon		74[g]	85	89[g]	89	97	42	53	68	70	73
Gambia		34[g]	42	45	47	71	13	3	4	4	4
Georgia			100	100[m]	100[m]	100[m]	100[m]	51	54	55	55
Germany	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100	100	100	100
Ghana		45	65	69	78[h]	91[h]	63[h]	6	17	19	21
Gibraltar	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]				
Greece	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100	100	100	100
Greenland	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]				
Grenada				90	91			91	98	100	100
Guadeloupe											
Guam		100[e]	100[e]	100[e]	100[e]	100[e]	100[e]				
Guatemala		73[j]	84	87	85[j]	94[j]	75[j]	40	37	37	36
Guinea		17	24	26[g]	28	69	4	2	5	5	6
Guinea-Bissau			6[i]	12	17[i]	33[i]	4[i]	2	2	3	3
Guyana		76	81	83	87[i]	94[i]	84[i]	45	57	59	61
Haiti		34[g]	36	38[g]	38	53	17	6	8	8	9
Honduras		68	81[j]	84[j]	89[j]	99[j]	76[j]	35	45	46	48
Hong Kong (SAR, China)	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]				
Hungary	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100	100	100	100
Iceland	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100	100	100	100
India		60	76	80[g]	79	98	70	24	32	33	34
Indonesia		86[n]	94[n]	96[n]	97[n]	100[n]	94[n]	2	40	48	57
Iran (Islamic Rep. of)		98[g]	99	99	99	100	95	89	98	99	100
Iraq			98	98	99	100	96	83	94	96	98
Ireland	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100	100	100	100
Isle of Man	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]				
Israel	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100	100	100	100
Italy	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100	100	100	100
Jamaica	70[g]	85	93	95	97	95	100	72	87	90	93
Japan	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100	100	100	100
Jordan	97[g]	99	100	100[g]	100	100	100	96	100	100	100
Kazakhstan		99	100	100	100	100	100	83	89	91	92
Kenya		16	19[h]	27	36[h]	68[h]	13[h]	3	5	6	6
Kiribati			63[g]	52	48	81	22	6	4	4	3
Korea (Dem. People's Rep. of)			28	30	32			3	6	6	7
Korea (Rep. of)		100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100	100	100	100
Kosovo			99[g]	100[e]	100[e]	100[e]	100[e]				
Kuwait	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100	100	100	100
Kyrgyzstan		100	99[i]	100[i]	100[i]	100[i]	100[i]	61	72	74	76
Lao PDR		43	68	73	78	95	68	2	4	4	5
Latvia	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	87	95	96	97
Lebanon			100	100	100	100	100	95	100	100	100
Lesotho			19	23	28[h]	62[h]	12[h]	19	28	30	32
Liberia			5	7	9	17	2	2	2	2	2
Libya		100[g]	99	99	98	100	92				
Liechtenstein	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]				
Lithuania	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100	100	100	100
Luxembourg	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100	100	100	100
Macao (SAR, China)		100[e]	100[e]	100[e]	100[e]	100[e]	100[e]				
Macedonia (The former Yugoslav Rep. of)			100[e]	100[e]	100[e]	100[e]	100[e]	60	61	61	61
Madagascar		13	16	16	17	29	11	2	2	2	2
Malawi		5[h]	9[h]	7[h]	12[h]	46[h]	5[h]	2	3	3	3
Malaysia			99	100[g]	100	100	100	93	100	100	100
Maldives		84[f]	97	99	100[f]	100[f]	100[f]	41	87	95	99
Mali		10	22	26[g]	27	51	12	3	2	2	2
Malta	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100	100	100	100
Marshall Islands		68	84	87	90	94	81	32	39	40	41
Martinique											
Mauritania			32	35	39[o]	77[o]	2[o]	31	41	43	45
Mauritius		99[g]	99	99	99	100	79	90	97	98	99
Mayotte											
Mexico		98[j]	99[j]	99[j]	99[j]	100[j]	98[j]	82	85	86	86

	Access to electricity (% of population[a])							Access to clean fuels and technologies for cooking[c] (% of population)			
			Total			Urban[b]	Rural	Total			
	1990	2000	2010	2012	2014	2014	2014	2000	2010	2012	2014[c]
Micronesia (Federated States of)		46[g]	65[g]	68	72	57	76	15	22	24	25
Moldova (Rep. of)			100[e]	100[e]	100[e]	100[e]	100[e]	83	91	92	93
Monaco	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100	100	100	100
Mongolia		67[g]	82	84	86	100	51	27	31	31	32
Montenegro	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	65	72	73	74
Montserrat											
Morocco		67	86	90	92[f]	95[f]	85[f]	90	97	98	99
Mozambique		7	17	19	21	54	6	2	4	4	4
Myanmar			49[f]	51	52[f]	86[f]	49[f]	4	8	8	9
Namibia		37[g]	45	48	50	83	21	34	43	44	46
Nauru			99	99	99			76	91	93	96
Nepal		27	67	76	85[i]	98[i]	82[i]	7	21	23	26
Netherlands	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100	100	100	100
New Caledonia		100[e]	100[e]	100[e]	100[e]	100[e]	100[e]				
New Zealand	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100	100	100	100
Nicaragua		73	78	79	82[j]	98[j]	57[j]	35	45	47	49
Niger		8	12	14[g]	14	53	5	2	2	3	3
Nigeria	27[g]	43	48[g]	55	58	78	39	13	5	4	2
Niue											
Northern Mariana Islands		100[e]	100[e]	100[e]	100[e]	100[e]	100[e]				
Norway[p]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100	100	100	100
Oman			100[e]	100[e]	100[e]	100[e]	100[e]	100	100	100	100
Pakistan		75	91	94	98	100	96	24	39	42	45
Palau			99	98[q]	100[q]	100[q]	99[q]	55	57	58	58
Palestine (State of)		100[i]	100[i]	99	100[i]	100[i]	100[i]				
Panama	70[g]	81[g]	87[g]	90	92	100	66	81	84	85	86
Papua New Guinea		12	20[g]	19	20	76	12	13	26	29	31
Paraguay		89	97[j]	98[j]	99[j]	100[j]	98[j]	41	57	61	64
Peru		72[j]	88[j]	91[j]	93[j]	99[j]	75[j]	38	59	63	68
Philippines		74	85	87	89	97	83	39	43	44	45
Poland	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100	100	100	100
Portugal	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100	100	100	100
Puerto Rico			100[e]	100[e]	100[e]	100[e]	100[e]				
Qatar	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	90	99	100	100
Reunion											
Romania	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	72	79	81	82
Russian Federation	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	92	99	100	100
Rwanda		6[r]	10[r]	13	20[r]	72[r]	9[r]	2	2	2	2
Saint Barthelemy											
Saint Helena											
Saint Kitts and Nevis			98	99	100[e]	100[e]	100[e]	100	100	100	100
Saint Lucia			96	97	98	100	97	82	96	99	100
Saint Martin (French part)	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]				
Saint Pierre and Miquelon											
Saint Vincent and the Grenadines		80	93	96	99	100	95	91	99	100	100
Samoa		87	96	98	98[h]	99[h]	98[h]	25	27	27	27
San Marino	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100	100	100	100
Sao Tome and Principe		53[i]	60	58[i]	69[i]	76[i]	55[i]	18	27	29	30
Saudi Arabia			100[e]	100[e]	100[e]	100[e]	100[e]	98	100	100	100
Senegal		37	53	57	61[h]	85[h]	33[h]	39	37	36	36
Serbia			100	100[e]	100[e]	100[e]	100[e]	63	69	70	71
Seychelles		94	97[g]	99	100[e]	100[e]	99	76	96	99	100
Sierra Leone			14	14	13	32	1	3	2	2	2
Singapore	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100	100	100	100
Sint Maarten (Dutch part)	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]				
Slovak Republic	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	93	100	100	100
Slovenia	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	88	95	97	98
Solomon Islands		10	28	31	35	39	34	7	8	9	9
Somalia			15	17	19	31	11	2	6	8	9
South Africa		71	83[s]	85[s]	86[s]	94	71	56	75	78	82
South Sudan			2[g]	4	5	8	4	2	2	2	3
Spain	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100	100	100	100
Sri Lanka			85[g]	89	92	98	91	20	20	19	19
Sudan	33[i]	35	37	38	45[i]	76[i]	32[i]	6	18	21	23
Suriname		100	100	100	100	100	97	79	88	89	91
Swaziland			51	57	65[i]	100	27	27	33	34	35
Sweden	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100	100	100	100
Switzerland	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100	100	100	100

	Access to electricity (% of population[a])							Access to clean fuels and technologies for cooking[c] (% of population)			
	Total					Urban[b]	Rural	Total			
	1990	2000	2010	2012	2014	2014	2014	2000	2010	2012	2014[c]
Syrian Arab Republic			93[g]	94	96	100	86	95	100	100	100
Tajikistan		98	99	99[g]	100	100	99	62	69	70	72
Tanzania (United Rep. of)		10	15[g]	15[g]	16	41	4	2	2	2	2
Thailand		82[g]	100[g]	100	100	100	100	60	72	74	76
Timor-Leste			38[g]	42	45	63	37	5	4	4	4
Togo		17[h]	37	41	46[h]	83[h]	16[h]	2	4	5	6
Tonga		85	92	93[g]	95	100	91	50	60	62	63
Trinidad and Tobago		91[g]	99	100[e]	100[e]	100[e]	100[e]	96	100	100	100
Tunisia		95[f]	100[f]	100[f]	100[f]	100	100	91	99	100	100
Turkey			100[g]	100	100	100	100				
Turkmenistan		100[g]	100[g]	100	100	100	100	98	100	100	100
Turks and Caicos Islands	89[g]	96	94	93	95	95	100[e]				
Tuvalu			97	98[g]	99	99	97	23	28	29	30
Uganda		8	13	14	20[f]	51[f]	10[f]	2	2	2	2
Ukraine			100[e]	100	100[e]	100[e]	100[e]	90	95	97	98
United Arab Emirates	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	96	100	100	100
United Kingdom of Great Britain and Northern Ireland	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100	100	100	100
United States of America	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100	100	100	100
United States Virgin Islands	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]	100[e]				
Uruguay			99	99	100[e]	100[e]	97	94	98	99	99
Uzbekistan		100	100	100	100	100	100	81	88	89	90
Vanuatu		22	31	33	34	100	12	13	15	16	16
Venezuela (Bolivarian Rep. of)		98	99	99	99	100	92	94	96	97	97
Viet Nam		86	98	100	99[i]	100[i]	99[i]	24	43	47	51
Wallis and Futuna Islands											
Yemen		51	66	69	72	97	59	61	62	62	62
Zambia	14[h]	17[h]	22[h]	23	28[h]	62[h]	4[h]	13	15	16	16
Zimbabwe		33	36	36	32[i]	83[i]	10[i]	28	31	31	31
World	**73**	**78**	**84**	**85**	**85**	**96**	**73**	**50**	**56**	**56**	**57**
Africa	38	38	43	45	47	76	27	25	26	26	26
Africa (excluding North Africa)	23	26	32	35	37	70	17	11	12	12	12
North Africa	75	81	85	86	88	95	80	75	83	84	85
Arab region	76	82	88	89	90	97	81	79	87	87	88
Arab Least Developed Countries (LDCs)	32	40	48	49	55	80	41	28	36	37	39
Arab North Africa	75	85	94	96	97	99	93	91	98	99	100
Gulf Cooperation Council Countries	100	100	100	100	100	100	100	98	100	100	100
Mashreq	92	96	98	99	99	100	98	88	98	99	100
Asia–Pacific	70	79	88	90	90	99	83	40	48	49	51
East and North-East Asia	89	94	99	99	99	100	100	52	59	60	61
North and Central Asia	99	100	100	100	100	100	100	87	94	95	96
South and South-West Asia	47	61	77	81	82	98	73	26	33	34	35
South-East Asia	63	79	88	90	91	96	87	23	44	48	53
The Pacific	83	82	83	83	83	99	44	80	81	81	82
Europe, North America, and Central Asia	99	99	100	100	100	100	100	95	97	98	98
Eastern Europe, Caucasus, and Central Asia	96	98	100	100	100	100	100	88	94	95	96
North America	100	100	100	100	100	100	100	100	100	100	100
Southeast Europe	98	100	100	100	100	100	100	68	74	75	76
Western and Central Europe	100	100	100	100	100	100	100	100	100	100	100
Latin America and Caribbean	85	92	96	97	97	99	89	78	84	85	87
Caribbean	71	77	81	82	82	88	69	58	65	67	68
Latin America	87	93	97	98	98	100	91	79	86	87	88
Low income	8	12	22	25	28	55	17	4	6	6	6
Lower middle income	49	63	76	79	80	95	70	26	35	37	38
Upper middle income	88	94	98	98	99	100	97	58	66	68	70
High income	100	100	100	100	100	100	100	98	99	99	99

Note: Unless otherwise noted, data are World Bank estimates based on the statistical model described in chapter 2, annex 2, in the main report.

a. Most surveys report data on the percentage of households with access to electricity rather than on the percentage of the population with access.

b. Data are calculated based on the rural and total population with access and are not based on a statistical model.

c. Data are from the World Health Organization's Global Health Observatory (http://apps.who.int/gho/data/node.main.134, updated April 6, 2016).

d. From the National Risk and Vulnerability Assessment.

e. Based on the assumption of universal access in countries that are either part of a region classified by the United Nations as developed or classified as high income by the World Bank (see chapter 2, annex 2, in the main report).

f. Based on census data.

g. Based on household survey data.

h. Based on Demographic and Health Survey data.

i. Based on Multiple Indicator Cluster Survey data.

j. From the Socio-Economic Database for Latin America and the Caribbean.

k. From the Enquête sur les conditions de vie des ménages du Burundi 2013/14.

l. Based on Living Standards Measurement Study data.

m. From the ECAPOV database.

n. From the National Socioeconomic Survey.

o. From the Enquête permanente sur les conditions de vie.

p. Includes Svalbard and Jan Mayen Islands.

q. Based on Household Income and Expenditure Survey data.

r. From the Enquête intégrale sur les conditions de vie des ménages 4 2013/14.

s. Based on General Household Survey data.

