European Commission

Science for Environment Policy

3 December 2015
Issue 438

Subscribe to free weekly News Alert

Source: Deng, Y.Y., Haigh, M., Pouwels, W., Ramaekers, L., Brandsma, R., Schimscar, S., Grözinger, J. & de Jager, D. (2015). Quantifying a realistic, worldwide wind and solar electricity supply. *Global Environmental Change*. 31: 239-252. DOI: 10.1016/j.gloenvcha.2015.01.005

Contact:
y.deng@ecofys.com

Read more about:
Climate change and energy, Environmental technologies, Land use

Realistic renewable energy exceeds 2070 electricity needs in most countries

Wind and solar energy are effectively limitless resources, but construction of renewable power must compete for a finite amount of land. This study uses a constrained assessment of available land to see whether global energy demand could be fully met by renewable sources. The analysis predicts that by 2070, the world could produce between 730 and 3700 exajoules of electricity per year (EJ/a[1]) from renewable power, which, even at lowest available land estimates, could meet 2070 electricity needs in most countries.

Renewable power sources are increasingly incorporated into policy frameworks for future energy security. However, most projections of energy potential assume no resource limitations for wind or solar energy, or apply estimates of full technical potential. By contrast, this study estimated the amount of suitable land worldwide for solar and wind power and applied realistic technical and non-technical constraints.

The team used geographic information system (GIS) data to measure suitable space for land and sea-based technologies at a resolution of 1km^2. They then successively excluded areas based on a range of limitations, including acceptance, cost, competition with other land use, ecosystem protection, elevation, technological development, grid connection or remoteness, and societal factors.

To obtain values for the final useful electric energy, the researchers also considered the intensity of the energy resource, the conversion efficiency of the harvesting technology, and the costs of connecting to the nearest electricity line infrastructure. They also factored in how technological progress is expected to increase energy output over time. For example, solar power is anticipated to show the greatest changes in technological progress, and an increase in module efficiency from 16% today to 35% in 2070 was incorporated.

The researchers also incorporated urban solar power by calculating available space on roofs and facades for photovoltaic (PV) panels, based on building floor area.

Of a total of 146 x 10^6 km^2 of (non-ice covered) suitable land, less than 5 x 10^6 km^2, or 3.5%, was deemed available for renewable power after exclusions. Offshore, less than 10 x 10^6 km^2 remained available for sea-based technologies. For urban PV, 62 x 10^3 km^2 of urban space was available based on figures from 2010, rising to a predicted 169 x 10^3 km^2 by 2070.

However, the proportion of the available land that could be used depends on societal attitudes towards renewable energy in the future, as well as economic competition with other land uses. To incorporate this uncertainty, the researchers developed three potential capacity scenarios based on low, medium and high space usage for renewable energy generation. Each scenario was used to work out total energy production for three time periods: the base year 2010, 2030 (for short-term potential), and 2070 (for long-term potential).

Overall, the analysis showed that global capacity to generate renewable power is large. The total long-term potential for renewable electricity onshore, offshore and on buildings is calculated to be between 730–3700 EJ/a, depending on the availability case. An estimated additional potential of 50–110 EJ/a could be contributed by geothermal and hydroelectricity.

As building-based PV could contribute as much as a third of overall solar power and does not require additional land, the researchers recommend focusing support policies in this area.

The researchers acknowledge that constraints will vary between countries and regions. An analysis of 12 world regions indicated that some regions, such as North Africa and the Americas, have more than enough land and offshore space to meet national demand. Other regions, like Europe and parts of Asia, are more constrained. However, using the medium space usage scenario, the analysis suggested that by 2080, between 60–90% of the world's population could live in countries that are self-sufficient in renewable electricity.

Continued on next page.

1. One exajoule equals 10^{18} joules.

3 December 2015
Issue 438

Subscribe to free weekly News Alert

Source: Deng, Y.Y., Haigh, M., Pouwels, W., Ramaekers, L., Brandsma, R., Schimscar, S., Grözinger, J. & de Jager, D. (2015). Quantifying a realistic, worldwide wind and solar electricity supply. *Global Environmental Change*. 31: 239-252. DOI: 10.1016/j.gloenvcha.2015.01.005

Contact:
y.deng@ecofys.com

Read more about:
Climate change and energy, Environmental technologies, Land use

European Commission

Science for Environment Policy

Realistic renewable energy exceeds 2070 electricity needs in most countries *(continued)*

Overall, in 2010 the global electricity demand was 65 EJ/a, and the researchers report expert projections that this demand may increase by a factor 2–5 by 2050. Even in the low space usage scenario, the researchers found renewable energy could meet global electricity demand in 2070.

The researchers note their results for the potential of individual technologies fall within the ranges of the IPCC's Special Report on Renewables (SRREN). However, they estimated a much larger potential in off-shore wind by incorporating innovative technologies, such as floating turbines. By going beyond the typical depths of ~40 m used in other estimates, they estimate that 85% of wind power potential could occur at depths over 200 m, representing around 160–550 EJ/a.

The researchers say that their study highlights the importance of assessing the overall availability of land, rather than the expected development of more efficient conversion technology, as availability carries the largest uncertainty. These findings should help policymakers understand the potential contribution of wind and solar power to long-term energy systems policy.