Transformation to wind and solar achievable with low indirect GHG emissions

December 11 2017

Different low carbon technologies including wind and solar energy, and fossil carbon capture and sequestration (CCS) differ greatly when it comes to indirect greenhouse gas emissions in their life cycle. This is the result of a comprehensive new study conducted by an international team of scientists, now published in the journal *Nature Energy*. Contrary to some arguments, the researchers found that wind and solar energy are more favorable when it comes to life-cycle emissions. They also show that a full decarbonization of the global power sector by scaling up these technologies would induce only modest indirect greenhouse gas emissions—and hence not impede the transformation towards a climate-friendly power system.

"Both fossil and non-fossil power technologies still come with a certain amount of greenhouse gas emissions within their life cycle—on the one hand, because constructing and operating them requires energy. On the other hand, because of methane emissions, e.g. from coal and gas production," explains lead author Michaja Pehl. "However, we found there are substantial differences across technologies regarding their greenhouse gas balance. Electricity production from biomass, coal, gas and hydropower, for instance, induces much higher indirect greenhouse gas emissions than nuclear electricity, or wind and solar-based power supply."

With their study, the researchers provide an innovative and comprehensive global analysis of embodied energy use and indirect greenhouse gas emissions from all relevant power sector technologies.

For the first time, their study combines the strengths of simulations based on integrated energy-economy-climate models that estimate cost-optimal, long-term strategies to meet climate targets with life cycle assessment approaches. So far, these research branches have operated separately. Exploring the life cycle emissions of future low-carbon supply systems and the implications for technology choices, they found that fossil power plants equipped with CCS will still account for life-cycle emissions of around 100 grams of CO_2-equivalents per kWh of electricity produced, 10 times more than the around 10 grams of CO_2-equivalents for wind and solar power they project for 2050 in a climate protection scenario in which power production is almost completely decarbonized.

Wind and solar provide a much better greenhouse gas emissions balance than fossil-based technologies

"There is no such thing as truly clean coal. Conventional coal power currently comes with around 1000 grams of CO_2-equivalents per kWh. Capturing CO_2 from coal plants can reduce emissions per kWh by around 90 percent, but substantial life-cycle greenhouse gas emissions remain," says Gunnar Luderer, energy system analyst from PIK and project leader. "To keep global warming below 2°C, however, virtually carbon free electricity is necessary. This makes it increasingly implausible that coal power will play a major role in the future, even if equipped with CO_2 scrubbers."

"When it comes to life cycle greenhouse gas emissions, wind and solar energy provide a much better greenhouse gas balance than fossil-based low carbon technologies, because they do not require additional energy for the production and transport of fuels, and the technologies themselves can be produced to a large extend with decarbonized electricity," states Edgar Hertwich, an industrial ecologist from Yale University who co-authored the study. Due to technological innovation,

less energy will be needed to produce wind turbines and solar photovoltaic systems.

"Some critics have argued renewable energies could come with high hidden greenhouse gas emissions that would negate their benefits to the climate. Our study now shows that the opposite is true," concludes Luderer. "During the transition to clean power supply, the additional life-cycle emissions for building up wind and solar capacities are much smaller than the remaining emissions from existing fossil power plants before they can finally be decommissioned. The faster the low-carbon transformation of power supply is accomplished, the lower is the overall remaining carbon burden for the climate."

More information: Michaja Pehl et al, Understanding future emissions from low-carbon power systems by integration of life-cycle assessment and integrated energy modelling, *Nature Energy* (2017). DOI: 10.1038/s41560-017-0032-9

Provided by Potsdam Institute for Climate Impact Research