2 ENERGY EFFICIENCY

	Primary energy intensity[a] (megajoules per 2011 PPP $)				Change in energy intensity[b] (%)											
					Primary energy			Final energy								
								Agricultural		Industrial		Services		Residential		
	1990	2010	2012	2014	1990–2010	2010–12	2012–14	2010–12	2012–14	2010–12	2012–14	2010–12	2012–14	2010–12	2012–14	2012–13	2013–14
Afghanistan[c]	1.88	2.94	2.98	2.64	2.25	0.76	-6.00	-4.33	4.93	12.51	5.69	52.33	5.19	-0.08	0.30	-15.83	-4.59
Albania[d]	7.91	3.26	2.94	3.34	-4.34	-4.97	6.54	1.29	4.28	1.08	7.42	-3.13	2.61	2.31	4.64	6.29	2.30
Algeria[d]	3.50	3.61	3.89	4.10	0.15	3.81	2.64	-1.75	5.48	4.06	7.16	8.80		10.40	4.15	33.17	37.00
American Samoa[c]														-5.80	0.33		
Andorra[c]														-4.71	0.91		
Angola[d]	4.61	3.70	3.86	3.65	-1.09	2.13	-2.78							0.11	0.29	-1.75	-12.94
Anguilla[c]																	
Antigua and Barbuda[c]	3.95	4.18	4.14	4.01	0.28	-0.52	-1.54			9.63	-1.43	1.52	-2.10	1.58	0.18	0.02	-0.14
Argentina[d]	5.44	4.25	4.16	4.47	-1.22	-1.09	3.68	-4.46	6.39	-1.54	3.87	-3.98	4.59	2.00	1.56	-54.72	171.81
Armenia[d]	24.37	5.39	5.75	5.35	-7.27	3.24	-3.48	-3.59	4.49	6.95	-1.51	4.26	38.84	10.92	3.63	-3.09	-6.69
Aruba[c]																	
Australia[d]	7.42	5.86	5.49	5.16	-1.17	-3.25	-2.99	0.62	0.67	-2.07	-0.97	-2.83	0.05	-0.58	-2.17	3.24	-93.39
Austria[d]	4.36	3.95	3.69	3.59	-0.50	-3.38	-1.26	5.78	-2.16	-3.05	-0.79	-6.97	-2.10	-2.54	-4.23	31.22	-47.73
Azerbaijan[d]	15.57	3.36	3.88	3.76	-7.38	7.50	-1.54	-0.31	-0.11	12.88	0.43	52.88	-9.73	-6.80	2.72	-4.33	12.44
Bahamas[c]	4.34	2.94	3.39	4.03	-1.94	7.40	9.02	10.72		33.44	32.39	41.12		-2.55	15.92	10.87	-8.04
Bahrain[d]	12.48	10.45	9.79	10.03	-0.89	-3.18	1.18	-5.84	-2.84	-0.99	6.24	-6.70	6.65	0.09	3.87	21.83	6.69
Bangladesh[d]	3.90	3.44	3.30	3.13	-0.63	-2.02	-2.61	12.30	-5.82	-3.19	-4.28	-7.05	-1.04	1.04	1.79	-47.78	-13.45
Barbados[c]	4.65	4.74	4.56	3.88	0.10	-1.90	-7.79							-4.60	-2.14	-0.89	0.05
Belarus[d]	23.13	7.73	7.98	7.06	-5.33	1.59	-5.93	1.70	1.45	-4.98	-1.36	1.51	-6.06	0.68	-3.62	-5.33	-38.30
Belgium[d]	6.62	5.70	4.98	4.82	-0.75	-6.48	-1.61	-2.35	4.79	-5.26	-1.23	-6.19	-4.08	-5.91	-6.40	52.12	-109.32
Belize[c]	8.56	5.06	4.69	4.53	-2.59	-3.65	-1.77	-3.87	-1.13	6.00	2.13	-6.58	-3.80	-4.13	-10.68	0.20	-0.47
Benin[d]	9.55	9.14	9.03	8.74	-0.22	-0.61	-1.60			2.90	24.63	-3.35	-2.69	0.22	0.96	-2.98	-1.04
Bermuda[c]	2.94	2.31	2.04	2.30	-1.20	-6.03	6.20			-12.01	17.85	1.26	-7.90	6.83	8.77	-1.91	0.68
BES Islands[c]																	
Bhutan[c]	30.02	12.55	11.56	11.06	-4.27	-4.03	-2.19		2.71	-5.15	8.01		2.92	-1.11	-1.41	0.29	-2.94
Bolivia (Plurinational State of)[d]	4.30	4.99	5.48	5.22	0.75	4.78	-2.37	1.85	1.20	2.07	-2.42	3.31	2.59	2.82	2.82	-7.21	1.28
Bosnia and Herzegovina[d]	47.11	7.58	7.82	8.85	-8.73	1.57	6.35	0.61	28.98	3.27	7.93			-0.56	57.28	-8.09	49.75
Botswana[d]	4.56	3.36	3.30	3.37	-1.53	-0.82	1.04	5.12	1.02	-3.10	4.07	-2.75	1.15	0.13	0.06	-4.74	1.29
Brazil[d]	3.81	3.89	3.89	4.06	0.11	0.03	2.16	-0.29	-1.10	-0.82	0.41	2.15	3.39	-0.75	1.24	-83.78	173.03
British Virgin Islands[c]														-1.83	-0.19		
Brunei Darussalam[d]	3.65	4.79	5.43	5.25	1.37	6.40	-1.66			-3.72	1.05	-1.93	1.57	2.97	-2.88	-0.90	1.14
Bulgaria[d]	14.60	6.63	6.69	6.34	-3.87	0.45	-2.65	6.46	-6.18	-2.10	-1.27	0.35	-4.94	3.03	-3.52	-23.89	3.87
Burkina Faso[c]	12.92	6.44	6.17	5.95	-3.42	-2.09	-1.82	4.53	23.40	-6.69	11.55			-1.70	-1.89	2.35	-9.86
Burundi[c]	9.79	13.30	7.93	7.83	1.55	-22.78	-0.66			3.61	-10.54			-23.98	-6.14	-5.52	-0.20
Cabo Verde[c]	4.03	3.16	2.84	2.70	-1.21	-5.24	-2.57			-0.17	6.06	-6.18	4.42	1.29	0.01	-0.23	-0.33
Cambodia[d]	14.28	6.15	5.83	5.59	-4.13	-2.58	-2.13			-5.70	-3.48	16.55	6.91	2.01	1.09	-7.45	-2.86
Cameroon[d]	6.24	5.50	5.02	4.93	-0.63	-4.47	-0.91	4.71	1.35	-4.85	12.18	-2.11	-2.30	0.02	-0.02	-5.85	-6.74
Canada[d]	10.17	8.01	7.74	7.70	-1.19	-1.72	-0.24	-3.33	-0.54	0.97	0.31	-8.03	0.11	-0.36	2.83	25.13	-79.31
Cayman Islands[c]														-0.84	1.02		
Central African Republic[c]	11.19	5.71	5.47	8.87	-3.31	-2.10	27.32			3.58	16.77	-3.67	9.32	-3.86	-4.23	8.14	0.18
Chad[c]	6.78	3.18	3.01	2.79	-3.72	-2.59	-3.84			-6.58	-2.88	-4.43	-0.27	-1.89	-1.85	-1.82	-3.19
Chile[d]	4.83	3.92	4.24	3.88	-1.04	3.95	-4.29	1.70	-15.00	-1.18	3.19	-3.63	2.43	4.82	-18.22	33.39	-95.04
China[d]	21.18	8.68	8.19	7.43	-4.36	-2.86	-4.74	-0.32	0.50	-4.62	-4.95	1.51	-3.58	2.41	2.68	-2,593.15	-2,906.04
Chinese Taipei[d]																	
Colombia[d]	3.93	2.61	2.38	2.34	-2.02	-4.52	-0.76	1.82	-0.58	-3.27	-4.51	2.82	-5.16	-0.45	-1.22	-27.62	-24.94
Comoros[c]	3.35	4.94	4.64	4.66	1.97	-3.08	0.20							1.08	0.45	0.25	-0.18
Congo (Dem. Rep. of)[d]	11.14	21.13	24.32	22.59	3.25	7.27	-3.63			-19.00	-5.45		-26.28	-8.74	10.34	40.02	27.20
Congo (Rep. of)[d]	2.63	3.09	4.39	4.08	0.81	19.23	-3.57			54.18	-9.62		-17.94	25.53	0.07	2.61	-3.14
Cook Islands[c]																	
Costa Rica[d]	3.11	3.38	3.13	3.03	0.42	-3.74	-1.60	-1.15	-0.08	-4.45	2.63	-1.08	-1.79	-11.56	-3.27	-2.37	-4.46
Côte d'Ivoire[d]	4.64	7.75	9.10	8.43	2.60	8.37	-3.75	13.13	-0.65	10.44	6.58	3.45	12.26	6.17	0.86	-7.94	-10.71
Croatia[d]	4.90	4.45	4.19	3.97	-0.48	-2.95	-2.73	5.22	1.23	-2.65	0.32	-3.27	-1.12	-2.17	-7.08	-0.88	-12.90
Cuba[d]	5.03	2.48	2.27	2.13	-3.48	-4.21	-3.18	-5.96	6.16	-4.06	-1.45	-0.37	1.75	2.06	2.53	-19.73	4.47
Curacao[d]														-19.26	1.09		
Cyprus[d]	4.15	3.66	3.41	3.29	-0.63	-3.52	-1.71	10.77	3.96	-1.77	26.44	-6.37	-2.11	0.77	-9.35	-1.31	1.63
Czech Republic[d]	10.12	6.31	6.00	5.72	-2.33	-2.53	-2.36	1.55	-1.42	-2.41	-1.90	-4.41	-5.24	-3.80	-4.35	10.66	-47.66
Denmark[d]	4.25	3.42	3.00	2.79	-1.08	-6.29	-3.65	-0.82	-1.22	-4.49	-3.40	-3.29	-3.79	-6.39	-4.97	-5.40	-32.47
Djibouti[c]	3.53	4.76	4.42	4.13	1.50	-3.69	-3.33							0.12	0.19	-0.20	-0.31
Dominica[c]	2.03	2.87	2.91	2.78	1.74	0.64	-2.18			2.80	0.23	3.34	-4.06	0.32	-0.11	0.03	-0.05
Dominican Republic[d]	4.40	2.84	2.90	2.43	-2.16	0.95	-8.40	-1.89	-6.98	-2.08	-8.29	3.26	8.19	-1.53	-0.16	-21.03	-19.00
Ecuador[d]	3.47	3.53	3.24	3.44	0.08	-4.22	3.11	7.17	-0.59	-2.32	0.01	2.60	0.52	1.06	1.73	-2.54	19.87
Egypt[d]	3.98	3.66	3.80	3.48	-0.41	1.83	-4.29	-0.72	-8.88	-3.96	-1.24	6.94	-0.53	1.64	-2.45	-208.15	-56.41
El Salvador[d]	4.34	3.95	3.77	3.52	-0.47	-2.30	-3.48	-100.00		-9.06	-9.54	62.44	-1.53	-7.70	-0.45	-6.92	1.56
Equatorial Guinea[c]	12.66	2.53	2.61	2.63	-7.73	1.52	0.39							1.29	-3.05	-2.66	2.95
Eritrea[d]		4.99	4.81	4.95		-1.81	1.44							0.94	0.02	0.31	0.37
Estonia[d]	17.99	7.96	6.91	7.23	-3.99	-6.84	2.28	4.04	2.36	-5.87	-3.10	-4.15	3.80	-2.45	-4.06	-1.54	-5.83

