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THE BOTTOM LINE

Substantial potential exists for further tapping of renewable energy sources. In fact, the technical potential for renewable energy use around the globe is substantially higher than projected global energy demand in 2050. The technical potential for solar energy is the highest among the renewable energy sources, but there is also substantial untapped potential for biomass, geothermal, hydro, wind, and ocean energy. Most of this technical potential (in the form of hydropower, geothermal, and solar) is located in the developing world.

Doubling the Share of Renewable Energy in the Global Energy Mix

Why is this issue important?

Renewable energy promises important social and environmental benefits

Developed and developing countries alike are increasingly motivated by the benefits offered by renewable energy, including enhanced energy security, reduced greenhouse gas emissions and local environmental impacts, increased economic and industrial development, and more options for reliable and modern energy access. Today, about 120 countries—more than half of them developing countries—have a national target related to renewable energy. Moreover, 88 countries have introduced price- or quantity-based incentives for renewable energy. Just over half of those countries are developing.

Doubling the share of renewable energy in the global energy mix is one of the three complementary objectives of the Sustainable Energy for All (SE4ALL) initiative. Formally launched in the UN General Assembly in September 2012 and co-chaired by the president of the World Bank Group and the UN Secretary-General, SE4ALL calls on governments, businesses, and civil society to address urgent energy challenges, including increasing the use of renewable energy, by 2030 (SE4ALL 2012).

To support the achievement of this goal, a starting point must be set, indicators developed, and a framework established to track those indicators until 2030. The World Bank and International Energy Agency lead a consortium of 15 international agencies to compile and analyze data made available by leading institutions and to select a set of indicators to track progress toward the goal and monitor related policy, technology, and investment. This note is based on

chapter 4 of SE4ALL's Global Tracking Framework (World Bank 2014). SE4ALL will publish an updated version of the GTF in 2015.

What are the current level and patterns of production of renewable energy?

As traditional renewables fade in importance, modern forms surge

Over the 20 years between 1990 and 2010, and particularly since 2000, the production of energy from renewable sources for electricity, heating, and transportation expanded rapidly as renewable energy technologies matured and became more widely adopted. Global consumption of renewable energy grew from 40 exajoules in 1990 to almost 60 exajoules in 2010 (figure 1)—an increase that is equivalent to the total final energy consumption of India and Malaysia in 2010. The compound annual growth rate (CAGR) of energy production from renewable sources was 1.5 percent during 1990–2000 and 2.4 percent during 2000–10.

Yet as the consumption of energy from renewable sources rose, global total final energy consumption grew at a roughly comparable pace of 1.1 percent during 1990–2000 and 2.0 percent during 2000–10, increasing from 243 exajoules in 1990 to 330 exajoules in 2010. The boost in consumption is equivalent to the annual energy consumption of China, India, and Japan combined. As a result of the two trends, the share of renewable energy in the global energy mix remained relatively stable, growing from 16.6 percent in 1990 to 18.0 percent in 2010.



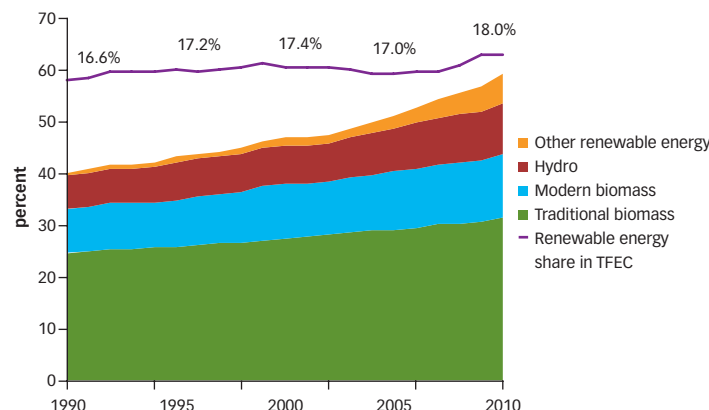
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"Wind, solar, geothermal, waste, and marine—together contribute barely 1 percent of global energy demand, though they have been growing at an exponential rate."

