ALLOCATION OF RENEWABLE GENERATION FROM AN ENERGY PORTFOLIO

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Overview
The aim of this research is to demonstrate whether an optimal spatio-temporal allocation of renewable energy production could reduce the volume of electricity produced and sold through the balancing market [1].

Methods
We introduce a simplified model for the power output of renewable energy sources with tunable Gaussian correlated fluctuations and analyze the economic and emission impact of production fluctuations via Modern Portfolio Theory analysis, introduced by Markowitz [2]. We show how – depending on the correlation patterns – a careful geographical allocation of renewal energy sources can reduce both the amount of energy needed for balancing the power system and its uncertainty.
We then introduce an extended framework that allows for the optimization of a non-Gaussian portfolio of renewable energy sources whose production follows either historical weather datasets or synthetic time-series stochastic models. Analysis of time series [3] together with such enriched frameworks allows for the analysis of multiple realistic renewable generation scenarios for the optimal size and spatial allocation of future energy storage facilities.

Results
We indicate how an optimal spatio-temporal allocation of renewable energy production could reduce the size of the electric power balancing market with the consequences of:

- reducing the stress and the congestion on the power grids
- maximizing their output by avoiding curtailment
- lowering average energy prices on balancing markets
- reducing the indirect carbon footprint of renewable sources
- optimizing the hours of operations of renewable and conventional energy sources

Conclusions
With the inclusion of investment and operative costs of renewable generation and related infrastructures (together with a 5-10 years forecast of trends in electricity demand), the above-mentioned framework can also be adopted as a tool to guide regulators, energy policies, and utilities in order to:

- focus the development of non-programmable renewable resources towards the most effective locations
- minimize the amount of subsidies to renewable generative capacity necessary to reach a given emission reduction goal
- improve the attractiveness of investment in subsidized renewable generation by avoiding overcapacity and extending per-unit generation hours
- provide incentives for the retirement of older and less efficient traditional power generation held for reserve
- optimize the size and spatial allocation of future energy accumulation facilities
- allocate a larger share of public funding for smart infrastructure upgrades and research & innovation activities
- allow utilities to develop business models tailored according to the local distribution of renewable sources and storage systems

References
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