	Primary energy intensity[a] (megajoules per 2011 PPP $)				Change in energy intensity[b] (%)										Avoided energy consumption (petajoules)	
					Primary energy			Final energy								
								Agricultural		Industrial		Services		Residential		
	1990	2010	2012	2014	1990–2010	2010–12	2012–14	2010–12	2012–14	2010–12	2012–14	2010–12	2012–14	2010–12	2012–14	2012–13	2013–14
Ethiopia [d]	30.63	18.96	16.69	14.60	–2.37	–6.17	–6.49	3.46	5.56	–4.11	–4.57	–4.60	–1.91	0.16	0.06	–102.41	–112.05
Faeroe Islands [c]														–3.30	1.66		
Falkland Islands (Malvinas) [c]																	
Fiji [c]	4.56	3.27	3.04	3.12	–1.64	–3.65	1.26			13.23	–3.67	–8.03	3.35	–5.32	5.96	0.82	–0.42
Finland [d]	8.33	7.25	6.65	6.74	–0.69	–4.21	0.67	–3.50	–7.50	1.97	0.28	–2.26	–0.96	–3.78	–3.85	–12.45	–3.55
France [d,e]	5.45	4.58	4.32	4.12	–0.87	–2.89	–2.27	4.85	–4.18	–3.53	–0.66	–1.99	–4.56	–2.38	–5.70	126.56	–444.39
French Guiana [c]																	
French Polynesia [c]														–2.68	–4.44		
Gabon [d]	2.66	8.45	5.35	6.79	5.94	–20.43	12.70	6.87	–3.55	–29.69	29.31	1.57	0.07	0.30	0.09	61.15	–19.55
Gambia [c]	4.77	4.41	4.52	4.62	–0.38	1.16	1.12			–0.08	1.74			–1.86	–1.01	–0.62	0.91
Georgia [d]	13.50	4.94	5.15	5.64	–4.90	2.02	4.65	29.00	–73.29	11.30	–8.24	20.36	42.42	1.75	7.98	9.11	9.28
Germany [d]	5.88	4.12	3.77	3.63	–1.77	–4.26	–1.85			–2.47	–2.48	–4.60	–0.96	–4.00	–5.08	198.67	–525.40
Ghana [d]	7.89	4.14	3.83	3.63	–3.18	–3.73	–2.73	18.85	–26.90	–10.63	–3.36	1.50	14.07	–1.61	1.07	–7.90	–5.31
Gibraltar [d]																	
Greece [d]	4.18	3.55	4.05	3.63	–0.81	6.84	–5.42	–38.10	–4.25	7.12	6.81	7.98	–5.85	4.86	–12.72	–51.58	1.64
Greenland [c]														2.19	–1.83		
Grenada [c]	2.24	3.40	3.49	2.95	2.11	1.34	–8.00	–100.00		–7.64	–5.81	–4.49	5.88	0.91	–2.61	–0.01	–0.06
Guadeloupe [c]																	
Guam [c]														–3.87	–1.37		
Guatemala [d]	3.91	4.35	4.40	4.86	0.53	0.63	5.12			4.29	43.20	–2.62	3.54	–0.87	2.48	21.88	26.12
Guinea [c]	15.51	11.40	10.61	10.17	–1.53	–3.53	–2.06			–5.31	–9.48	6.77	–11.59	–2.41	–2.39	–5.70	0.47
Guinea-Bissau [c]	12.63	12.87	12.36	12.38	0.09	–2.01	0.10			–2.05	4.28			–1.07	–1.13	0.19	–0.20
Guyana [c]	11.58	7.36	7.46	6.61	–2.24	0.70	–5.86	17.96	–5.99	–10.29	–10.20	3.59	1.04	0.28	–1.26	–3.49	0.25
Haiti [d]	4.39	10.58	10.46	9.95	4.50	–0.60	–2.45							0.77	–0.93	–2.39	1.26
Honduras [d]	6.34	5.87	6.10	6.01	–0.38	1.90	–0.70			13.16	–27.85	–6.23	–4.33	4.04	2.39	–6.49	–15.64
Hong Kong (SAR, China) [d]	2.34	1.69	1.66	1.57	–1.61	–1.08	–2.82			3.08	0.21	–2.54	–1.25	0.67	1.19	–8.58	7.62
Hungary [d]	6.84	4.86	4.43	4.08	–1.70	–4.44	–4.02	–5.02	5.40	–5.87	17.97	–6.78	–12.95	–5.21	–6.65	14.88	–20.28
Iceland [d]	12.99	18.32	18.54	18.18	1.73	0.60	–0.98	–5.02	10.61	–0.78	1.07	3.05	–1.97	2.40	–1.16	0.33	–1.29
India [d]	8.29	5.35	5.20	4.94	–2.16	–1.44	–2.49	4.73	3.19	–1.94	0.42	–1.47	–5.17	0.47	1.33	–538.62	–558.27
Indonesia [d]	5.08	4.34	3.85	3.70	–0.79	–5.78	–2.04	–10.45	–16.52	–11.56	–0.84	–3.12	–1.59	3.60	1.21	–123.98	–93.62
Iran (Islamic Rep. of) [d]	5.08	6.58	7.20	7.69	1.30	4.64	3.38	–1.73	–1.48	12.49	3.54	–8.82	2.36	–2.88	3.71	368.17	46.22
Iraq [d]	4.17	4.01	4.01	4.14	–0.19	–0.11	1.70			18.27	0.93	–8.12	9.97	–2.52	–9.92	–58.23	–154.63
Ireland [d]	5.55	2.95	2.62	2.39	–3.10	–5.73	–4.51	1.35	–15.87	2.06	0.07	–4.99	–8.25	–9.00	–3.16	–3.24	–24.15
Isle of Man [c]																	
Israel [d]	5.20	4.30	4.16	3.67	–0.95	–1.59	–6.09							0.70	–16.03	–63.90	7.41
Italy [d,f]	3.52	3.43	3.26	3.03	–0.12	–2.53	–3.60	–1.40	–0.40	–2.16	–4.20	–2.74	–4.03	–1.70	–8.21	–34.58	–204.47
Jamaica [d]	6.60	4.97	5.09	5.10	–1.41	1.21	0.08	8.89	–40.88	9.69	10.68	–8.48	–4.14	0.94	–3.91	6.92	–0.99
Japan [d]	5.03	4.74	4.23	4.09	–0.30	–5.45	–1.73	4.49	–5.58	–0.16	–2.72	–3.36	2.49	–2.38	–3.03	–85.70	–227.29
Jordan [d]	6.13	4.37	4.59	4.51	–1.68	2.45	–0.86	9.40	6.12	–3.60	–2.62	–8.08	–3.35	4.63	–4.74	–14.43	4.28
Kazakhstan [d]	13.83	8.47	8.07	7.60	–2.42	–2.38	–2.92	2.82	–3.23	–2.22	–7.77	–22.31	17.18	6.66	4.35	–47.45	–324.98
Kenya [d]	8.05	7.98	7.43	7.82	–0.04	–3.49	2.59	–22.36	22.35	–12.11	2.82	0.02	1.59	–0.01	0.08	–6.47	2.41
Kiribati [c]	3.12	5.38	5.01	4.83	2.76	–3.47	–1.87							–2.43	–0.58	–0.01	–0.02
Korea (Dem. People's Rep. of) [d]														–0.06	0.51		
Korea (Rep. of) [d]	7.51	6.96	6.92	6.63	–0.38	–0.32	–2.12	–1.92	–8.55	–0.99	–0.02	–3.27	–2.80	0.48	–3.45	–74.60	–165.32
Kosovo [d]		7.42	6.55	5.84		–6.06	–5.58	8.21	3.88	–3.82	–12.41	–0.98	3.13	0.53	0.39	–1.27	–0.76
Kuwait [d]	4.80	5.96	5.91	5.41	1.08	–0.41	–4.32			–0.82	2.71	0.78	0.37	–1.74	–1.64	–16.42	62.85
Kyrgyzstan [d]	20.54	7.58	10.76	8.56	–4.86	19.09	–10.79	–2.71	12.55	27.36	–12.59	12.44	–15.41	15.30	20.55	–18.12	–18.27
Lao PDR [c]	8.05	3.00	2.51	2.30	–4.82	–8.52	–4.25	–14.27	–5.15	–10.00	16.36			–1.32	–0.98	–4.55	–4.85
Latvia [d]	8.06	5.00	4.44	4.14	–2.36	–5.82	–3.46	–6.45	–0.62	–2.24	–2.80	–1.26	–3.58	1.08	–4.18	–12.16	–1.80
Lebanon [d]	3.91	3.78	4.08	4.15	–0.17	3.85	0.86			1.60	–1.20	–6.53	7.54	11.95	1.01	–8.81	21.43
Lesotho [c]	17.43	11.67	11.75	11.02	–1.98	0.34	–3.17			–1.48	6.80	–5.24	–5.15	–0.55	–0.94	–1.92	–1.67
Liberia [c]	20.69	27.13	25.55	24.02	1.36	–2.95	–3.04	1.19	2.47	–25.17	–25.30			0.81	1.26	–4.46	–0.47
Libya [d]	4.65	4.76	5.09	8.03	0.11	3.45	25.57							–5.96	–7.78	85.92	89.40
Liechtenstein [c]														4.96	–8.28		
Lithuania [d]	11.27	4.58	4.36	3.88	–4.40	–2.51	–5.69	–4.18	–2.12	–5.05	–7.25	–3.39	–3.73	–0.07	–3.56	–11.63	–2.24
Luxembourg [d]	6.58	3.84	3.67	3.14	–2.66	–2.29	–7.41	0.35	18.33	–3.04	–8.88	–4.61	–6.26	–3.85	–3.71	–8.97	–12.93
Macao (SAR, China) [c]	1.17	0.63	0.49	0.46	–3.08	–12.10	–2.59							2.35	3.60	–1.04	2.08
Macedonia (The former Yugoslav Rep. of) [d]	5.40	5.13	5.18	4.30	–0.25	0.47	–8.83	–1.96	–5.89	–3.24	–15.44	–0.36	–10.51	–1.41	–7.05	–5.14	–3.25
Madagascar [c]	4.44	5.13	5.15	5.18	0.73	0.14	0.36			39.80	–0.39	1.34	4.20	–2.53	–16.62	–5.22	–1.60
Malawi [c]	9.14	6.27	5.96	5.46	–1.86	–2.55	–4.24			4.94	–2.92	–20.91	2.60	–4.48	–3.26	–2.33	–3.13
Malaysia [d]	4.80	5.18	4.95	5.13	0.38	–2.26	1.88	–2.40	–3.10	4.79	–2.07	–7.26	–2.96	0.66	0.21	109.49	–5.62
Maldives [c]	2.62	3.47	3.71	3.99	1.42	3.32	3.80			2.24	1.26	–0.73	13.68	–1.66	19.33	–0.81	1.74
Mali [c]	5.69	2.37	2.04	1.96	–4.28	–7.36	–1.79			1.91	0.45	–15.32	–1.33	–1.43	–2.89	–5.89	–1.49
Malta [d]	4.95	3.02	3.10	2.57	–2.44	1.33	–9.03							0.88	–0.33	0.09	–0.09
Marshall Islands [c]		7.91	7.55	7.45		–2.31	–0.67									0.01	0.01
Martinique [c]																	

	Primary energy intensity[a] (megajoules per 2011 PPP $)				Change in energy intensity[b] (%)										Avoided energy consumption (petajoules)	
					Primary energy			Final energy								
								Agricultural		Industrial		Services		Residential		
	1990	2010	2012	2014	1990–2010	2010–12	2012–14	2010–12	2012–14	2010–12	2012–14	2010–12	2012–14	2010–12	2012–14	2012–13	2013–14
Mauritania [c]	4.01	3.73	3.82	3.50	–0.35	1.16	–4.21	–1.41	–1.95	7.91	–5.85	–2.25	50.17	3.53	–1.43	–2.40	–0.86
Mauritius [d]	3.48	2.83	2.68	2.62	–1.04	–2.57	–1.14	0.23	–0.05	–3.90	–1.77	–0.30	0.60	0.79	2.78	–0.55	–0.50
Mayotte [c]																	
Mexico [d]	4.82	4.01	4.07	3.85	–0.91	0.68	–2.73	2.10	–5.25	0.42	–5.76	–2.10	0.67	–0.81	–2.11	–58.95	–188.16
Micronesia (Federated States of) [c]		5.01	5.77	6.84		7.34	8.89			–6.10	32.86	–4.67	1.53	2.07	1.73	0.23	0.18
Moldova (Rep. of) [d]	17.40	10.50	9.68	8.16	–2.49	–4.00	–8.18	–15.14	–17.84	–7.95	–13.40	–5.43	–5.22	2.13	1.06	–12.45	–1.13
Monaco [c]																	
Mongolia [d]	12.75	7.89	7.25	6.78	–2.37	–4.14	–3.31	–6.27	–12.58	2.87	–12.98	–2.57	–4.68	–1.67	–1.00	–7.73	–17.58
Montenegro [d]		5.77	5.19	4.43		–5.15	–7.57	–4.37	26.52	3.10	–23.63	129.79	173.59	–8.72	–4.63	–3.64	–0.99
Montserrat [c]																	
Morocco [d]	3.25	3.37	3.40	3.23	0.19	0.40	–2.63	1.16	–4.29	2.33	–5.33	–2.42	4.08	2.08	0.76	–22.55	–6.53
Mozambique [d]	49.44	18.76	17.31	16.58	–4.73	–3.94	–2.13	4.88	9.65	–1.64	–2.01	–7.85	5.02	–1.95	0.51	–15.04	–9.96
Myanmar [d]	14.89	3.15	3.10	3.24	–7.48	–0.74	2.29	20.44	27.03					0.36	0.16	–16.65	15.12
Namibia [d]		3.50	3.39	3.32		–1.56	–1.18	9.94	12.18	3.67	–0.57	–5.23	–6.95	–0.18	4.08	0.78	–1.12
Nauru [c]														1.89	2.61		
Nepal [d]	10.79	7.97	7.27	7.67	–1.51	–4.45	2.69	0.88	6.06	10.46	1.33	3.35	–0.25	–3.21	6.02	29.02	–7.31
Netherlands [d]	5.69	4.59	4.25	3.97	–1.07	–3.73	–3.44	–4.56	–5.88	–0.57	–1.15	–5.09	–7.02	–7.05	–8.63	12.76	–205.46
New Caledonia [c]														2.74	–2.22		
New Zealand [d]	6.66	5.51	5.46	5.57	–0.94	–0.48	1.07	3.97	–5.38	–1.95	2.28	–0.61	–2.53	–1.18	–1.52	1.36	5.07
Nicaragua [d]	6.75	5.36	5.31	5.42	–1.15	–0.44	0.97	38.45	6.99	–6.19	–4.64	–2.32	6.76	0.18	0.38	–2.79	0.28
Niger [d]	6.58	6.98	6.23	7.01	0.30	–5.51	6.08	2.46	–12.35	–3.78	–7.81	–11.00	6.95	–7.78	12.13	15.35	–2.36
Nigeria [d]	9.60	6.15	6.26	5.64	–2.20	0.92	–5.12	–39.72	–3.48	12.11	–15.16	26.82	–11.55	0.34	–0.19	–217.48	–333.28
Niue [c]																	
Northern Mariana Islands [c]														1.25	–0.16		
Norway [d,g]	4.80	4.61	3.89	3.65	–0.20	–8.20	–3.08	0.69	–10.21	–1.30	0.41	–3.10	–7.03	–4.45	–4.92	–1.11	–43.29
Oman [d]	2.78	5.68	6.79	6.52	3.64	9.28	–1.96	3.74	4.70		3.58		–0.37	0.54	0.56	10.49	21.85
Pakistan [d]	5.46	4.87	4.67	4.43	–0.57	–2.11	–2.58	–10.41	4.50	–4.55	–3.42	–3.10	–2.03	1.32	–0.77	–109.27	–84.83
Palau [c]		13.88	12.70	12.99		–4.31	1.10					–4.76	–3.97	–4.94	–0.57	0.06	–0.05
Palestine (State of) [c]	4.69	3.38	2.96	3.70	–1.63	–6.37	11.82	77.25	31.10	4.13	–16.54	15.38	–9.63	0.19	–0.37	3.86	14.79
Panama [d]	3.28	2.69	2.47	2.27	–0.99	–4.22	–4.00	1.51	10.04	–1.16	–12.62	–6.04	4.98	0.66	1.67	–6.68	–1.32
Papua New Guinea [c]	13.19	9.50	8.16	7.94	–1.63	–7.31	–1.33					27.36	45.39	–2.05	–1.72	5.12	–8.60
Paraguay [d]	5.06	4.45	4.49	3.88	–0.64	0.43	–6.94			–3.25	–3.21	3.18	2.57	–0.55	–0.80	–25.95	0.62
Peru [d]	3.55	2.69	2.62	2.81	–1.36	–1.45	3.59	12.82	–23.85	–1.97	5.31	3.13	4.05	–5.16	–0.31	9.84	–21.27
Philippines [d]	4.84	3.22	3.12	3.03	–2.01	–1.60	–1.51	–6.33	4.63	–5.25	–2.45	–2.83	2.95	–0.43	0.46	–14.39	–19.15
Poland [d]	11.17	5.15	4.70	4.32	–3.80	–4.50	–4.07	–0.28	–7.73	–4.02	–2.53	–4.20	–5.30	–2.82	–4.38	–81.05	–158.91
Portugal [d]	3.47	3.40	3.29	3.25	–0.11	–1.60	–0.54	–6.47	–1.22	–3.38	0.27	0.86	1.42	–4.48	–1.92	–1.27	–10.30
Puerto Rico [c]	0.01	0.21	0.39	0.49	15.86	35.63	11.56	–5.56	5.56	3.71	–15.35			–1.84	3.94	0.86	0.03
Qatar [d]	8.03	5.13	5.95	6.32	–2.21	7.65	3.05			5.93	0.12	–3.77	6.29	–1.39	15.40	–6.83	44.36
Reunion [c]																	
Romania [d]	10.05	4.17	4.09	3.48	–4.30	–0.97	–7.75	13.82	–22.13	3.60	–5.89	–11.15	–0.69	0.22	–3.83	–74.49	–32.50
Russian Federation [d]	12.03	8.73	8.70	8.19	–1.59	–0.21	–2.95	9.95	–11.48	–2.33	–2.84	–4.32	–0.26	–0.82	1.43	–468.47	9.82
Rwanda [c]	5.73	6.14	5.69	5.34	0.35	–3.74	–3.16							0.72	–0.64	–1.22	–4.18
Saint Barthelemy [c]																	
Saint Helena [c]																	
Saint Kitts and Nevis [c]	3.69	2.96	2.99	2.68	–1.10	0.47	–5.21	6.17	9.93	11.40	–10.11	–4.22	–4.90	–0.91	0.03	–0.09	–0.10
Saint Lucia [c]	2.24	3.14	3.19	3.19	1.71	0.71	0.03			–0.06	7.88	1.84	2.18	–1.86	0.00	0.00	0.03
Saint Martin (French part) [c]																	
Saint Pierre and Miquelon [c]																	
Saint Vincent and the Grenadines [c]	2.19	3.10	3.46	2.83	1.75	5.62	–9.48			1.40	16.23	–7.15	12.34	8.83	9.49	–0.39	0.11
Samoa [c]	4.34	4.53	4.06	4.26	0.21	–5.37	2.45	–43.02	–2.46	2.42	83.18	–6.96	–2.41	–5.71	3.23	0.16	–0.03
San Marino [c]																	
Sao Tome and Principe [c]	5.71	5.08	5.00	4.61	–0.58	–0.86	–3.98					5.48	–5.33	–0.37	–1.90	–0.07	
Saudi Arabia [d]	4.20	6.25	5.82	5.83	2.01	–3.45	0.08	5.91	2.61	–5.40	2.90	3.05	0.22	2.35	2.26	–59.60	122.96
Senegal [d]	5.04	5.66	5.60	5.10	0.58	–0.56	–4.56	1.67	–55.20	4.70	0.04	2.59	–9.54	–1.06	–10.30	–10.16	–0.31
Serbia [d]	7.23	7.29	6.76	6.12	0.04	–3.65	–4.85	24.20	–16.09	–1.95	–6.49	–4.68	–5.56	1.33	–5.64	–17.28	–15.72
Seychelles [c]	2.23	3.34	2.87	2.98	2.05	–7.35	1.86			–4.24	17.07	3.57	–11.90	1.49	–2.12	–0.88	1.01
Sierra Leone [c]	9.32	7.62	6.72	5.73	–1.00	–6.10	–7.71			–38.77	–9.76	–4.65	–15.02	–2.67	–2.92	–7.83	–0.68
Singapore [d]	4.62	2.91	2.71	2.70	–2.28	–3.57	–0.20			–0.46	–2.33	–2.58	–2.83	–2.25	0.41	–6.51	–17.80
Sint Maarten (Dutch part) [c]																	
Slovak Republic [d]	11.83	5.65	5.06	4.66	–3.63	–5.40	–4.05	–6.17	–16.80	–3.62	–2.84	–17.37	–4.55	–5.51	–3.00	4.84	–35.67
Slovenia [d]	6.40	5.28	5.18	4.81	–0.96	–0.95	–3.61	5.88	–4.77	–0.55	–1.05	–7.17	–3.86	–4.24	–8.04	–2.34	–13.78
Solomon Islands [c]	9.40	6.39	5.47	5.33	–1.91	–7.51	–1.29							–1.76	–1.24	–0.13	–0.02
Somalia [c]	23.57	43.35	41.94	40.07	3.09	–1.65	–2.25							–1.39	0.32	–2.43	–0.44
South Africa [d]	10.44	9.67	9.00	9.16	–0.38	–3.50	0.84	8.40	1.50	–2.68	1.98	3.86	–0.63	3.63	–0.51	79.36	–51.76
South Sudan [d]			1.37	1.28			–3.57								–4.55	–3.45	–0.01
Spain [d]	4.03	3.48	3.55	3.25	–0.72	0.95	–4.30	8.14	–4.47	6.92	1.30	1.07	–6.63	–4.41	–2.36	–54.61	–106.90
Sri Lanka [d]	3.69	2.37	2.31	2.03	–2.19	–1.18	–6.32	–47.69	26.89	–5.40	–1.55	–2.47	–6.73	6.82	–10.31	–45.16	–9.36

