Fifteenth inventory
2013 edition

Worldwide electricity production from renewable energy sources

Stats and figures series

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1. Electricity production in the world: general forecasts

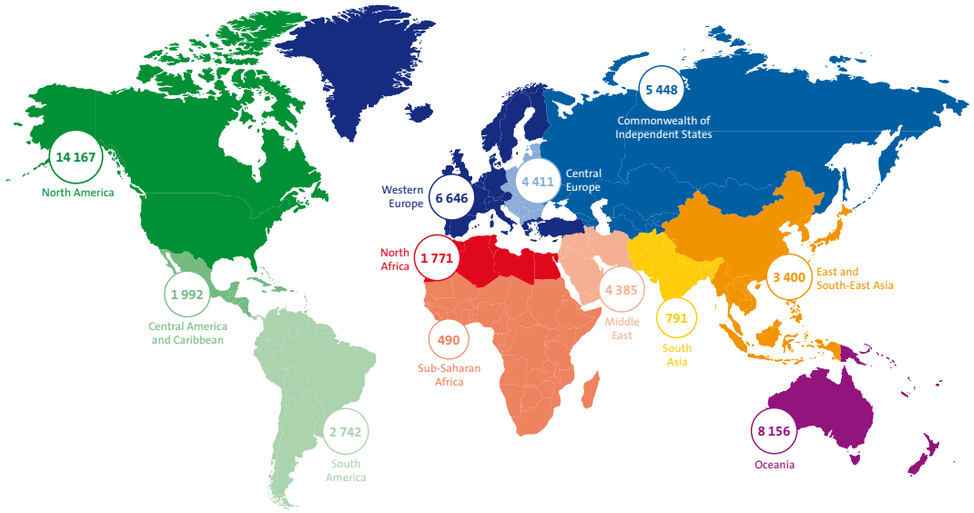
1.1. Economic development and the production of electricity

• Electricity production – a development indicator to be handled with caution

Electricity is an indispensable ingredient of economic development, and this goes for all countries. Its relative importance increases in relation to technical progress, industrialisation and the need for modern comforts. Increase in its production translates into better quality of life and the creation of wealth. A good indicator for measuring the differences in development between the various regions in the world is obtained by comparing per capita electricity output. North America has, as always, the highest per capita electricity production figure (14 167 kWh/cap). That is more than double Western Europe's production ratio (6 646 kWh/cap), more than three times that of Central Europe (4 411 kWh/cap), still more than four times that of East and South-East Asia (3 400 kWh/cap), eight times that of North Africa (1 771 kWh/cap) and almost thirty times that of Sub-Saharan Africa (490 kWh/cap).

However caution needs to be applied when using this indicator as it makes no sense to measure the level of development arithmetically, for in some regions, higher per capita output of electricity does not equate to a higher level of development. For example, per capita electricity output in the CIS (Commonwealth of Independent States) is almost twice as high as it is in South America (0.49 kWh per unit of GDP for the CIS compared to 0.26 kWh per unit of GDP for South America), but the per capita income in purchasing power parity terms in these two regions is very similar ($ 11 069/cap for the CIS compared to ($ 10 645/cap for South America).

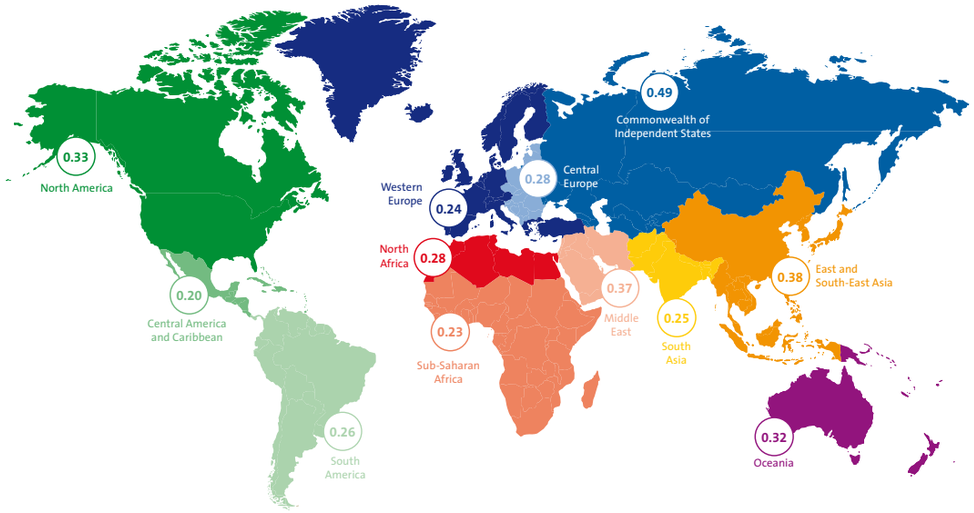
Electricity production per capita in the regions of the world in 2012 (kWh per capita)