Figure 1. World consumption of renewable energy (exajoules) grew substantially but remained fairly stable as a share of global energy consumption (%)



Source: IEA 2012.

Note: TFEC = total final energy consumption.

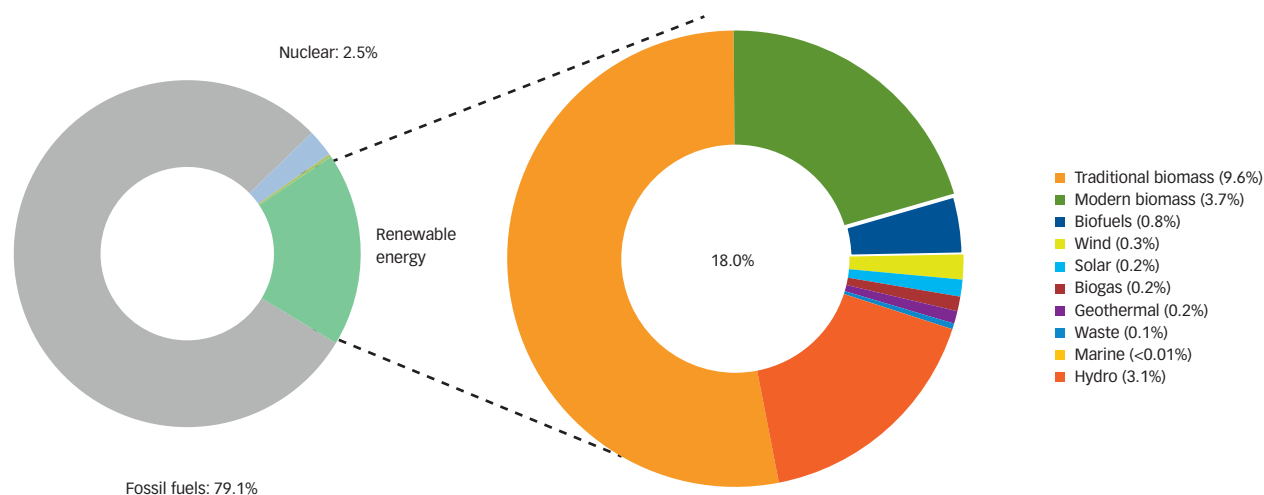
The starting point for the share of renewable energy in the global energy mix against which future progress will be measured is established as 18 percent of total final energy consumption in 2010. The SE4ALL global objective is 36 percent by 2030.

It is estimated that traditional biomass accounts for about half of the renewable energy total (figure 2), although data on these traditional usages are imprecise, and the sustainability of these sources cannot be reliably gauged.¹ An examination of the methodological issues of measuring the renewable energy share can be found in box 1.

A further quarter of the renewable energy total derives from modern forms of bioenergy, and most of the remainder is hydro-power. Other forms of renewable energy—including wind, solar,

1. The UN Food and Agriculture Organization defines traditional biomass as "woodfuels, agricultural by-products, and dung burned for cooking and heating purposes." In developing countries, traditional biomass is still widely harvested and used in an unsustainable and unsafe way. It is mostly traded informally and noncommercially. So-called modern biomass, by contrast, is produced in a sustainable manner from solid wastes and residues from agriculture and forestry. The IEA assumes that all solid biomass consumed in developing countries is "traditional" and all solid biomass consumed in developed countries is "modern," but the surveys presently used to compile energy balances are not specific enough to test this assumption.

Figure 2. Traditional biomass accounted for more than half of the renewable energy consumed in 2010



Source: IEA 2012.

Note: TFEC = total final energy consumption.

“Electricity, generation from renewable sources increased from 2,300 terawatt-hours (TWh) in 1990 to 4,160 TWh in 2010. More than 80 percent of all electricity generated globally from renewable sources was from hydropower.”

Box 1. Methodological challenges in defining and measuring renewable energy

There are various definitional and methodological challenges in measuring and tracking the share of renewable energy in the global energy mix used for heating, electricity, and transportation.