	Primary energy intensity[a] (megajoules per 2011 PPP $)				Change in energy intensity[b] (%)										Avoided energy consumption (petajoules)	
					Primary energy			Final energy								
								Agricultural		Industrial		Services		Residential		
	1990	2010	2012	2014	1990–2010	2010–12	2012–14	2010–12	2012–14	2010–12	2012–14	2010–12	2012–14	2010–12	2012–14	2012–13	2013–14
Sudan[d]	9.85	4.68	4.18	4.11	-3.66	-5.45	-0.87	-14.97	2.31	-14.81	-4.76	-3.71	-1.63	-9.59	0.46	-8.91	-4.59
Suriname[d]	5.11	3.99	4.00	3.38	-1.22	0.09	-8.07	7.74	-4.49	5.11	0.87	3.63	-1.04	5.55	2.18	-2.52	0.87
Swaziland[c]	3.65	4.80	4.87	5.00	1.38	0.71	1.30	-1.32	-5.88	-1.71	10.21	-18.85	31.46	3.22	3.08	1.70	-0.43
Sweden[d]	7.47	5.30	5.10	4.73	-1.70	-1.89	-3.71	-17.89	-10.12	-0.48	-0.62	-7.14	0.87	-2.03	-8.80	-49.77	-45.15
Switzerland[d]	3.26	2.59	2.46	2.32	-1.15	-2.54	-2.87	13.73	-13.10	-4.93	-1.33	-4.29	-7.53	-4.99	-6.21	5.38	-84.66
Syrian Arab Republic[d]	9.61	6.93	6.53	6.29	-1.62	-2.91	-1.89	2.87	0.98			-29.68	-25.19	-14.81	-12.22	30.09	-12.81
Tajikistan[d]	11.54	5.66	5.29	5.51	-3.50	-3.35	2.12	-6.29	-3.41	-10.40	-24.82	142.09	5.57	-6.16	7.97	3.46	1.08
Tanzania (United Rep. of)[d]	11.18	9.24	9.14	8.54	-0.95	-0.56	-3.37	0.05	-0.09	0.51	0.12	-4.67	-1.23	-0.19	-0.28	-31.02	-25.01
Thailand[d]	4.67	5.45	5.39	5.56	0.78	-0.48	1.55	3.26	0.87	5.01	0.54	-1.92	-9.67	2.38	-0.93	-72.93	-15.17
Timor-Leste[c]		2.20	2.19	3.00		-0.40	17.15					-12.64	15.03	-7.39	2.33	0.56	0.34
Togo[d]	10.34	16.60	15.14	14.53	2.39	-4.51	-2.03			7.72	2.86	-16.14	-1.47	0.46	0.11	-0.90	-2.44
Tonga[c]	3.26	3.24	2.94	3.07	-0.04	-4.81	2.29					0.68	2.71	-18.54	3.04	0.12	-0.01
Trinidad and Tobago[d]	16.92	21.15	20.01	19.83	1.12	-2.73	-0.44			1.91	4.83	-2.60	0.28	-2.77	5.20	2.85	13.38
Tunisia[d]	4.46	3.86	3.80	3.72	-0.72	-0.79	-0.96	-2.86	5.48	4.15	3.06	-0.02	-1.60	1.02	1.20	-6.29	3.64
Turkey[d]	3.83	3.71	3.70	3.55	-0.16	-0.11	-2.13	-6.47	-1.74	0.29	-3.57	30.05	-5.58	-2.85	-8.24	-222.27	-9.60
Turkmenistan[d]	23.94	18.78	16.59	14.29	-1.21	-6.01	-7.17							-5.98	4.07	-44.41	-51.89
Turks and Caicos Islands[c]														0.59	-0.08		
Tuvalu[c]	3.45	3.88	3.69	3.70	0.59	-2.45	0.09	100.36	-0.74			-10.21	1.19	-4.34	-0.17		0.00
Uganda[c]	20.88	8.25	7.51	7.03	-4.54	-4.58	-3.27	-6.84	3.71	-3.59	-16.67	7.52	9.29	-0.72	-3.20	-4.68	-28.14
Ukraine[d]	19.38	15.41	13.52	12.49	-1.14	-6.32	-3.90	-0.31	-10.87	-2.94	0.89	0.67	-1.52	-0.51	-6.53	-52.92	-125.97
United Arab Emirates[d]	4.12	5.40	5.32	5.03	1.36	-0.71	-2.81			-1.98	-5.51	2.31	-3.59	0.16	3.99	-8.93	-146.17
United Kingdom of Great Britain and Northern Ireland[d]	5.66	3.74	3.47	3.05	-2.05	-3.75	-6.14	1.96	-2.71	-2.14	-3.72	-2.36	-6.54	-5.71	-7.97	-74.84	-447.03
United States of America[d]	8.67	6.07	5.69	5.63	-1.76	-3.18	-0.58	-8.48	-8.36	-3.24	-0.95	-3.96	2.54	-4.86	4.96	643.88	-154.19
United States Virgin Islands[c]														-2.60	-5.64		
Uruguay[d]	3.08	2.97	3.09	2.91	-0.18	2.08	-3.00	-1.41	-0.29	2.57	7.07	-1.00	-4.93	1.00	0.88	0.04	4.58
Uzbekistan[d]	31.22	15.13	14.47	11.18	-3.56	-2.22	-12.09	-6.74	-5.68	-1.86	-13.30	2.07	-15.73	7.32	-10.47	-306.01	-76.01
Vanuatu[c]	3.13	3.87	3.69	4.30	1.07	-2.38	7.91							-2.32	-2.41	-0.16	0.60
Venezuela (Bolivarian Rep. of)[d]	5.77	6.31	5.79	5.49	0.44	-4.22	-2.60	4.71	2.15	-8.81	-4.54	-2.19	-5.65	-0.33	-0.77	-161.79	14.24
Viet Nam[d]	7.55	6.32	5.74	5.72	-0.88	-4.70	-0.17	-2.41	2.08	-3.64	0.59	-4.35	4.23	0.99	2.44	-42.74	21.45
Wallis and Futuna Islands[c]																	
Yemen[d]	2.59	3.17	2.79	3.33	1.00	-6.11	9.24							-13.72	6.58	70.79	-24.49
Zambia[d]	12.08	7.77	7.58	7.40	-2.18	-1.23	-1.17	11.49	1.08	11.01	0.93	-1.08	-6.17	-0.50	-0.84	-4.21	-7.16
Zimbabwe[d]	14.70	20.71	18.44	17.76	1.73	-5.65	-1.86	-8.26	-10.65	-0.82	-12.49	-25.97	-13.55	0.43	0.25	-16.64	-11.15
World	**7.83**	**5.95**	**5.73**	**5.49**	**-1.36**	**-1.92**	**-2.06**	**-0.97**	**-2.07**	**-2.36**	**-2.18**	**-3.19**	**-1.30**	**-0.91**	**0.16**	**-4,365.63**	**-7,460.32**
Africa	7.49	6.17	6.12	5.97	-0.96	-0.42	-1.17	-0.55	-2.48	-1.52	-0.99	4.57	1.41	-0.61	0.20	-217.73	-379.61
Africa (excluding North Africa)	9.95	7.93	7.64	7.32	-1.13	-1.82	-2.15	0.98	-0.16	-2.73	-2.54	7.25	-4.30	-1.01	0.14	-206.64	-546.78
North Africa	4.15	3.81	3.90	3.88	-0.43	1.10	-0.25	-2.48	-5.25	-1.13	0.66	0.16	12.98	1.52	0.06	-134.08	29.88
Arab Region	4.38	4.91	4.91	4.90	0.58	-0.02	-0.15	-1.44	-4.04	-0.11	0.54	0.38	4.33	0.62	0.04	-193.40	34.97
Arab Least Developed Countries (LDCs)	6.27	4.04	3.65	3.80	-2.17	-4.94	1.91	-12.44	1.44	-12.91	-4.88	-4.08	-1.25	-9.77	1.42	59.22	-29.38
Arab North Africa	3.77	3.80	3.94	4.21	0.05	1.77	3.34	-2.02	-0.97	3.81	3.89	-2.15	41.73	5.36	2.08	85.23	95.37
Gulf Cooperation Council Countries (GCC)	4.42	6.00	5.88	5.80	1.54	-1.04	-0.62	5.64	2.70	-1.08	0.83	1.70	-0.52	1.18	2.64	-54.49	123.69
Mashreq	4.52	4.07	4.06	3.89	-0.52	-0.15	-2.19	0.52	-7.00	-1.86	-1.50	-0.95	-1.51	-0.46	-4.44	-296.43	-179.42
Asia-Pacific	9.07	6.61	6.38	6.00	-1.57	-1.80	-2.98	0.96	-1.32	-2.37	-3.20	-2.31	-2.49	0.83	1.03	-4,130.32	-4,027.93
East and North-East Asia	9.76	7.48	7.13	6.63	-1.32	-2.32	-3.63	-0.45	-0.33	-3.40	-4.23	-2.10	-2.27	1.75	1.80	-2,379.56	-2,677.37
North and Central Asia	12.74	8.77	8.73	8.15	-1.85	-0.24	-3.40	6.33	-10.06	-2.38	-4.03	-4.36	0.24	0.08	0.37	-819.28	-382.45
South and South-West Asia	6.36	5.15	5.08	4.92	-1.05	-0.70	-1.60	1.80	1.55	0.64	0.17	1.25	-4.33	-0.19	0.77	-727.97	-653.31
South-East Asia	5.24	4.53	4.22	4.18	-0.72	-3.48	-0.48	-3.20	-4.89	-3.39	-1.01	-3.68	-3.01	2.28	0.93	-188.92	-117.26
The Pacific	7.35	5.85	5.51	5.25	-1.13	-2.95	-2.37	1.20	-1.20	-2.02	-0.58	-2.51	-0.27	-0.88	-2.03	13.08	-92.82
Europe, North America, and Central Asia	8.03	5.59	5.33	5.12	-1.80	-2.31	-2.01	-2.08	-6.44	-1.70	-1.84	-3.37	-0.39	-3.06	-0.88	-406.45	-3,482.34
Eastern Europe, Caucasus, and Central Asia	12.48	7.97	7.79	7.21	-2.22	-1.09	-3.84	2.33	-7.66	-2.53	-4.21	0.18	-1.34	-0.39	-1.89	-1,251.66	-680.23
North America	8.80	6.23	5.86	5.80	-1.71	-3.01	-0.53	-7.06	-7.40	-2.33	-0.63	-4.40	2.31	-4.37	4.72	682.12	-232.70
Southeast Europe	9.60	5.14	5.01	4.57	-3.07	-1.29	-4.51	9.04	-12.57	1.42	-4.18	-6.46	-2.33	0.12	-0.87	-129.56	-14.75
Western and Central Europe	5.53	4.17	3.91	3.67	-1.40	-3.13	-3.17	-1.14	-4.73	-1.80	-1.59	-3.33	-4.16	-3.73	-5.99	51.00	-2,640.20
Latin America and Caribbean	4.48	4.03	3.98	3.96	-0.53	-0.65	-0.26	0.99	-0.32	-2.19	-1.65	0.19	1.42	-0.03	-0.70	-420.17	-6.33
Caribbean	5.71	4.86	4.62	4.33	-0.81	-2.46	-3.20	2.53	-5.00	-0.97	-1.09	3.34	-0.76	0.31	0.46	-28.11	-11.14
Latin America	4.41	3.98	3.94	3.94	-0.50	-0.51	-0.09	0.97	-0.25	-2.23	-1.70	0.07	1.51	-0.06	-0.78	-391.74	9.94
Low income	12.63	10.52	9.83	9.34	-0.91	-3.35	-2.53	-2.67	-0.93	-5.03	-3.29	-3.05	-2.58	-2.88	1.12	-258.43	-138.98
Lower middle income	8.44	5.28	5.05	4.75	-2.32	-2.25	-3.00	1.56	-0.93	-3.34	-1.81	-0.16	-4.05	1.06	0.11	-1,776.68	-1,530.70
Upper middle income	8.76	6.64	6.47	6.17	-1.38	-1.23	-2.40	-0.24	-0.67	-2.17	-3.42	0.95	-1.36	1.36	1.61	-2,211.87	-2,753.82
High income	7.10	5.42	5.16	4.99	-1.34	-2.42	-1.62	-1.58	-5.31	-2.03	-1.14	-3.75	-0.14	-3.08	-0.63	-123.99	-3,027.52

a. For some countries no energy intensity value is shown because GDP data were not available.

b. All changes refer to compound annual rates.

c. Based on data from the United Nations Statistics Division's Energy Statistics Database and the World Bank's World Development Indicators database.

d. Based on data from the International Energy Agency's World Energy Statistics and Balances database and the World Bank's World Development Indicators database.

e. Includes Monaco.

f. Includes San Marino.

g. Includes Svalbard and Jan Mayen Islands.

