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Use of meteorological information in the risk analysis of a mixed wind farm and solar power plant portfolio

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The renewable energy industry has rapidly developed during the last two decades and so have the needs for high quality comprehensive meteorological services. It is, however, only recently that international financial institutions bundle wind farms and solar power plants and offer shares in these aggregate portfolios. The monetary value of a mixed wind farm and solar power plant portfolio is determined by legal and technical aspects, the expected annual energy production of each wind farm and solar power plant and the associated uncertainty of the energy yield estimation or the investment risk. Building an aggregate portfolio will reduce the overall uncertainty through diversification in contrast to the single wind farm/solar power plant energy yield uncertainty. This is similar to equity funds based on a variety of companies or products.

Meteorological aspects contribute to the diversification in various ways. There is the uncertainty in the estimation of the expected long-term mean energy production of the wind and solar power plants. Different components of uncertainty have to be considered depending on whether the power plant is already in operation or in the planning phase. The uncertainty related to a wind farm in the planning phase comprises the methodology of the wind potential estimation and the uncertainty of the site specific wind turbine power curve as well as the uncertainty of the wind farm effect calculation. The uncertainty related to a solar power plant in the pre-operational phase comprises the uncertainty of the radiation data base and that of the performance curve. The long-term mean annual energy yield of operational wind farms and solar power plants is estimated on the basis of the actual energy production and it's relation to a climatologically stable long-term reference period. These components of uncertainty are of technical nature and based on subjective estimations rather than on a statistically sound data analysis.

And then there is the temporal and spatial variability of the wind speed and radiation. Their influence on the overall risk is determined by the regional distribution of the power plants. These uncertainty components are calculated on the basis of wind speed observations and simulations and satellite derived radiation data. The respective volatility (temporal variability) is calculated from the site specific time series and the influence on the portfolio through regional correlation.

For an exemplary portfolio comprising fourteen wind farms and eight solar power plants the annual mean energy production to be expected is calculated, the different components of uncertainty are estimated for each single wind farm and solar power plant and for the portfolio as a whole. The reduction in uncertainty (or risk) through bundling the wind farms and the solar power plants (the portfolio effect) is calculated by Markowitz'

Modern Portfolio Theory. This theory is applied separately for the wind farm and the solar power plant bundle and for the combination of both. The combination of wind and photovoltaic assets clearly shows potential for a risk reduction. Even assets with a comparably low expected return can lead to a significant risk reduction depending on their individual characteristics.