Intermittence of wind energy hardly affects CO2 emissions in Spain

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Researchers at the UPM have found that real contribution to emissions targets is positive even in energy markets with high penetration of wind energy.

The finding has generated the first comprehensive analysis on interaction between wind parks and thermal power plants in Spain and has concluded that global balance of CO2 reduction is still significant. Besides, the study suggests how to enhance effectiveness of potential sources that can be helpful for promoters of renewable technologies.

Renewable energy is capable of replacing fossil fuels and to reduce emissions dramatically. However, the fuel economy and emissions in electrical systems established are not proportional to the generation of intermittent sources due to the "cycling" of thermal plants that provide the balance to the network.

"Cycling" is related to the changes produced by gas or carbon plants for diverse reasons including renewable generation resulting in spending more fuel per MWh. Therefore, intermittence of wind energy can affect negatively the expected reduction of emissions because even still replacing each MWh of energy, they are not lowered in equal proportion that when efficiency decreases at partial loads.

Certain reports bring into question even if wind energy supported by traditional thermal energy could produce more emissions than the most efficient gas plants operating by themselves. Those debates highlight the

independent analysis of the electrical system, overall countries with high penetration of wind energy aiming to clarify their real contribution to emission targets.

Thus, researchers at the School of Industrial Engineering have studied the interaction between wind production and thermal plants in Spain by establishing the extra consumption of fuel in affected units, they assessed all the combustion plants in 2011 by observing scenarios where wind power caused relevant drifts in their programmes and by defining a procedure to quantify the CO2 reduction based on emission factors and efficiency curves of the functioning facilities.

The Spanish Electric Network aims to use the highest renewable energy production by ensuring the reliability of their facilities in the same way that they publish detailed data of analysis.

In general terms, the low factors of use of gas and carbon technologies have indicated that they are not used strongly as a base load. Researchers studied real scenarios without wind in the relative to generation of 36 carbon plants (10.8 GW) and 51 gas plants (25.6 GW) that are the major thermal potential installed in Spain. Thanks to the net production of each installation we can calculate the fuel ratio of diverse charge regimens which are multiplied by nominal factors to obtain total emissions.

The results, along with data of 2011, show lower emissions when wind power generation replaces the conventional power, but with a decreasing slope indicating that reductions are not equivalent: every wind MWh introduced in the network allows us to avoid all the CO2 of each displaced thermal MWh at a low penetration. When penetration levels are as high as 50%, the wind effect is accumulative and reductions would reach just 80%. However, this reduction is still significant and there are no negative cases as mentioned by other reports.

Finally, the report suggests some recommendations to enhance the effectiveness of potential sources such as modeling, management of electric systems or energy storage. Promoters of renewable technologies must be aware of the issues derived from their integration in the electrical network, in a way that the leadership shown so far in the early stages of transition of fossil energies should orientate searching for solutions accordingly to the European targets for the future of sustainable energy.

The report was conducted within the ERMA Master (UPM) and was presented at The Sustainable Energy and Environmental Protection conference (SEEP 2012, Dublin) and published on *Energy Journal* (2013).

More information: Gutierrez-Martin, F. et al. Effects of wind intermittency on reduction of CO2 emissions: The case of the Spanish power system, *Energy* (2013). dx.doi.org/10.1016/j.energy.2013.01.057

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