The variations stemming from per capita electricity output not only reflect income disparities, they are also caused by differences in the electricity content of economic growth (i.e. the amount of electricity required to produce one unit of GDP). Electricity production may have quite different paths at comparable economic levels, because of richer primary energy resources, followed by geographical and historical considerations, the quality of established electricity infrastructures, the extent of the national grid, electricity imports or exports or even an economy based on sectors or technologies that make higher or lower demands of electricity. The price of electricity is another factor – it varies primarily in line with the country's fossil fuel resources (Middle-East, North Africa, Russia, Australia, China), its hydraulic potential (Brazil, Canada, Norway, Sweden), the size of its nuclear sector (France) or the political choice to subsidise the price of electricity to improve the competitiveness of the nation's industry.

Globally, 0.32 kWh is required to produce US$1 of added value (NB: constant 2005 dollars expressed as purchasing power parity), and this figure has been relatively constant over the past decade. There are wild disparities between the world's regions. The Central America and Caribbean region requires the least amount of electricity to create one unit of wealth (0.20 kWh/US$). This contrasts with the CIS which requires the most amount of electricity to create one unit of wealth (0.49 kWh/US$). Western Europe is one of the thriftiest regions in this respect (0.24 kWh/US$). East and South-East Asia, a highly industrialised region, is one of the regions that requires the most electricity to create one unit of wealth (0.38 kW/US$).

Electricity production per unit of GDP in the regions of the world in 2012 (kWh/$2005 ppp)



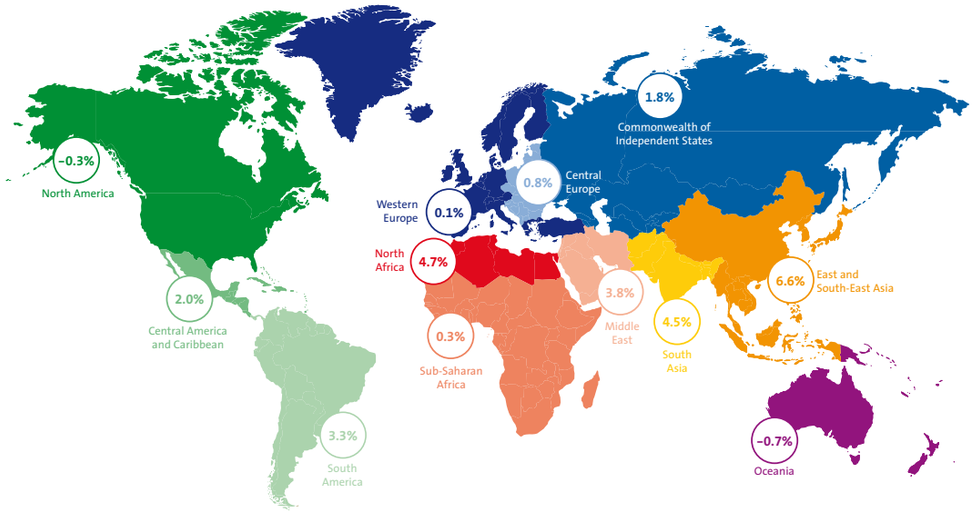
- **Per capita electricity output growth between 2002 and 2012 only slowing down in the post-industrial countries**

A dynamic analysis of electricity production distinguishes the developing regions where the per capita increase in electricity consumption is growing at the fastest rate, from those already-industrialised regions where the per capita increase in electricity consumption increase is lower. Annual per capita electricity output in the East and South-East Asia region is currently increasing at the fastest pace (by a mean 6.6%), followed by North Africa (by a mean 4.7%), South Asia (by a mean 4.5%) and the Middle-East (by a mean 3.8%).

Mean annual per capita increase in electricity output is almost stable in industrialised regions such as Western Europe (0.1%), and even slightly negative in North America (down by a mean 0.3% per annum) where concerted efforts being made to control energy consumption, and where an increasing proportion of manufactured goods are imported.

There are two reasons why the Sub-Saharan region is included in the group of regions where the annual per capita increase in electricity output is among the lowest (0.3%). The first is its very high demographic growth (the highest of all the regions in the world). The second is the presence of South Africa within its perimeter, which is a country with the characteristics of a developed country and that accounts for 65% of the region's electricity.