3 RENEWABLE ENERGY

	Share in total final energy consumption (%)												Final use of renewable energy (petajoules)			Total final energy consumption (petajoules)
					Solid biofuels											
	Renewable energy				Traditional use	Modern use	Hydro	Liquid biofuels	Wind	Solar	Geothermal	Other (biogas, renewable waste, marine)	Electricity	Heat	Transport	
	1990	2010	2012	2014	2014	2014	2014	2014	2014	2014	2014	2014	2014	2014	2014	2014
Afghanistan [a]	15.92	14.84	13.97	16.75	8.82	0.00	7.93	0.00	0.00	0.00	0.00	0.00	11.57	12.88	0.00	145.97
Albania [b]	25.52	37.12	40.05	38.69	7.81	1.62	27.40	1.25	0.00	0.61	0.00	0.00	23.49	8.61	1.07	85.71
Algeria [b]	0.18	0.26	0.19	0.07	0.02	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.65	0.25	0.00	1,311.92
American Samoa [a]	0.00	0.00	0.70	0.70	0.00	0.00	0.00	0.00	0.00	0.70	0.00	0.00	0.00	0.00	0.00	0.49
Andorra [a]	14.27	19.09	19.20	19.89	0.28	0.00	18.52	0.00	0.00	0.00	0.00	1.09	1.53	0.11	0.00	8.25
Angola [b]	72.26	54.19	52.25	50.80	46.35	1.12	3.33	0.00	0.00	0.00	0.00	0.00	15.66	223.47	0.00	470.74
Anguilla [a]	0.30	0.12	0.13	0.13	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.44
Antigua and Barbuda [a]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.53
Argentina [b]	8.92	8.96	9.87	10.77	0.45	2.52	5.55	2.15	0.10	0.00	0.00	0.00	143.93	62.10	51.48	2,390.30
Armenia [b]	2.12	9.36	6.57	7.72	1.72	0.00	6.00	0.00	0.01	0.00	0.00	0.00	4.96	1.42	0.00	82.62
Aruba [a]	0.20	5.46	6.86	6.92	0.32	0.00	0.00	0.00	6.60	0.00	0.00	0.00	0.43	0.02	0.00	6.43
Australia [b]	8.01	8.55	8.44	9.50	0.00	5.38	1.74	0.31	0.97	0.87	0.00	0.23	111.67	181.34	9.75	3,187.79
Austria [b]	25.14	30.95	33.70	35.78	0.00	16.13	14.01	2.55	1.31	1.00	0.07	0.70	176.64	168.64	24.87	1,034.41
Azerbaijan [b]	0.72	4.45	2.85	2.12	0.74	0.34	0.97	0.00	0.00	0.00	0.00	0.06	3.43	3.56	0.01	330.64
Bahamas [a]		1.78	1.23	1.10	0.00	1.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.00	25.70
Bahrain [b]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	184.58
Bangladesh [b]	71.66	41.07	38.63	37.49	37.26	0.00	0.18	0.00	0.00	0.04	0.00	0.00	2.32	379.32	0.00	1,018.14
Barbados [a]	18.94	9.03	4.13	3.17	0.08	3.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.37	0.00	11.59
Belarus [b]	0.82	7.02	7.25	6.63	2.24	4.17	0.05	0.14	0.00	0.00	0.00	0.03	0.79	46.36	0.11	712.31
Belgium [b]	1.27	5.67	7.79	9.04	0.00	4.43	0.08	1.29	1.41	0.95	0.00	0.87	49.40	53.81	16.64	1,326.02
Belize [a]	38.01	33.71	37.11	36.54	0.20	26.84	9.50	0.00	0.00	0.00	0.00	0.00	1.02	2.90	0.00	10.72
Benin [b]	93.70	51.55	51.08	48.60	40.45	8.15	0.00	0.00	0.00	0.00	0.00	0.00	0.02	77.16	0.00	158.81
Bermuda [a]		2.39	1.57	2.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.44	0.00	0.12	0.00	4.71
BES Islands [a]			0.11	0.27	0.11	0.00	0.00	0.00	0.16	0.00	0.00	0.00	0.01	0.00	0.00	3.61
Bhutan [a]	95.90	90.89	87.85	86.66	74.81	0.15	11.70	0.00	0.00	0.00	0.00	0.00	7.21	46.22	0.00	61.65
Bolivia (Plurinational State of) [b]	37.36	20.08	17.92	16.82	6.86	7.43	2.52	0.00	0.01	0.01	0.00	0.00	7.45	38.30	0.00	272.03
Bosnia and Herzegovina [b]	7.30	19.57	15.28	41.75	32.44	1.23	8.08	0.00	0.00	0.00	0.00	0.00	14.00	58.37	0.00	173.37
Botswana [b]	47.58	30.19	30.28	29.17	29.16	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	22.72	0.00	77.92
Brazil [b]	49.86	47.01	43.62	41.81	3.04	18.47	12.57	7.02	0.41	0.28	0.00	0.02	1,317.74	1,837.32	636.58	9,068.53
British Virgin Islands [a]	1.45	0.85	0.87	0.87	0.87	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	1.50
Brunei Darussalam [b]	0.67	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	38.39
Bulgaria [b]	1.92	14.37	15.75	16.97	8.28	2.62	2.64	1.22	0.76	0.94	0.38	0.13	15.69	42.68	4.52	370.63
Burkina Faso [a]	93.16	83.68	77.62	76.48	75.72	0.45	0.30	0.00	0.00	0.00	0.00	0.00	0.42	106.13	0.00	139.31
Burundi [a]	95.20	96.76	93.96	90.05	87.66	0.99	1.40	0.00	0.00	0.00	0.00	0.00	0.77	48.65	0.00	54.88
Cabo Verde [a]	36.63	21.74	24.40	26.20	23.06	0.26	0.00	0.00	2.67	0.20	0.00	0.00	0.18	1.49	0.00	6.39
Cambodia [b]		68.47	68.31	67.95	48.95	15.10	3.90	0.00	0.00	0.01	0.00	0.00	9.04	147.19	0.00	229.91
Cameroon [b]	81.59	78.60	78.14	77.39	65.46	6.63	5.29	0.00	0.00	0.00	0.00	0.00	14.67	196.79	0.00	273.25
Canada [b]	22.02	22.14	23.10	22.58	0.00	6.74	13.75	1.05	0.81	0.09	0.00	0.14	1,106.26	501.10	78.37	7,466.99
Cayman Islands [a]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.50
Central African Republic [a]	93.49	79.81	78.02	77.19	39.57	34.75	2.87	0.00	0.00	0.00	0.00	0.00	0.50	13.04	0.00	17.54
Chad [a]	98.16	90.79	90.65	89.24	87.97	1.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	58.42	0.00	65.47
Chile [b]	34.03	27.03	30.33	26.42	0.00	18.30	7.40	0.00	0.46	0.23	0.00	0.02	98.54	169.17	0.00	1,013.48
China [b]	34.08	17.41	16.83	17.10	10.21	0.19	4.12	0.09	0.61	1.20	0.26	0.42	3,839.05	9,178.92	71.00	76,546.09
Chinese Taipei [b]	1.94	1.55	2.26	2.04	0.00	0.29	0.72	0.18	0.25	0.31	0.00	0.29	27.37	11.25	1.47	1,962.33
Colombia [b]	38.25	27.93	26.64	24.52	5.72	6.23	12.42	0.12	0.01	0.00	0.00	0.00	137.06	120.77	1.15	1,056.34
Comoros [a]	49.84	46.41	48.01	46.49	46.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.56	0.00	3.37
Congo (Dem. Rep. of) [b]	92.05	96.83	95.53	92.87	75.96	13.75	3.15	0.00	0.00	0.00	0.00	0.00	28.41	807.99	0.00	900.59
Congo (Rep. of) [b]	65.41	55.15	65.51	62.37	59.74	0.74	1.89	0.00	0.00	0.00	0.00	0.00	1.57	50.28	0.00	83.13
Cook Islands [a]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.72
Costa Rica [b]	45.38	42.31	38.62	37.87	3.78	14.02	14.99	0.00	1.64	0.01	3.43	0.00	29.77	25.30	0.00	145.41
Côte d'Ivoire [b]	73.58	75.49	74.90	70.84	62.07	7.26	1.50	0.00	0.00	0.00	0.00	0.00	5.00	223.34	0.00	322.35
Croatia [b]	21.92	29.78	29.42	33.65	16.58	0.86	14.00	0.47	1.13	0.20	0.17	0.22	39.50	45.34	1.21	255.77
Cuba [b]	42.89	13.16	17.10	18.75	0.19	15.26	0.10	3.16	0.02	0.02	0.00	0.00	2.23	53.90	0.00	299.35
Curacao [b]		0.24	0.36	0.35	0.00	0.00	0.00	0.00	0.35	0.00	0.00	0.00	0.09	0.00	0.00	24.60
Cyprus [b]	0.50	6.35	8.35	9.39	0.45	0.99	0.00	0.71	1.05	5.39	0.11	0.70	1.04	3.91	0.40	57.02
Czech Republic [b]	2.88	9.74	11.13	12.75	0.00	8.49	0.49	1.44	0.12	0.62	0.00	1.58	21.84	82.50	13.26	922.19
Denmark [b]	7.04	21.35	27.28	30.22	0.00	15.66	0.01	1.93	8.48	0.59	0.01	3.53	61.61	88.38	9.67	528.35
Djibouti [a]	26.59	34.43	34.07	34.15	34.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.16	0.00	6.33
Dominica [a]	14.60	8.66	9.40	9.87	3.80	0.00	6.07	0.00	0.00	0.00	0.00	0.00	0.10	0.06	0.00	1.62
Dominican Republic [b]	28.06	18.00	17.71	18.38	9.77	4.93	2.23	0.26	0.86	0.33	0.00	0.00	7.22	30.57	0.55	208.67
Ecuador [b]	24.20	12.11	13.10	12.22	1.96	2.85	7.27	0.06	0.05	0.01	0.02	0.00	38.05	22.95	0.32	501.88
Egypt [b]	8.50	5.72	5.69	6.41	1.88	1.96	2.31	0.00	0.22	0.04	0.00	0.00	47.75	71.70	0.00	1,862.77
El Salvador [b]	67.14	34.30	27.26	28.17	13.12	3.93	5.77	0.00	0.00	0.00	5.23	0.11	11.87	14.92	0.00	95.15
Equatorial Guinea [a]	84.71	5.92	6.00	6.38	5.54	0.00	0.84	0.00	0.00	0.00	0.00	0.00	0.58	3.83	0.00	69.12
Eritrea [b]		81.25	80.15	80.30	76.53	3.75	0.00	0.00	0.00	0.03	0.00	0.00	0.01	18.06	0.00	22.50
Estonia [b]	3.36	25.13	24.91	25.25	0.00	23.70	0.05	0.21	1.03	0.00	0.00	0.26	2.78	26.44	0.24	116.66

