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Electricity generation: very different capacity factors!

The US Energy Information Administration (EIA) has an interesting post on the huge differences between countries and origins of electricity generation efficiency, or more precisely the capacity factors.

1. Definition of the capacity factor and the "Volllaststunden".

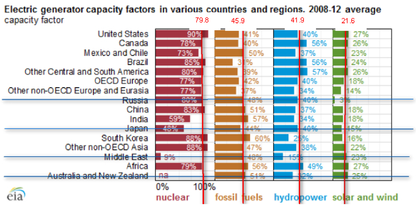
Let me recall that the capacity factor is simply the yearly energy produced divided by a hypothetical maximum which would have been produced if the generator had functioned 8760 hours at its the name plate capacity. An example: suppose a wind turbine has a nam capacity of 2.5 MW; if it would deliver this power during the year (what is clearly impossible!), it would produce an energy of 2.5*8760 = 21900 MWh. Now its real production has been only 4380 MWh. So the capacity factor is:

CF = 4380/21900 = 0.20 which is often given as a percentage by multiplying by 100, i.e. here CF%= 20%.

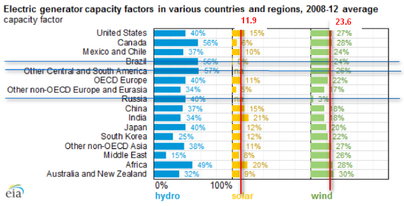
In Germany one uses mostly the term "Volllaststunden" (yes, you can write this using 3 letter l). The VS would be equal in our example to VS = (CF%)*8760/100, i.e. 1752 hours.

2. Capacity factors vary with type of electricity generation and country

The IEA report has several interesting statistics which give the capacity factors of different countries and regions for the period 2008 to 2012. I modified the first table by discarding 4 countries or regions: Russia, because its quasi nonexistent wind/solar production, Japan, because its shutdown of all its nuclear reactors after the Fukushima accident, the Middle East because it has only negligible nuclear electricity production, and Australia/New Zealand for the same reason. That leaves 12 countries or regions with the following statistics:



The vertical red lines give the average capacity factors of the different types of production: nuclear is the absolute champion with 79.8%, fossil and hydro are close at 45.9% and 41.9%, and solar/wind come out very low at 21.9%. If we call "renewables" the last two categories, clearly hydro is the only one delivering acceptable capacity factors. Now lets separate the last category into solar and wind. This time one can keep 13 countries or regions, omitting only Brazil, Central/South America and Russia for not having (or having communicated) any solar production.



Solar comes out at an abyssal low CF of 11.9%, whereas wind practically doubles with CF=23.6%

Our first conclusion comes as no surprise: nuclear really shines when it comes to availability and stability; both solar and wind can not deliver (at least for the moment) a reliable electricity production!

3. Why the big differences?

In most countries, solar and wind have an absolute priority to deliver their electricity into the grid, penalizing the non-renewables which must be turned down to adapt production to demand. If that political decision would not exist, and the free market rules would apply, solar and wind production would have still lower capacity factors. Regarding hydro, one clearly sees that countries like Canada and Brazil have a clear advantage in disposing of enormous hydro potential, which may have reached its peak for many reasons. The OECD hydro electricity production is practically at its maximum, so the CF of 40% will be impossible to increase in the future.

Fossil producers suffer the most from the prioritizing of solar and wind: nuclear facilities are difficult to rapidly ramp down or up, but gas turbines (and even some of the latest coal power stations) can do this quite easily, and so are often used to deliver peak load. Often a certain type of generation is put on hold for commercial reasons, so the capacity factors must be taken with a grain of salt: they not only reflect technical deficiencies or for instance lower wind resource, but also ramp down/up decisions taken at the big electricity exchanges (as the EEX at Leipzig) for monetary reasons.

Now the 100 billion dollar question: if you want carbon free electricity, which type of generation would you choose?

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added 14 Oct 2015:

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