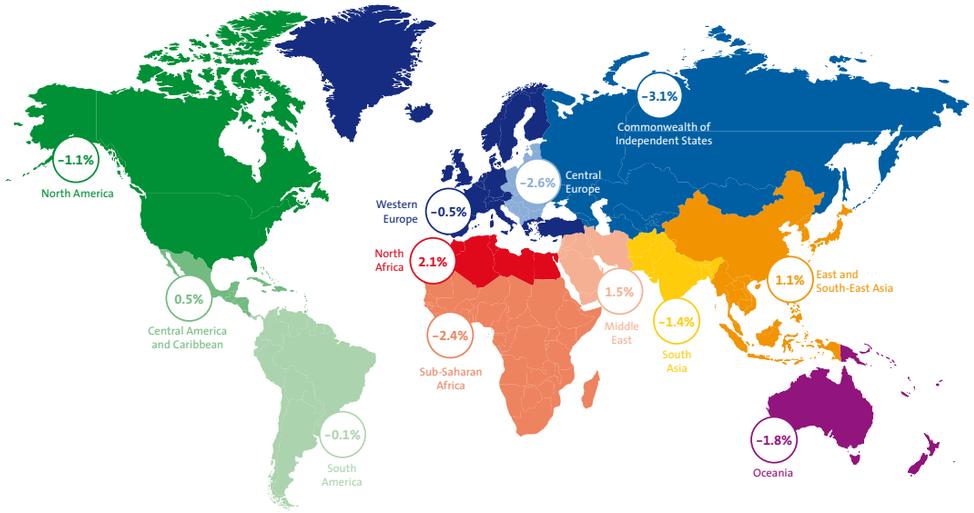
Growth in the per capita production of electricity in the regions of the world (mean annual growth rate, 2002–2012)



The creation of wealth and the electricity production trend across the world are fairly well correlated with a slight downward tendency. Electricity production per unit of GDP fell on average across the world by 0.3% per annum between 2002 and 2012. However this figure masks disparities between the post-industrial regions whose economic activity is in transition to service sectors that have lower electricity demands, and regions in the throes of intensive industrialisation driven by exports of manufactured goods for instance, that need more and more electricity to produce each additional unit of GDP. As developed countries move away from a purely production-based economy, electronic capital goods have to be made in countries undergoing rapid industrialisation, which heightens the disparities. In North America and Western Europe the tie-up between economic growth and electricity production is the most tenuous (shedding 1.1% and 0.5% respectively per annum on average), as these two regions are increasing their production of high added-value services that require little energy, and importing more and more industrial goods.

The CIS and Central Europe are special cases in point as the current restructuring of their ever less "energy-hungry" industrial and electricity sectors, has the effect of reducing the amount of electricity required to produce one additional unit of GDP (3.1% and 2.6% less per annum on average respectively). This contrasts with the Middle East, North Africa, East and South-East Asia and Central America, where the creation of each additional unit of GDP requires an increasing amount of electricity. East and South-East Asia (rising 1.1% per annum on average) and China, are prime examples undergoing booming industrialisation, which limits the influence of already industrialised countries such as Japan and South Korea.

Growth of electricity production per unit of GDP in the regions of the world (mean annual growth rate, 2002–2012)



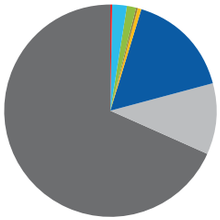
1.2. Electricity production from renewable sources

• More than 20% of global electricity production

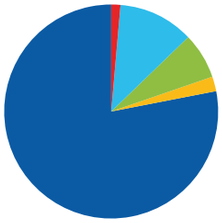
Renewable electricity production (pumped-storage plant output included) rose to 4 699.2 TWh in 2012 across the globe, taking the share past 20% of total output (20.8%). Fossil fuels remained the bedrock of global electricity production with more than two-thirds of the total (68.1% in 2012), and just over one out of every ten electrons (10.9%) was generated by nuclear fission. The remaining 0.2% was provided by the incineration of non-renewable waste.

There are six different sources of renewable electricity. Hydroelectricity (including pumped-storage plants) is the principle source with a 78% share in 2012. Wind power, the number two renewable energy source since 2009, accounts for 11.4% of the renewable total. It outperforms the biomass sub-sectors of solid biomass, liquid biomass, biogas and renewable household waste (that total 6.9%). They are followed by solar power with its photovoltaic and solar thermal power plants (2.2%), geothermal power (1.5%), and marine energies (0.01%), a sector that is in the demonstration phase.