First, while there is a broad consensus among international organizations and government agencies on what constitutes renewable energy, their legal and formal definitions vary slightly in the type of resources included and the sustainability considerations taken into account. For the purposes of the global tracking being carried out under the SE4ALL initiative, the definition of renewable energy embraces the notion of sustainable natural replenishment. But data are not currently available to distinguish whether renewable energy (notably biomass) has been sustainably produced. There is also some uncertainty regarding the measurement of traditional biomass. Therefore, as an interim measure SE4ALL will track renewable energy without specific sustainability criteria, while supporting the strengthening of methodologies for tracking sustainability across all renewable energy sources. Renewable energy will be defined broadly as:

“Energy from natural sources that are replenished at a faster rate than they are consumed, including hydro, bioenergy, geothermal, aerothermal, solar, wind, and ocean.”

Second, an important methodological choice is whether tracking should be undertaken at the primary level of the energy balance or on the basis of final energy. Power generation from fossil fuels leads to substantial energy losses in conversion, leading to a discrepancy between primary energy, or fuel input, and final energy, or useful energy output. Since renewable energy sources do not have fuel inputs, they are reported only in final energy terms; expressing them in primary terms would require the use of somewhat arbitrary conversion factors.

Third, the high aggregation levels and data gaps in certain categories of available data repositories still limit the analysis. Data gaps have also been identified in the areas of distributed generation and off-grid electricity services. An additional challenge is related to measuring the heat output from certain renewable sources of energy such as heat pumps and solar water heaters.

For the purposes of global tracking, data for the period 2000–10 have been compiled from energy balances of 139 countries published by the International Energy Agency. The data will be complemented by indicators on: (i) policy targets for renewable energy and adoption of relevant policy measures; (ii) technology costs for each of the renewable energy technologies; and (iii) total investment in renewable energy from the Renewable Energy Network 21, the International Renewable Energy Agency, and Bloomberg New Energy Finance, respectively.

Looking ahead, significant international efforts are needed to improve data collection methodologies and bridge identified data gaps. In particular, there is a need to develop internationally agreed-upon standards for sustainability for each of the main technologies, which can then be used to assess the degree to which deployment meets the standards. This is particularly critical in the case of biomass, where traditional harvesting practices can be associated with deforestation.

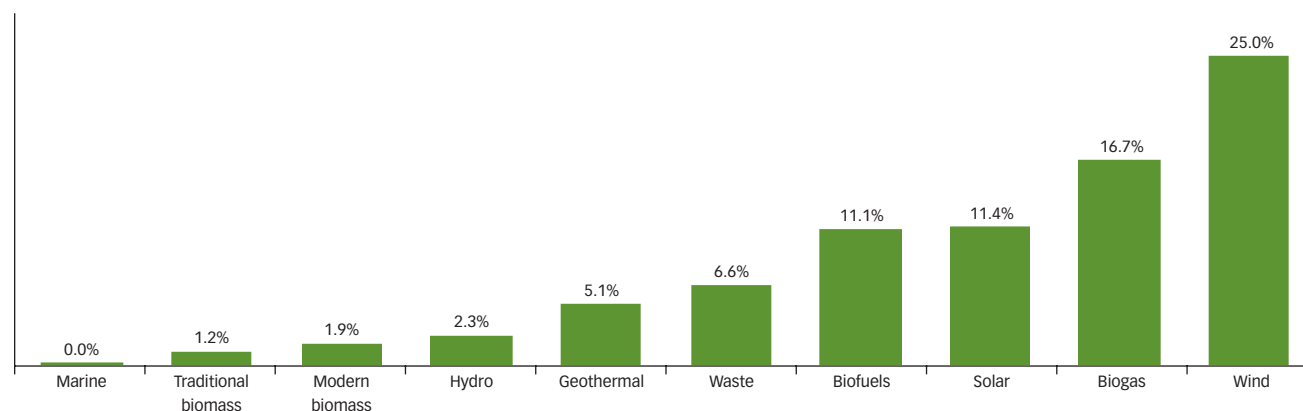
geothermal, waste, and marine²—together contribute barely 1 percent of global energy demand, though they have been growing at an exponential rate. For example, between 1990 and 2010 wind power grew at a CAGR of 25.0 percent and solar at 11.4 percent, compared with a growth rate of slightly over 1 percent for traditional biomass (figure 3).