	Share in total final energy consumption (%)												Final use of renewable energy (petajoules)			Total final energy consumption (petajoules)
					Solid biofuels											
	Renewable energy				Traditional use	Modern use	Hydro	Liquid biofuels	Wind	Solar	Geothermal	Other (biogas, renewable waste, marine)	Electricity	Heat	Transport	
	1990	2010	2012	2014	2014	2014	2014	2014	2014	2014	2014	2014	2014	2014	2014	2014
Ethiopia [b]	96.64	94.53	93.76	92.72	90.46	0.83	1.36	0.01	0.06	0.00	0.00	0.00	23.49	1,505.27	0.21	1,649.04
Faeroe Islands [a]	2.54	3.38	4.70	6.54	0.00	0.00	5.08	0.00	1.45	0.00	0.00	0.00	0.52	0.00	0.00	7.95
Falkland Islands (Malvinas) [a]	1.13	3.71	3.79	3.87	0.82	0.00	0.00	0.00	3.06	0.00	0.00	0.00	0.02	0.01	0.00	0.67
Fiji [a]	53.09	29.77	32.94	37.57	1.37	29.64	6.49	0.00	0.07	0.00	0.00	0.00	1.33	6.28	0.00	20.25
Finland [b]	24.51	33.61	38.83	41.19	0.00	31.70	5.72	2.15	0.47	0.01	0.00	1.14	109.93	272.70	20.84	979.51
France [b,c]	10.41	11.87	12.37	13.13	0.00	6.19	3.01	2.17	0.83	0.36	0.08	0.49	245.42	367.76	121.68	5,595.64
French Guiana [a]	5.50	28.88	33.79	30.61	8.92	2.72	17.21	0.00	0.00	1.76	0.00	0.00	1.69	1.04	0.00	8.91
French Polynesia [a]	4.73	11.57	9.34	10.15	0.42	0.00	9.30	0.00	0.00	0.43	0.00	0.00	0.73	0.03	0.00	7.53
Gabon [b]	78.28	85.85	75.63	81.05	21.76	58.01	1.28	0.00	0.00	0.00	0.00	0.00	2.54	156.50	0.00	196.24
Gambia [a]	61.44	50.17	49.83	48.06	48.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.21	0.00	10.83
Georgia [b]	12.77	39.15	28.69	31.89	12.60	0.22	18.66	0.00	0.00	0.05	0.36	0.00	28.32	20.09	0.00	151.78
Germany [b]	2.10	10.29	12.02	13.38	0.00	4.71	0.72	1.52	2.09	1.64	0.05	2.65	482.50	488.53	116.79	8,130.88
Ghana [b]	80.63	49.86	44.34	45.22	28.58	8.08	8.55	0.00	0.00	0.00	0.00	0.00	23.73	101.65	0.00	277.28
Gibraltar [b]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.00
Greece [b]	7.81	11.09	13.86	16.09	0.00	6.57	2.57	1.05	2.12	3.47	0.08	0.23	43.11	50.40	5.81	617.46
Greenland [a]		7.74	8.30	10.66	0.00	0.00	10.49	0.00	0.00	0.00	0.00	0.18	0.81	0.01	0.00	7.76
Grenada [a]	7.24	9.35	10.13	9.88	9.16	0.72	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.00	2.76
Guadeloupe [a]	6.75	3.52	3.97	4.55	0.48	0.00	0.36	0.00	0.89	1.57	1.24	0.00	0.96		0.00	18.13
Guam [a]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.68
Guatemala [b]	74.97	66.59	66.22	59.90	53.43	3.21	3.10	0.00	0.00	0.00	0.16	0.00	20.47	240.36	0.00	435.42
Guinea [a]	89.30	79.10	78.45	80.01	78.66	0.35	1.00	0.00	0.00	0.00	0.00	0.00	1.29	102.04	0.00	129.15
Guinea-Bissau [a]	88.58	87.81	87.61	87.06	79.34	7.72	0.00	0.00	0.00	0.00	0.00	0.00	0.00	23.36	0.00	26.83
Guyana [a]	42.41	33.84	28.26	24.02	4.58	19.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.40	0.00	26.67
Haiti [b]	81.12	79.02	83.16	78.39	74.36	3.94	0.10	0.00	0.00	0.00	0.00	0.00	0.13	102.53	0.00	130.96
Honduras [b]	70.13	53.16	48.78	54.04	43.38	6.45	3.65	0.00	0.56	0.00	0.00	0.00	8.76	87.02	0.00	177.23
Hong Kong (SAR, China) [b]	1.07	0.83	0.82	1.79	0.60	0.06	0.00	1.03	0.00	0.00	0.00	0.10	0.39	2.48	3.86	375.77
Hungary [b]	3.86	9.04	10.15	10.36	0.00	7.14	0.20	1.25	0.44	0.08	0.80	0.45	13.35	44.35	7.89	632.99
Iceland [b]	54.67	75.42	77.36	76.42	0.00	0.00	37.73	0.15	0.02	0.00	38.43	0.09	60.59	26.33	0.27	114.08
India [b]	58.65	39.48	38.39	36.54	26.60	7.60	1.62	0.07	0.46	0.17	0.00	0.02	525.51	7,333.72	14.32	21,550.03
Indonesia [b]	58.60	38.38	39.10	38.07	31.82	4.33	0.72	0.73	0.00	0.00	0.48	0.00	81.78	2,383.59	45.67	6,596.51
Iran (Islamic Rep. of) [b]	1.24	0.90	0.93	0.94	0.16	0.16	0.60	0.00	0.02	0.00	0.00	0.00	41.42	21.00	0.00	6,654.53
Iraq [b]	1.60	1.71	1.26	0.91	0.00	0.12	0.79	0.00	0.00	0.00	0.00	0.00	6.85	1.04	0.00	865.47
Ireland [b]	2.28	5.24	6.58	8.47	0.00	2.18	0.57	0.90	4.13	0.12	0.00	0.56	21.31	10.14	3.75	415.53
Isle of Man [a]		4.05	6.43	3.81	0.00	0.00	0.46	0.00	0.00	0.00	0.00	3.35	0.01	0.08	0.00	2.28
Israel [b]	5.80	8.50	8.66	9.34	0.00	0.07	0.01	0.00	0.00	9.23	0.00	0.04	2.80	46.43	0.00	526.91
Italy [b,d]	3.78	12.79	14.39	17.09	0.00	6.25	4.66	1.34	1.21	1.94	0.59	1.11	439.81	298.28	44.60	4,579.68
Jamaica [b]	7.63	13.72	17.04	15.99	8.65	5.09	0.42	1.46	0.36	0.00	0.00	0.00	1.06	11.43	1.26	86.00
Japan [b]	4.55	4.59	4.54	5.53	0.00	1.78	2.49	0.00	0.15	0.89	0.15	0.07	480.58	120.25	0.00	10,870.92
Jordan [b]	2.77	2.97	2.93	3.13	0.06	0.03	0.08	0.00	0.00	2.95	0.00	0.01	0.20	6.57	0.00	216.08
Kazakhstan [b]	1.41	1.38	1.33	1.36	0.06	0.00	1.30	0.00	0.00	0.00	0.00	0.00	19.54	0.92	0.00	1,501.79
Kenya [b]	77.50	76.27	78.50	75.52	71.83	0.07	1.62	0.00	0.02	0.00	1.98	0.00	22.56	439.36	0.00	611.66
Kiribati [a]	5.77	2.71	2.84	2.95	2.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.71
Korea (Dem. People's Rep. of) [b]	7.19	10.63	14.33	17.02	1.19	7.52	8.31	0.00	0.00	0.00	0.00	0.00	34.97	36.66	0.00	420.91
Korea (Rep. of) [b]	1.63	1.31	1.61	2.84	0.00	1.63	0.17	0.33	0.07	0.18	0.09	0.36	27.46	104.44	15.64	5,198.65
Kosovo [b]		20.92	20.86	21.46	18.82	1.70	0.91	0.00	0.00	0.03	0.00	0.00	0.47	10.54	0.00	51.29
Kuwait [b]	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	593.37
Kyrgyzstan [b]	7.93	25.59	22.45	28.25	0.08	0.01	28.16	0.00	0.00	0.00	0.00	0.00	36.09	0.12	0.00	128.18
Lao PDR [a]	94.93	88.01	88.28	90.34	72.85	0.00	16.65	0.00	0.00	0.84	0.00	0.00	12.64	52.64	0.00	72.25
Latvia [b]	17.57	33.06	40.37	40.24	15.03	16.71	5.81	0.64	0.41	0.00	0.00	1.64	12.93	49.73	1.01	158.24
Lebanon [b]	11.34	5.20	4.91	3.20	2.08	0.30	0.32	0.00	0.00	0.51	0.00	0.00	0.63	5.71	0.00	197.74
Lesotho [a]	52.03	53.45	52.32	51.82	47.37	0.00	4.44	0.00	0.00	0.00	0.00	0.00	2.47	26.30	0.00	55.52
Liberia [a]	88.24	89.29	85.85	89.82	10.80	79.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	66.61	0.00	74.16
Libya [b]	3.13	1.57	1.91	1.75	1.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.33	0.00	361.01
Liechtenstein [a]		58.69	61.92	62.18	5.97	0.00	28.29	0.00	0.00	21.11	0.00	6.81	1.34	0.39	0.00	2.78
Lithuania [b]	3.10	21.69	24.28	28.07	10.76	10.13	1.81	1.34	2.90	0.33	0.02	0.78	13.55	39.31	2.65	197.73
Luxembourg [b]	1.72	3.66	4.17	6.97	0.00	1.81	0.84	1.98	0.62	0.83	0.00	0.89	4.69	2.83	2.99	150.99
Macao (SAR, China) [a]	0.66	6.83	11.70	10.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.73	0.00	2.88	0.00	26.84
Macedonia (The former Yugoslav Rep. of) [b]	2.41	22.59	16.88	18.30	8.74	1.07	7.54	0.00	0.44	0.09	0.43	0.00	5.83	7.39	0.00	72.19
Madagascar [a]	85.91	81.93	76.70	73.56	32.19	39.36	2.01	0.00	0.00	0.00	0.00	0.00	2.43	86.28	0.00	120.58
Malawi [a]	84.03	79.73	81.16	80.58	34.37	37.11	9.10	0.00	0.00	0.00	0.00	0.00	5.85	45.99	0.00	64.34
Malaysia [b]	11.98	3.82	4.41	4.77	1.83	0.11	2.20	0.59	0.00	0.04	0.00	0.01	46.36	35.98	11.67	1,970.94
Maldives [a]	4.46	1.16	1.04	0.91	0.87	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.01	0.14	0.00	16.03
Mali [a]	88.15	84.86	85.14	83.56	77.98	2.11	3.47	0.00	0.00	0.00	0.00	0.00	2.07	47.72	0.00	59.59
Malta [b]	0.00	1.39	2.60	3.95	0.25	0.00	0.00	1.22	0.00	2.20	0.00	0.29	0.24	0.25	0.22	18.17
Marshall Islands [a]		0.00	0.26	0.23	0.00	0.00	0.00	0.00	0.00	0.23	0.00	0.00	0.00	0.00	0.00	0.27
Martinique [a]	2.13	2.63	2.49	2.43	0.30	0.95	0.00	0.00	0.03	0.75	0.00	0.39	0.01	0.44	0.00	18.37

	Share in total final energy consumption (%)												Final use of renewable energy (petajoules)			Total final energy consumption (petajoules)
					Solid biofuels							Other (biogas, renewable waste, marine)				
	Renewable energy				Traditional use	Modern use	Hydro	Liquid biofuels	Wind	Solar	Geothermal		Electricity	Heat	Transport	
	1990	2010	2012	2014	2014	2014	2014	2014	2014	2014	2014	2014	2014	2014	2014	2014
Mauritania [a]	47.00	34.00	31.84	32.58	32.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.10	0.00	40.22
Mauritius [b]	47.07	13.66	11.61	10.64	0.71	8.50	0.93	0.00	0.03	0.26	0.00	0.22	1.98	1.47	0.00	32.49
Mayotte [a]	33.41	9.96	12.24	11.73	9.58	0.00	0.00	0.00	0.00	2.14	0.00	0.00	0.05	0.28	0.00	2.83
Mexico [b]	14.41	9.36	8.96	9.80	0.00	6.30	2.50	0.00	0.41	0.19	0.39	0.01	159.32	299.83	0.00	4,685.77
Micronesia (Federated States of) [a]		1.84	1.59	1.32	0.34	0.64	0.00	0.00	0.00	0.34	0.00	0.00	0.00	0.02	0.00	1.66
Moldova (Rep. of) [b]	1.14	8.44	10.47	13.05	11.13	0.81	1.01	0.00	0.00	0.00	0.00	0.08	1.02	11.56	0.00	96.37
Monaco																
Mongolia [b]	1.89	4.35	3.54	3.97	2.50	1.06	0.00	0.00	0.42	0.00	0.00	0.00	0.58	5.00	0.00	140.67
Montenegro [b]		54.52	46.20	45.98	24.06	2.18	19.74	0.00	0.00	0.00	0.00	0.00	5.19	6.89	0.00	26.27
Montserrat [a]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.51
Morocco [b]	19.48	14.50	11.47	11.78	4.10	5.51	1.00	0.00	1.17	0.00	0.00	0.00	12.85	56.83	0.00	591.64
Mozambique [b]	93.10	91.30	90.82	88.85	70.43	8.81	9.62	0.00	0.00	0.00	0.00	0.00	40.88	336.84	0.00	425.12
Myanmar [b]	90.91	85.02	78.95	68.52	63.21	2.09	3.22	0.00	0.00	0.00	0.00	0.00	22.51	456.94	0.00	699.71
Namibia [b]		26.37	28.56	27.62	6.21	1.72	19.58	0.00	0.00	0.11	0.00	0.00	13.37	5.49	0.00	68.31
Nauru [a]	0.00	0.08	0.09	0.04	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.42
Nepal [b]	95.12	87.29	84.70	84.38	78.19	0.87	2.90	0.00	0.00	0.00	0.00	2.41	14.01	393.15	0.00	482.55
Netherlands [b]	1.32	3.88	4.97	5.67	0.00	1.93	0.02	0.88	1.15	0.22	0.08	1.38	41.43	44.94	14.62	1,781.64
New Caledonia [a]	10.16	4.45	6.02	3.98	0.01	0.00	2.99	0.00	0.59	0.39	0.00	0.00	1.18	0.12	0.00	32.52
New Zealand [b]	30.02	31.24	30.77	30.86	0.00	7.99	14.66	0.03	1.33	0.08	6.57	0.20	110.06	53.42	0.18	530.28
Nicaragua [b]	68.77	52.64	52.08	51.84	39.04	7.51	1.10	0.00	2.35	0.00	1.84	0.00	6.45	43.77	0.00	96.87
Niger [b]		80.70	72.73	78.13	78.11	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.02	86.39	0.00	110.60
Nigeria [b]	87.78	86.78	86.45	87.27	81.11	5.84	0.32	0.00	0.00	0.00	0.00	0.00	15.48	4,192.00	0.00	4,820.96
Niue [a]	0.57	26.70	24.20	23.14	0.58	0.00	0.00	0.00	0.00	22.56	0.00	0.00	0.00	0.02	0.00	0.07
Northern Mariana Islands [a]		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.17
Norway [b,e]	59.17	56.33	58.45	57.09	0.00	4.34	50.44	0.73	0.82	0.00	0.00	0.76	381.32	37.30	5.43	742.78
Oman [b]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	684.87
Pakistan [b]	57.50	46.30	46.17	47.21	39.17	4.89	3.10	0.00	0.04	0.00	0.00	0.00	93.94	1,318.03	0.00	2,991.12
Palau [a]		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.92
Palestine (State of) [a]	22.08	14.06	12.24	10.53	5.98	0.42	0.00	0.00	0.00	4.12	0.00	0.00	0.00	6.77	0.00	64.29
Panama [b]	43.59	19.94	20.62	19.77	5.00	2.73	10.78	1.00	0.25	0.00	0.00	0.00	15.72	10.85	1.42	141.57
Papua New Guinea [a]	70.48	55.25	55.47	50.03	41.25	4.76	2.82	0.00	0.00	0.00	1.20	0.00	6.37	54.74	0.00	122.14
Paraguay [b]	78.51	64.25	62.68	63.12	19.16	23.55	18.15	2.26	0.00	0.00	0.00	0.00	35.26	83.01	4.34	194.26
Peru [b]	39.43	30.73	28.25	25.64	12.42	0.78	10.04	2.19	0.09	0.08	0.00	0.04	74.61	90.16	13.26	694.45
Philippines [b]	50.95	28.81	30.22	28.72	14.53	7.51	2.42	1.47	0.04	0.00	2.73	0.01	58.38	247.14	14.31	1,113.59
Poland [b]	2.50	9.51	10.94	11.55	0.00	8.90	0.25	1.18	0.87	0.03	0.03	0.28	56.73	203.56	29.54	2,509.90
Portugal [b]	26.95	27.83	25.52	30.50	0.00	13.34	7.89	1.86	6.14	0.84	0.11	0.32	98.84	78.68	10.92	617.88
Puerto Rico [a]	1.75	0.57	0.56	1.63	0.00	0.00	0.38	0.00	1.03	0.22	0.00	0.00	1.16	0.00	0.00	70.93
Qatar [b]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	559.67
Reunion [a]	37.52	16.45	16.91	16.79	1.47	7.20	3.60	0.00	0.13	4.10	0.00	0.29	1.45	5.06	0.00	38.73
Romania [b]	3.36	24.10	21.55	24.34	14.67	1.79	4.89	0.78	1.61	0.42	0.11	0.06	62.78	146.82	6.98	889.77
Russian Federation [b]	3.75	3.34	3.35	3.46	0.26	0.42	2.77	0.00	0.00	0.00	0.01	0.00	440.16	107.28	0.00	15,840.68
Rwanda [a]	84.27	90.66	89.03	88.45	80.26	7.40	0.79	0.00	0.00	0.00	0.00	0.00	0.62	67.94	0.00	77.51
Saint Barthelemy																
Saint Helena [a]	15.07	10.50	8.72	10.61	6.49	0.00	0.00	0.00	3.85	0.27	0.00	0.00	0.00	0.01	0.00	0.08
Saint Kitts and Nevis [a]	40.03	0.99	1.33	1.49	0.01	0.00	0.00	0.00	1.32	0.16	0.00	0.00	0.03	0.00	0.00	1.79
Saint Lucia [a]	5.47	2.20	2.18	2.15	2.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00	3.79
Saint Martin (French part)																
Saint Pierre and Miquelon [a]	0.00	0.53	0.44	0.39	0.00	0.00	0.00	0.00	0.39	0.00	0.00	0.00	0.00	0.00	0.00	0.73
Saint Vincent and the Grenadines [a]	15.44	5.43	5.78	7.50	2.36	0.00	5.14	0.00	0.00	0.00	0.00	0.00	0.13	0.06	0.00	2.43
Samoa [a]	46.20	46.75	40.02	42.06	37.39	1.92	2.75	0.00	0.00	0.00	0.00	0.00	0.10	1.49	0.00	3.79
San Marino																
Sao Tome and Principe [a]	71.48	43.76	41.45	41.60	40.59	0.00	1.01	0.00	0.00	0.00	0.00	0.00	0.02	0.77	0.00	1.90
Saudi Arabia [b]	0.04	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.00	4,748.62
Senegal [b]	55.55	50.26	50.37	43.30	40.56	1.81	0.92	0.00	0.00	0.01	0.00	0.00	1.21	46.15	0.00	109.37
Serbia [b]	15.49	20.60	19.61	23.43	11.22	2.34	9.74	0.00	0.00	0.01	0.07	0.05	31.07	43.45	0.00	318.04
Seychelles [a]	4.25	0.63	0.63	1.03	0.56	0.00	0.00	0.00	0.43	0.04	0.00	0.00	0.02	0.03	0.00	5.13
Sierra Leone [a]	93.92	84.18	78.43	73.05	50.71	21.99	0.35	0.00	0.00	0.00	0.00	0.00	0.20	42.00	0.00	57.77
Singapore [b]	0.19	0.48	0.50	0.62	0.00	0.12	0.00	0.00	0.00	0.03	0.00	0.48	2.78	0.00	0.00	446.88
Sint Maarten (Dutch part) [a]			0.05	0.05	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.06
Slovak Republic [b]	2.23	10.28	10.47	12.14	0.00	5.85	3.62	1.51	0.01	0.58	0.04	0.54	19.96	19.64	5.60	372.32
Slovenia [b]	12.35	19.61	19.84	22.68	0.00	11.79	8.29	0.96	0.01	0.59	0.67	0.37	17.28	24.44	1.83	192.04
Solomon Islands [a]	59.01	64.61	63.53	62.96	62.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.20	0.00	5.08
Somalia [a]	91.88	93.57	93.75	93.86	67.58	26.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	91.62	0.00	97.62
South Africa [b]	16.63	17.09	16.64	16.59	13.32	2.82	0.09	0.00	0.10	0.25	0.00	0.00	9.92	479.69	0.00	2,951.72
South Sudan [b]			30.20	29.83	27.38	2.42	0.00	0.00	0.00	0.03	0.00	0.00	0.01	6.78	0.00	22.75
Spain [b]	10.54	14.40	15.77	17.35	0.00	5.41	3.73	1.30	4.95	1.65	0.03	0.29	327.65	173.80	40.04	3,120.65