Structure of electricity production – 2012



Structure of electricity production from renewable sources – 2012



World electricity production by source

TWh	2002	2009	2010	2011	2012	AAGR 02/12	GR 11/12
Geothermal	52.2	67.4	68.5	69.3	70.4	3.0%	1.5%
Wind	52.5	276.4	351.2	451.5	534.3	26.1%	18.3%
Biomass	147.1	246.8	288.9	307.6	326.2	8.3%	6.0%
solid biomass share	*108.3*	*173.9*	*207.0*	*218.9*	*232.5*	*7.9%*	*6.2%*
biogas share	*16.4*	*37.7*	*44.1*	*50.9*	*58.0*	*13.4%*	*13.8%*
liquid biomass share	*1.0*	*4.8*	*5.9*	*5.0*	*3.2*	*12.7%*	*–36.8%*
municipal waste share	*21.4*	*30.4*	*31.9*	*32.7*	*32.5*	*4.3%*	*–0.5%*
Non-renewable waste	40.5	40.1	52.0	55.7	56.0	3.3%	0.6%
industrial waste share	*19.6*	*12.7*	*23.7*	*25.5*	*25.9*	*2.9%*	*1.8%*
municipal waste share	*21.0*	*27.4*	*28.3*	*30.2*	*30.1*	*3.7%*	*–0.4%*
Solar	1.7	21.0	33.5	63.1	104.5	50.6%	65.5%
photovoltaic share	*1.2*	*20.0*	*31.8*	*60.8*	*100.4*	*55.9%*	*65.1%*
solar thermal share	*0.6*	*0.9*	*1.7*	*2.3*	*4.1*	*22.3%*	*77.5%*
Hydraulic	2 705.9	3 329.0	3 514.3	3 530.8	3 663.4	3.1%	3.8%
pumpig storage share	*79.6*	*76.0*	*78.4*	*75.7*	*74.4*	*–0.7%*	*–1.7%*
Marine energies	0.568	0.527	0.558	0.561	0.540	–0.5%	–3.7%
Nuclear	2 660.8	2 696.1	2 756.3	2 580.9	2 463.5	–0.8%	–4.5%
Fossil	10 512.4	13 500.7	14 422.7	15 113.0	15 394.3	3.9%	1.9%
Total renewable	**2 960.1**	**3 941.2**	**4 256.9**	**4 423.0**	**4 699.2**	**4.7%**	**6.2%**
Total conventional	**13 213.7**	**16 236.9**	**17 231.0**	**17 749.6**	**17 913.8**	**3.1%**	**0.9%**
Total production	**16 173.8**	**20 178.1**	**21 487.9**	**22 172.5**	**22 613.0**	**3.4%**	**2.0%**
Renewable share	***18.3%***	***19.5%***	***19.8%***	***19.9%***	***20.8%***		

Structure of electricity production from renewable sources in 2012

Source	TWh in 2012	% 2012
Hydraulic	3 663.4	78.0%
Wind	534.3	11.4%
Biomass	326.2	6.9%
Solar	104.5	2.2%
Geothermal	70.4	1.5%
Marine energies	0.540	0.01%
Total	**4 447.5**	**100.0%**

• In ten years renewable energy puts on 1 739 TWh

Gross renewable electricity production increased by 1 739 TWh between 2002 and 2012 (rising from 2960.1 to 4699.2 TWh), that equates to mean annual growth of 4.7%. Its growth rate was higher than that of fossil fuels (by a mean 3.9%). Its pace was also faster than that of conventional electricity (by a mean 3.1%) because of the contraction (by 197.3 TWh between 2002 and 2012) in nuclear power output.

Having increased slightly between 2010 (by 19.8%) and 2011 (19.9%), the renewable electricity share gained a percentage point in 2012 (20.8%), which is the fifth annual rise in a row (18.2% in 2007). If we leave aside 2007, which was a year of record growth for fossil-fuel electricity, the renewable electricity share has been on an upward trend since 2004 (from 17.9% in 2003 to 20.8% in 2012), namely almost a three percentage point rise in nine years. Therefore it can be confirmed that over the past decade renewable energies have consolidated their position in the global electricity production structure. Some further insight is required. While the renewable energy share has patently increased at world level, there are diverging trends at regional level. The share is increasing sharply in Western Europe through the combined share of wind power, biomass and solar power that was almost 12% in 2012 (compared to 10.5% in 2011). It is also increasing sharply in East and South-East Asia whose record hydropower contribution broke the 1 000 TWh barrier for the first time in 2012 (13.4% share in 2012 compared to 11.8% in 2011). The results of the world's other major regions are not so uniform. The renewable electricity share in the CIS is particularly vulnerable to hydropower output fluctuations. In South America, where renewably-sourced electricity production predominates, the share has contracted for the sixth year running. In North America, the green electricity share is increasing in stages. After increasing sharply in 2011, the share was stable in 2012.