Focusing specifically on electricity, generation from renewable sources increased from 2,300 terawatt-hours (TWh) in 1990 to 4,160 TWh in 2010. More than 80 percent of all electricity generated globally from renewable sources was from hydropower. The increase

in generation from renewable sources is equivalent to the combined electricity production of Russia and India in 2010. Global electricity generation (from all sources) almost doubled in the 20-year period, growing from 11,800 TWh in 1990 to 21,400 TWh in 2010, which is equivalent to the combined electricity generation of China, the United States, and India in 2010. As of 2011, therefore, renewable energy sources accounted for more than 20 percent of global power generated. It also accounted for 25 percent of global installed power generation capacity and fully half of newly installed power generation capacity.

2. Nuclear energy is not considered renewable.

Figure 3. Sources of renewable energy have been growing at widely varying rates (compound annual growth rates, 1990–2010)



Source: IEA 2012.

“Africa and Asia have the highest shares of renewable energy, ranging from 20 to 60 percent. These shares declined significantly in 1990–2010, however, in part owing to decreased reliance on traditional biomass for cooking and wider adoption of nonsolid cooking fuels.”

How has energy production from renewable sources evolved historically?

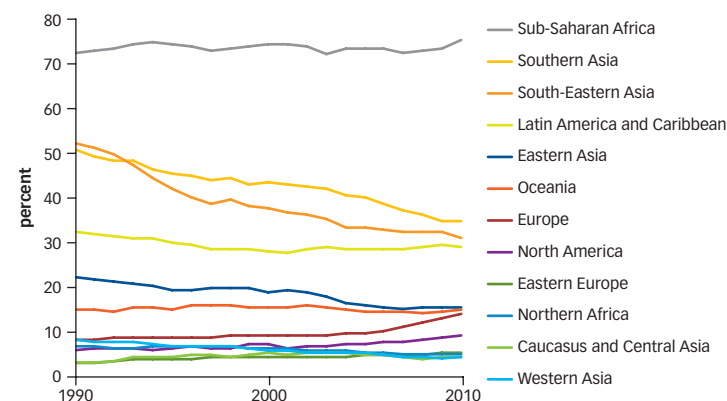
Consumption of modern forms of renewable energy are growing fast in the developed world

Looking across regions, it is striking that lower-income regions, such as Africa and Asia, have the highest shares of renewable energy, ranging from 20 to 60 percent. These shares declined significantly in 1990–2010, however, in part owing to decreased reliance on traditional biomass for cooking and wider adoption of nonsolid cooking fuels (figure 4). By contrast, higher-income regions such as Europe and North America present much lower shares of renewable energy (in the range of 10 to 15 percent), although those shares grew steadily over the two decades. Overall, Africa and Asia alone accounted for about two-thirds of global total final energy consumption of renewable energy in 2010, while Europe and North America together contributed about 20 percent (figure 5).

Almost 80 percent of renewable energy other than traditional biomass has been produced and consumed by high-income and emerging economies, most notably China, the United States, Brazil, Germany, India, Italy, and Spain (figure 6). The technology of focus differs from case to case, with China focusing mainly on hydropower; the United States on biofuels; Brazil, Germany, and India on modern

biomass; and Spain on wind power. Those countries moving most rapidly, such as China and Germany, experienced average annual rates of growth of 8–12 percent in 1990–2010. As of 2010, the countries with the highest shares of renewable energy (excluding traditional biomass) were Norway, Sweden, and Tajikistan, where the shares were about 50 percent (figure 7). It is promising that many