	Share in total final energy consumption (%)												Final use of renewable energy (petajoules)			Total final energy consumption (petajoules)
	Renewable energy				Solid biofuels							Other (biogas, renewable waste, marine)				
					Traditional use	Modern use	Hydro	Liquid biofuels	Wind	Solar	Geothermal		Electricity	Heat	Transport	
	1990	2010	2012	2014	2014	2014	2014	2014	2014	2014	2014	2014	2014	2014	2014	2014
Sri Lanka [b]	78.09	61.84	60.69	57.59	33.20	20.33	3.82	0.00	0.23	0.02	0.00	0.00	15.52	202.73	0.00	379.02
Sudan [b]	73.27	61.44	59.82	62.42	36.96	19.02	6.44	0.00	0.00	0.00	0.00	0.00	27.39	238.27	0.00	425.63
Suriname [b]		24.54	23.05	25.38	6.16	1.79	17.44	0.00	0.00	0.00	0.00	0.00	4.39	2.00	0.00	25.16
Swaziland [a]	85.25	62.68	63.03	63.55	21.06	37.34	5.15	0.00	0.00	0.00	0.00	0.00	1.95	22.14	0.00	37.91
Sweden [b]	34.06	45.98	49.90	49.54	0.00	26.79	14.59	2.86	2.57	0.05	0.00	2.69	245.67	337.79	37.03	1,252.56
Switzerland [b,f]	17.11	21.49	22.99	23.45	0.00	4.59	14.77	0.10	0.04	0.62	1.66	1.68	120.02	57.49	0.76	760.15
Syrian Arab Republic [b]	2.36	1.41	2.56	2.99	0.00	0.10	2.90	0.00	0.00	0.00	0.00	0.00	7.83	0.26	0.00	270.36
Tajikistan [b]	29.64	61.84	56.07	40.71	0.00	0.00	40.71	0.00	0.00	0.00	0.00	0.00	42.91	0.00	0.00	105.40
Tanzania (United Rep. of) [b]	94.78	90.32	86.35	86.67	66.92	18.91	0.83	0.00	0.00	0.01	0.00	0.00	7.58	769.46	0.00	896.51
Thailand [b]	33.64	22.65	23.29	23.59	9.19	10.68	0.64	2.01	0.04	0.16	0.00	0.88	55.20	602.84	61.20	3,049.44
Timor-Leste [a]		33.89	25.08	19.00	19.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.01	0.00	5.31
Togo [b]	78.70	65.83	72.74	72.83	59.86	9.00	3.97	0.00	0.00	0.00	0.00	0.00	3.65	60.59	0.00	88.20
Tonga [a]	1.49	1.01	1.13	1.63	1.03	0.00	0.00	0.00	0.00	0.60	0.00	0.00	0.01	0.01	0.00	1.30
Trinidad and Tobago [b]	1.19	0.33	0.32	0.28	0.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.49	0.00	176.02
Tunisia [b]	14.48	12.69	13.08	12.92	11.58	0.22	0.05	0.00	0.47	0.61	0.00	0.00	1.69	38.40	0.00	310.21
Turkey [b]	24.57	14.35	12.84	11.58	0.00	3.91	3.55	0.18	0.74	1.00	2.06	0.13	154.51	228.71	6.07	3,362.25
Turkmenistan [b]	0.28	0.07	0.04	0.04	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.31	0.00	746.40
Turks and Caicos Islands [a]	1.79	0.52	0.51	0.58	0.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	1.11
Tuvalu [a]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08
Uganda [a]	96.04	91.98	91.36	89.22	87.53	0.00	1.68	0.00	0.00	0.00	0.00	0.00	6.84	356.05	0.00	406.76
Ukraine [b]	0.65	2.88	2.86	3.50	1.85	0.53	0.89	0.07	0.12	0.04	0.00	0.00	25.82	57.34	1.72	2,426.68
United Arab Emirates [b]	0.00	0.12	0.12	0.17	0.00	0.12	0.00	0.00	0.00	0.05	0.00	0.00	0.94	2.37	0.00	1,971.75
United Kingdom of Great Britain and Northern Ireland [b]	0.65	3.69	4.82	7.29	0.00	2.68	0.39	0.97	2.14	0.32	0.00	0.79	212.48	94.76	47.12	4,857.84
United States of America [b]	4.18	7.51	8.48	8.91	0.00	3.46	1.39	2.50	0.98	0.29	0.12	0.18	1,766.71	2,084.79	1,440.88	59,375.95
United States Virgin Islands [a]	0.00	0.00	0.08	0.77	0.00	0.00	0.00	0.00	0.00	0.77	0.00	0.00	0.02	0.00	0.00	2.31
Uruguay [b]	44.81	52.82	46.92	55.43	7.10	30.19	15.68	1.27	1.19	0.00	0.00	0.00	33.17	60.60	1.88	172.55
Uzbekistan [b]	1.33	2.64	2.38	2.90	0.00	0.01	2.88	0.00	0.00	0.00	0.00	0.00	35.26	0.17	0.00	1,223.02
Vanuatu [a]	24.16	38.38	40.30	32.43	30.24	0.00	0.86	0.93	0.37	0.02	0.00	0.00	0.03	0.84	0.00	2.68
Venezuela (Bolivarian Rep. of) [b]	11.98	11.44	12.24	12.30	0.51	1.19	10.60	0.00	0.00	0.00	0.00	0.00	191.05	30.60	0.00	1,802.40
Viet Nam [b]	76.08	34.80	38.11	36.20	22.20	5.12	8.86	0.00	0.01	0.00	0.00	0.00	196.29	603.41	0.00	2,209.11
Wallis and Futuna Islands [a]		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17
Yemen [b]	2.15	0.96	1.33	1.06	0.00	1.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.37	0.00	222.94
Zambia [b]	82.98	92.10	88.63	88.09	56.91	19.95	11.23	0.00	0.00	0.00	0.00	0.00	37.50	256.65	0.00	333.93
Zimbabwe [b]	63.98	82.88	78.02	81.13	71.32	5.44	4.07	0.29	0.00	0.00	0.00	0.00	16.50	302.65	1.15	394.79
World [a,b]	**16.66**	**17.51**	**17.91**	**18.33**	**8.44**	**4.21**	**3.24**	**0.89**	**0.60**	**0.50**	**0.16**	**0.28**	**15,962.75**	**46,908.37**	**3,093.59**	**359,946.24**
Africa [a,b]	60.25	57.48	56.54	56.97	48.87	6.24	1.67	0.01	0.08	0.05	0.06	0.00	386.25	12,027.03	1.37	21,789.66
Africa (excluding North Africa) [a,b]	70.89	71.88	70.69	70.47	61.45	7.16	1.70	0.01	0.03	0.05	0.07	0.00	310.01	11,588.05	1.37	16,886.26
North Africa [a,b]	15.72	11.46	10.06	10.51	5.55	3.08	1.57	0.00	0.25	0.05	0.00	0.00	80.24	434.99	0.00	4,903.40
Arab region [a,b]	6.54	4.23	3.59	3.60	1.81	1.02	0.60	0.00	0.08	0.09	0.00	0.00	103.51	453.54	0.00	15,483.15
Arab Least Developed Countries (LDCs) [a,b]	56.61	41.95	42.15	40.82	24.74	12.10	3.98	0.00	0.00	0.00	0.00	0.00	24.22	256.92	0.00	688.78
Arab North Africa [a,b]	7.21	5.48	4.81	4.54	2.59	1.29	0.26	0.00	0.33	0.07	0.00	0.00	10.65	106.35	0.00	2,574.78
Gulf Cooperation Council Countries (GCC) [a,b]	0.03	0.03	0.03	0.04	0.00	0.03	0.00	0.00	0.00	0.01	0.00	0.00	0.93	2.67	0.00	8,742.87
Mashreq [a,b]	5.36	4.20	4.12	4.47	1.24	1.12	1.68	0.00	0.12	0.31	0.00	0.00	63.69	91.62	0.00	3,476.71
Asia-Pacific [a,b]	22.96	18.26	18.06	18.26	11.42	2.12	3.05	0.15	0.38	0.66	0.23	0.24	6,551.95	24,340.73	253.69	170,583.06
East and North-East Asia [a,b]	23.27	14.52	14.31	14.88	8.36	0.49	3.70	0.10	0.52	1.10	0.23	0.38	4,436.75	9,396.90	90.51	93,579.85
North and Central Asia [a,b]	3.59	3.51	3.39	3.54	0.33	0.34	2.86	0.00	0.00	0.00	0.01	0.00	561.85	146.49	0.01	19,982.32
South and South-West Asia [a,b]	48.81	31.53	30.69	29.52	21.43	5.48	1.77	0.06	0.35	0.19	0.19	0.06	866.28	9,935.65	20.39	36,661.29
South-East Asia [a,b]	51.50	31.48	32.40	31.33	22.37	5.23	2.29	0.83	0.01	0.04	0.38	0.18	488.92	4,526.81	132.84	16,432.04
The Pacific [a,b]	13.37	13.15	12.91	13.82	1.43	5.75	3.56	0.25	0.97	0.73	0.92	0.21	227.07	305.95	9.94	3,927.56
Europe, North America, and Central Asia [a,b]	5.88	9.97	10.83	11.50	0.36	4.21	3.15	1.60	1.06	0.48	0.18	0.45	7,141.14	6,590.62	2,127.42	137,935.89
Eastern Europe, Caucasus, and Central Asia [a,b]	3.89	4.84	4.70	4.76	0.51	0.89	2.64	0.03	0.10	0.31	0.26	0.02	749.82	533.85	7.90	27,106.84
North America [a,b]	6.16	9.07	10.13	10.44	0.00	3.83	2.77	2.34	0.96	0.26	0.10	0.17	3,007.21	2,451.66	1,519.25	66,842.94
Southeast Europe [a,b]	6.86	23.29	21.65	26.05	14.37	1.83	7.67	0.63	0.93	0.38	0.15	0.08	181.14	375.95	13.78	2,191.75
Western and Central Europe [a,b]	7.30	13.59	15.21	16.79	0.11	7.11	3.87	1.47	1.85	0.93	0.25	1.21	3,258.92	3,173.23	586.50	41,794.37
Latin America and Caribbean [a,b]	32.62	28.51	27.52	27.15	4.27	10.75	8.50	3.02	0.31	0.16	0.13	0.01	2,430.33	3,363.57	712.24	23,961.41
Caribbean [a,b]	36.54	20.78	22.54	22.32	13.03	7.27	0.58	1.15	0.22	0.08	0.00	0.00	11.28	206.07	1.81	981.88
Latin America [a,b]	32.33	28.85	27.74	27.36	3.89	10.90	8.84	3.10	0.32	0.16	0.13	0.01	2,417.08	3,159.48	710.43	22,979.53
Low income [a,b]	67.38	79.69	79.71	80.68	69.01	8.68	2.80	0.02	0.01	0.00	0.00	0.16	214.60	5,822.88	1.37	7,484.91
Lower middle income [a,b]	44.58	40.69	40.62	40.13	31.53	5.75	2.23	0.15	0.23	0.08	0.16	0.01	1,464.32	19,575.80	76.02	52,619.05
Upper middle income [a,b]	26.50	18.01	17.24	17.33	7.99	2.55	4.25	0.69	0.48	0.84	0.24	0.30	6,233.64	13,947.12	821.50	121,180.90
High income [a,b]	6.06	9.05	9.84	10.44	0.10	3.99	2.98	1.41	0.93	0.47	0.14	0.41	8,006.91	6,567.09	2,189.76	160,531.58

a. Data are from the United Nations.
b. Data are from the International Energy Agency.
c. Includes Monaco.
d. Includes San Marino.
e. Includes Svalbard and Jan Mayen Islands.
f. Includes oil data for Liechtenstein.