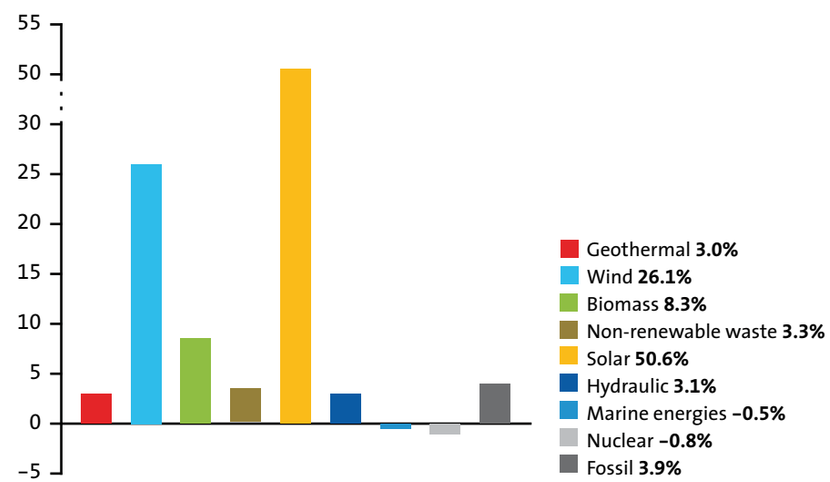
This powerful comeback by renewable electricity production was driven by the sharp increase in hydroelectricity production in Asia and the consolidated global spread of the other renewable sectors – primarily wind power, solar power and biomass.

• Growth of the renewable sectors five times faster than hydropower

For many years hydropower has been single-handedly fending off the relentless march of fossil fuels, but it is no longer alone. The implementation of new renewable electricity production technologies has been crucial in loosening the conventional electricity share's grip on the global total. At a mean annual rate of 15.1%, the growth of the renewable sectors excluding hydropower from 2002–2012 has been nearly five times as fast as that of hydropower (3.1%).
Thus, the renewable electricity share ignoring hydropower has picked up 3 percentage points in its share of global electricity production, rising from 1.6% of the total in 2002 to 4.6% in 2012. In contrast, the hydroelectricity share has lost 0.5 of one percentage point in the global total (from 16.7% in 2002 to 16.2% in 2012).
A detailed comparison of sector performance reveals that the best mean annual growth over the period was put in by solar power (50.6%), yet this figure is much lower than its growth between 2011 and 2012 (65.5%).

The wind energy sector also put on a very good showing over the period (averaging 26.1% per annum) but for the first time its pace dropped between 2011 and 2012 (to 18.3%). The blame lies with exceptionally low winds blowing across Western Europe where a major share of world capacity is concentrated.
The biomass sector grew at a more gentle pace (by a mean 8.3% per annum), but is still twice the total electricity production growth rate (by a mean 3.4% per annum). The upswing continued between 2011 and 2012 (6%), buoyed by an increasing number of coal-fired power plant conversions to biomass co-firing plants. Of the biomass segments, solid biomass (which generated 71.3% of all biomass electricity in 2012) increased by a mean 7.9% per annum. The growth of biogas electricity was much higher (13.4% per annum on average) because of the development of anaerobic digestion as a waste treatment process, and also the anaerobic digestion of energy crops (such as maize in Germany). The conversion of organic household waste into electricity in incineration plants also increased over the period (rising 4.3% per annum on average), although it stabilised between 2011 and 2012 (contracting by 0.5%). The growth of the liquid biomass segment was positive over the period (12.7% per annum on average), but it is clearly slowing down (it declined 36.8% between 2011 and 2012). In any case the segment is not really geared to electricity production but rather for the carburation of vehicles through the production of biodiesel, bioethanol or BTL fuels.

Mean annual growth rates 2002-2012



The geothermal sector, whose production is very localised, is a little more in the background as its mean annual growth over the period, at 3%, was less than that of total electricity production (3.4%).

Given the current momentum of the wind power, solar power and biomass sectors and the planned investments in hydroelectricity facilities, renewable electricity production growth should remain stay on course for the next few years and its share of global output should continue to rise.
Much of this capacity will be installed in Europe, North America, and also in Asia. In a few years' time China, which is already the top hydroelectricity producer, will probably become the top wind and solar power producer.

Renewably-sourced electricity production, excluding hydraulic (TWh)