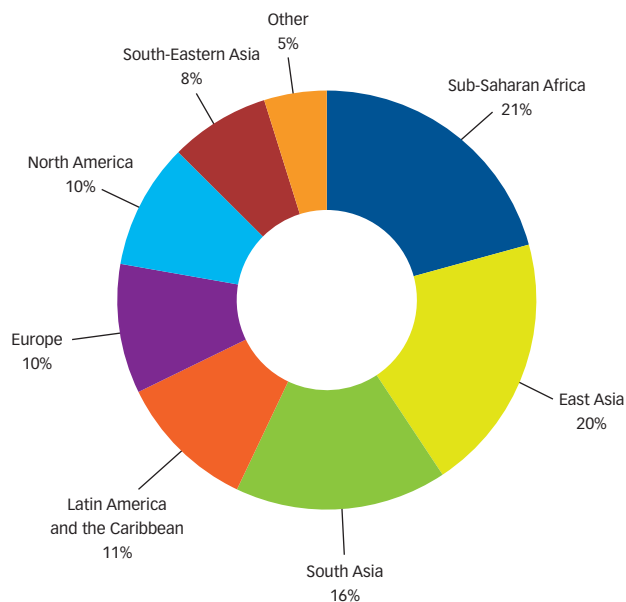
Figure 4. The share of renewable energy in total final energy consumption has varied greatly by region (1990–2010)



Source: IEA 2012.

"The technical potential for renewable energy use around the globe is substantially higher than projected global energy demand in 2050."

Figure 5. Africa and Asia accounted for about two-thirds of global total final energy consumption of renewable energy in 2010



Source: IEA 2012.

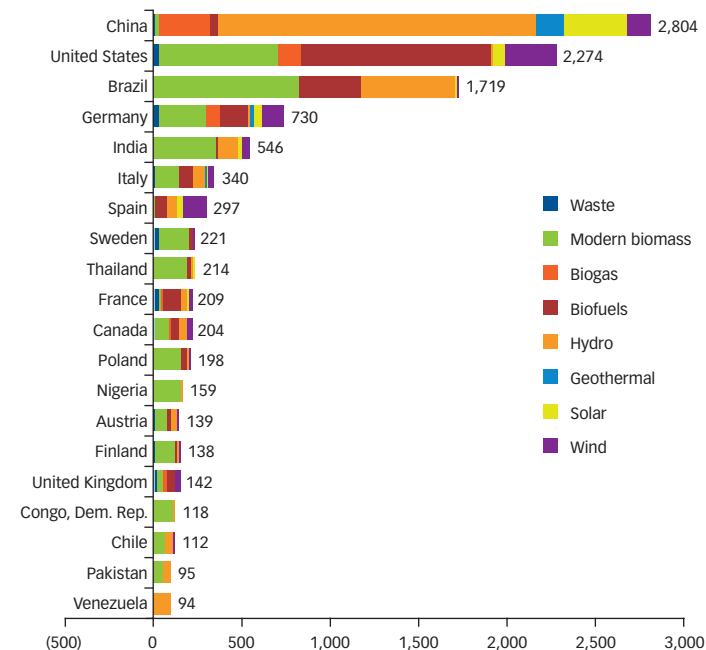
other emerging countries—among them Argentina, Mexico, Turkey, Indonesia, Philippines, and a few African countries—are starting to show progress in adopting policies to scale up renewables.

What will energy production from renewable sources look like in 2030?

With falling costs and great untapped potential, especially in the developing world, energy from renewable sources will be increasingly competitive and meet a growing share of global demand

Substantial potential exists for further tapping of renewable energy sources. Studies have consistently found that the technical potential for renewable energy use around the globe is substantially higher than projected global energy demand in 2050. The technical potential for solar energy is the highest among the renewable energy sources,

Figure 6. The largest consumers of modern renewable energy vary in the main forms consumed (petajoules of incremental consumption of renewable energy, excluding traditional biomass, 1990–2010)