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Global chapters

The chapters on access to energy (chapters 2 and 3) were prepared by a working group comprising the World Bank/Energy Sector Management Assistance Program (ESMAP) and International Energy Agency (IEA), Practical Action, Global Alliance for Clean Cookstoves, and World Health Organization (WHO). The main contributing authors were Elisa Portale, Juliette Besnard, and Julia Heckmann (World Bank/ESMAP); Ramesh Ramankutty and Sarah Hillware (World Bank/ESMAP); Dan Dorner and Hannah Daly (IEA); Carlos Dora, Heather Adair-Rohani, Sophie Gumy, Jessica Lewis (WHO); Lucy Stevens and Mattia Vianello (Practical Action); Sumi Mehta, Jessie Durrett, and Cecilia Flatley (Global Alliance for Clean Cookstoves); Rodrigo Leme and Adrian Whiteman (International Renewable Energy Agency, IRENA); and Glada Lahn (Chatham House, The Royal Institute of International Affairs).

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The energy efficiency chapter (chapter 4) was prepared by a working group comprising the World Bank/ESMAP, IEA, Copenhagen Centre on Energy Efficiency, World Energy Council, and International Partnership for Energy Efficiency Cooperation (IPEEC). The main contributing authors were Ivan Jaques and Esra Bozkir (World Bank/ESMAP); Tyler Bryant, Jae Sik Lee, Samuel Thomas, Pierpaolo Cazzola, Renske Schuitmaker, Gianluca Tonolo, Urszula Ziebinska, Roberta Quadrelli, Melanie Slade, and David Morgado (IEA); Timothy Farrell (Copenhagen Centre on Energy Efficiency); Stuart Neil (World Energy Council); and Benoit Lebot and Jurei Yada (IPEEC). Support in data preparation and analysis was provided by Olivier Lavagne d'Ortigue (World Bank/ESMAP).

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Regional chapters

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In preparation for the regional chapters, technical workshops or virtual consultations were organized for country consultation in each region.

For the **Africa region,** a Specialized Technical Committee session on Energy was organized by the United Nations Economic Commission for Africa in Lome, Togo on 13–17 March 2017, with the following participants from 14 countries and multiple organizations: Clément Bill Akouedenoudie, Energy Engineer, Ministry of Energy and Water, Benin; Marguerite Hayabele Guillame, Head of Monitoring, Ministry of Water and Energy, Cameroon; Babe Danki Emmanuel, Consultant Engineer, Ministry of Planning, Cameroon; Louis Kahindo Boyabonzene, Technical Advisor Electricity, Ministry of Energy and Hydraulic Resources, Congo (Dem. Rep. of); Christian Vunda Ngulumingi, Technical Advisor New and Renewable Energies, Ministry of Energy and Hydraulic Resources, Congo (Dem. Rep. of); Mohammed Omran, First Under-Secretary for Research, Planning & Authorities follow up, Ministry of Electricity and Energy, Egypt; Ahmed Magdy, Second Secretary, Embassy of Egypt in Addis Ababa, Egypt; Ahmed Zaghloul, Third Secretary, Embassy of Egypt in Lome, Egypt; Belyou Tekola, Senior Expert on Development Cooperation and Foreign Relation, Ministry of Water, Irrigation and Energy, Ethiopia; Wondimu Tekle, State Minister, Ministry of Water, Irrigation and Electricity, Ethiopia; Francisco-J. Onana Mangue, Focal Point - Expert, Ministry of Industry and Energy, Equatorial Guinea; Leovigildo Mahon Gerona, Technical Expert on Energy Generation, Ministry of Industry and Energy, Equatorial Guinea; Kwabena A. Otu-Danquah, Ag. Director, Renewable Energy and Energy Efficiency Promotion, Energy Commission, Ghana; Wisdom Ahiataku-Togobo, Director, Ministry of Energy, Ghana; Mehamed Douno, Deputy Director General, Strategy and Development, Ministry of Energy and Hydraulics, Guinea; Paul Mbuthi, Principal Renewable Energy Officer, Ministry of Energy and Petroleum, Kenya; Timothy Gakuu, Chief Economist, Ministry of Energy and Petroleum, Kenya; Barrack Ouma, Chief Geophysicist, Ministry of Energy and Petroleum, Kenya; Julius Mwathani, Senior Principal Superintending Engineer, Directorate of Electrical Power Development, Ministry

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For the **Europe, North America, and Central Asia region,** UNECE organized virtual consultations that took place between 12 December 2016 and 22 February 2017, and responses were received from the following participants from 12 countries: Mariela A. Stefanllari, President, Human Environment Culture Foundation, Albania; Olga Dovnar, Deputy Chairperson, International Cooperation Unit, National Statistical Committee, Belarus; Andrei Miniankou, Head of Department, Department for Energy Efficiency, State Committee on Standardization, Belarus; Vladimir Zui, Professor, Belarusian State University, Belarus; Valentina Ilieva, Official, Energy Strategies and Policies for Sustainable Energy Development Directorate, Ministry of Energy, Bulgaria; Zlatko Pavicic, Independent Expert, Croatia; Matija Vajdic, Senior Researcher, Energy Institute Hrvoje Pozar, Croatia; Sigurd Heiberg, Chairperson, Petronavit A.S., Norway; Margalita Arabidze, Head of Energy Efficiency and Renewable Energy Division, Ministry of Energy, Georgia; Anna Sikharulidze, Technical Manager, Sustainable Development Centre Remissia, Georgia; Gogita Todradze, Deputy Executive Director, National Statistics Office, Georgia; Tahmina Mahmud, Independent Expert, Tajikistan; and Maksym Chepeliev, Research Economist, Center for Global Trade Analysis, Department of Agricultural Economics, Purdue University, United States of America (for Ukraine). In addition, the following UNECE country representatives participated in the technical workshop organized by ESCAP in Bangkok, Thailand on 16 January 2017: Hayk Harutyunyan, Deputy Minister, Ministry of Energy Infrastructures and Natural Resources, Armenia; Vugar Jabbarov, Adviser, Ministry of Energy, Azerbaijan; Margalita Arabidze, Head of Energy Efficiency and Alternative Energy Division, Ministry of Energy, Georgia; Bekbergen Kerey, Deputy Director of Department of International Cooperation and Economic Integration Processes, Ministry of Energy, Kazakhstan; Aleksey Ponomarev, Vice President, Industrial Cooperation and Public Programs, Skolkovo Institute of Science and Technology, Skolkovo Innovation Center, Russian Fed.; and Ulugbek Agzamov, Head of Division of the Department for UN and

International Organizations Affairs, Ministry of Foreign Affairs, Uzbekistan.

For the **Latin America and Caribbean region,** a technical workshop was organized by the United Nations Economic Commission for Latin America and Caribbean in Santiago, Chile on 10 November 2016, with the following participants from 11 countries and several organizations: Andrea Heins, Undersecretary for Energy Efficiency, Ministry of Energy and Mining, Argentina; Mario Mendoza, Director General Energy Planning, Ministry of Hydrocarbons and Energy, Bolivia (Plurinational State of); Ricardo Gorini, Director, Energy Planning Company, Brazil; Ignacio Santelices, Director Energy Efficiency Division, Ministry of Energy, Chile; Laura Lizano, Sectoral Director of Energy, Ministry of Environment and Energy, Costa Rica; Ernesto Vilalta, Vice Minister of Energy, Ministry of Energy and Mines, Dominican Republic; Adrian Moreno, Undersecretary of Energy Efficiency and Renewables, Ministry of Electricity and Renewable Energy, Ecuador; Luis Reyes, Executive Secretary, National Energy Council, El Salvador; Luis Chang, Minister of Energy, Ministry of Energy and Mines, Guatemala; Odon de Buen, General Manager, National Commission for Efficient Use of Energy, Mexico; Carolina Mena, Director of Energy Efficiency, Ministry of Industry, Energy and Mining, Uruguay; Ghislaine Kieffer, Senior Energy Specialist, IRENA; Roberto Aiello, SEforALL Coordinator for Latin America, IADB; Ivan Jaques, Senior Energy Specialist, World Bank; and Francesco Giorgianni, Vice President Chile, World Energy Council.

Data sources

The report draws on two metadatabases of global household surveys, an electrification database managed by the World Bank, and a database on access to clean fuels and technologies managed by WHO.

The report is based on energy balances data provided by the IEA's Energy Data Center (IEA World energy balances, 2016) and UN Statistics Division. Gross domestic product and value added data are provided by the World Development Indicators of the World Bank. Population data comes the United Nations Population Division.

The report's renewable energy chapter benefited from significant new data processing and automatization efforts conducted by Roberta Quadrelli and Remi Gigoux (IEA's Energy Data Center), Yasmina Abdelilah (IEA's Renewable Energy Division), and Ralf Becker and Leonardo Souza (UN Statistics Division).

The energy efficiency chapter used modelling results for transport intensities from the IEA's Mobility Model, provided by Pierpaolo Cazzola and Renske Schuitmaker (IEA's Transport Unit of the Energy Technology Policy Division in the Directorate of Sustainability, Technology and Outlooks).

Review and consultation

The public consultation and peer review process was coordinated by Vivien Foster (World Bank) and Martin Hullin (REN21) and benefited from use of the REN21 online consultation platform.

Substantive comments were also provided by Atul Raturi (University of the South Pacific), Baradwaj Kummamuru Venkata (World Bioenergy Association), Mariela Stefanllari and Yamina Saheb (Openexp), Zoe Lagarde (IPEEC), Andrew Scott (Overseas Development Institute), Parthan Binu (Sustainable Energy Associates), David Lecoque (Alliance for Rural Electrification), Dipti Vaghela (Hydro Empowerment Network), Davida Wood (World Resources Institute), Ernesto Elenter (SEG), Emmanuel Ackom (UNEP–Technical University of Denmark Partnership), Galyna Trypolska (Institute for Economics and Forecasting, Ukrainian National Academy of Sciences), Gianluca Sambucini and Oleg Dzioubinski (UNECE), Gogita Todradze (National Statistics Office of Georgia), Hannah E. Murdock (REN21), Litvinyuk Igor (International Institute of Energy Policy and Diplomacy of Moscow State Institute of International Relations), Jessie Durret (The Global Alliance for Clean Cookstoves), John Hauge (The Global LPG Partnership, Inc.), Seijin Kim and Elena Virkkala Nekhaev (World Energy Council), Mareike Britten (Hivos), Maria Cristina Silva (Ministry of Energy, Chile), Olola Vieyra-Mifsud (Advisory Role to the Benin Government), Peter Boait (De Montfort University), Paul Munro (University of South Wales), Reid Detchon (United Nations Foundation), Kimberly Roseberry (ESCAP), Radia Sedaoui (ESCWA), Tara Shine (Tara Shine International Environment and Development Consultancy), Uliana Pysmenna (Institute for Economy and Forecasting), Vanesa Castan Broto (Bartlett Development Planning Unit, University College London), Radoslav Vukas (Ministry of Mining and Energy, Serbia), Yasmina Abdelilah (IEA), and Zitouni Ould-Dada (UNEP).

The World Bank's internal peer review process was led by Riccardo Puliti, with contributions from Marianne Fay, Neil Fantom, Gabriela Elizondo, Dana Rysankova and Ashok Sarkar (World Bank), and Jane Olga Ebinger (SEforALL).

The IEA's internal review process involved Kamel Ben Naceur, Rebecca Gaghen, Hannah Daly, Dan Dorner, Paolo Frankl, Adam Brown, Heymi Bahar, Yasmina Abdelilah, Roberta Quadrelli, Tyler Bryant, Jae Sik Lee, Samuel Thomas, Pierpaolo Cazzola, Renske Schuitmaker, Gianluca Tonolo, Urszula Ziebinska, Melanie Slade, and David Morgado.

Outreach

The communications process was coordinated by Susan Pleming, Aarthi Sivaraman, and Anita Rozowska (World Bank), Jad Mouawad (IEA), and Callum Grieve and Beth Woodthorpe-Evans (SEforALL).

The online platform (http://GTF.esmap.org) was developed by Sreejith K.S., Narayanan R., and Ram Prasad of Advanced Software Systems Inc., with input and guidance from Anshul Rana and Aarthi Sivaraman.

The report was edited, designed, and typeset by Bruce Ross-Larson and a team at Communications Development, including Jonathan Aspin, Joe Brinley, Joe Caponio, Mike Crumplar, Shannon Granville, Christopher Trott, John Wagley, and Elaine Wilson, with Debra Naylor of Naylor Design. Graphic design of the Executive Summary was by Duina Reyes.

ABBREVIATIONS AND ACRONYMS

AFREC	African Energy Commission
CAFE	Corporate average fleet economy
CAGR	Compound annual growth rate
COP21	2015 Paris Climate Conference
ECAPOV	Europe and Central Asia Poverty Database
ECLAC	United Nations Economic Commission for Latin America and the Caribbean
EJ	Exajoules
ENERGIA	International Network on Gender and Sustainable Energy
ESCAP	United Nations Economic and Social Commission for Asia and the Pacific
ESCWA	United Nations Economic and Social Commission for Western Asia
ESMAP	Energy Sector Management Assistance Program
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FIT	Feed-in tariff
GCC	Gulf Cooperation Council
GDP	Gross domestic product
GED	Global Electrification Database
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GNI	Gross national income
GTF	Global Tracking Framework
ICT	Information and communications technology
IEA	International Energy Agency
IIASA	International Institute for Applied Systems Analysis
IPEEC	International Partnership for Energy Efficiency Cooperation
IRENA	International Renewable Energy Agency
LDC	Least developed country
LPG	Liquefied petroleum gas
MEI	Moving Energy Initiative
MEPS	Minimum Energy Performance Standards
MTF	Multi-Tier Framework
NSS	National Sample Survey
OECD	Organisation for Economic Co-operation and Development
PPA	Power purchase agreement
PPP	Purchasing power parity
PV	Photovoltaic
RE	Renewable energy
REN21	Renewable Energy Policy Network for the 21st Century
RISE	Regulatory Indicators for Sustainable Energy
SADC	Southern African Development Community
SAPP	Southern African Power Pool
SDG	Sustainable Development Goal
SEDLAC	Socio-Economic Database for Latin America and the Caribbean
SEforALL	Sustainable Energy for All
SREP	Scaling up Renewable Energy Program
TFEC	Total final energy consumption
UN	United Nations
UNDESA	United Nations Department of Economics and Social Affairs
UNECA	United Nations Economic Commission for Africa
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
WEO	World Energy Outlook
WHO	World Health Organization

Visit the Global Tracking Framework website to download data and reports, as well as customized maps, comparative graphics, timelines, and country reports.

http://GTF.esmap.org

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