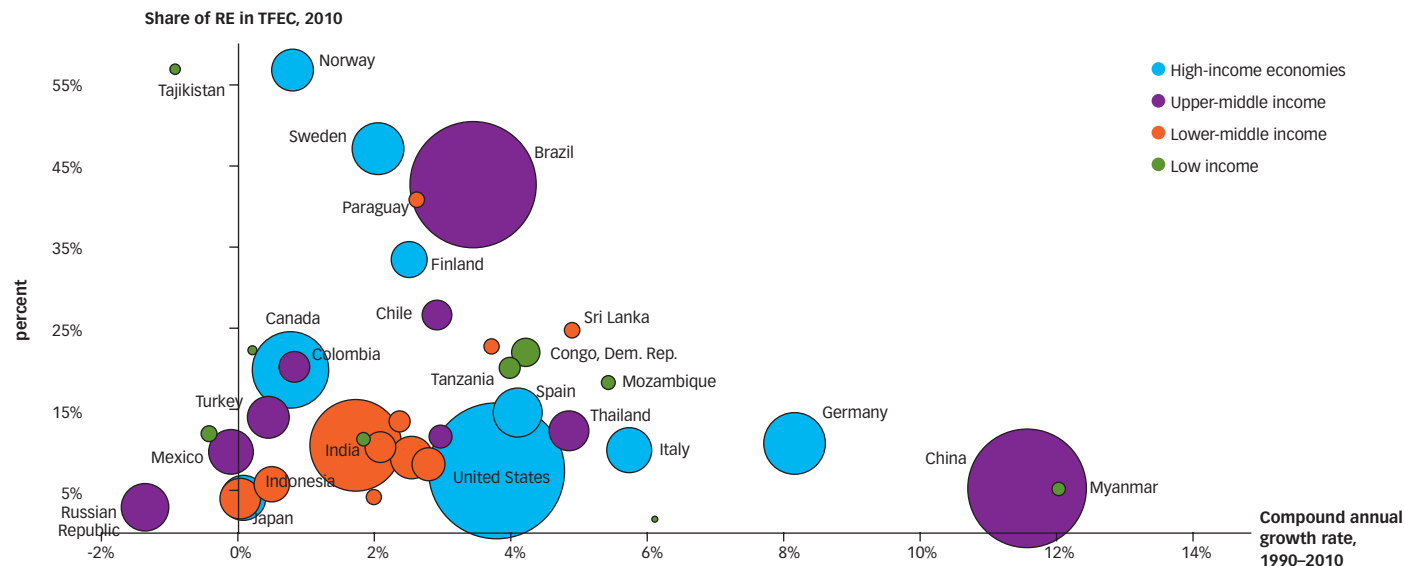
Source: IEA 2012.

Note: "Incremental consumption" indicates additional consumption of renewable energy over and above the level of consumption in 1990. Congo, Dem. Rep. = Democratic Republic of Congo.

but there is also substantial untapped potential for biomass, geothermal, hydro, wind, and ocean energy.

Available data suggest that most of this technical potential is located in the developing world. For example, at least 75 percent of the world's unexploited hydropower potential is found in Africa, Asia, and South America, and about 65 percent of total geothermal potential is found in countries that are not members of the Organisation for Economic Co-operation and Development (OECD). The solar belt—that is, the tropical latitudes that have the highest solar irradiance across the globe—endows many developing countries with a high potential for solar-based power generation and heating.

Figure 7. The world's largest energy users will have the greatest effect on achieving the SE4ALL renewable energy goal



Source: IEA 2012.

Note: TFEC = total final energy consumption; CAGR = compound annual growth rate; RE = renewable energy. Figure excludes traditional biomass, but includes the use of modern biomass. Congo and Tanzania appear because of their high use of modern biomass in the industrial sector. Negative CAGRs shown denote a reduction in the use of nontraditional solid biomass (most notably in industry) in Turkey, Mexico, and Indonesia. Unlabeled bubbles represent countries with a low share of RE in TFEC and a low CAGR.

“The costs of renewable energy—particularly wind and solar—have been falling steeply and are expected to fall further as the scale of production increases. As a result, renewable energy sources—in particular hydropower, wind, and geothermal—are increasingly competitive in many environments, while solar energy is becoming competitive in some environments.”

Despite the high potential for renewable energy, large-scale adoption will ultimately depend on economic factors. The costs of renewable energy—particularly wind and solar—have been falling steeply and are expected to fall further as the scale of production increases. As a result, renewable energy sources—in particular hydropower, wind, and geothermal—are increasingly competitive in many environments, while solar energy is becoming competitive in some environments. Nevertheless, it is still challenging for renewable energy to compete financially with conventional fossil-fuel alternatives, particularly given that the local and global environmental impact of these conventional sources of energy is not fully reflected in costs. The further integration of renewable energy sources into the public electricity supply system also calls for more proactive expansion of both transmission grids and back-up capacity for handling higher levels of variability in the production of wind and solar energy.

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