UNIVERSITY OF CAMBRIDGE
Electricity Policy Research Group

Optimal Wind Power Deployment in Europe – a Portfolio Approach

EPRG Working Paper EPRG0911

Fabien Roques, Céline Hiroux, Marcelo Saguan

Geographic diversification of wind farms can smooth out the fluctuations in wind power generation and reduce the associated system balancing and reliability costs. Conventional investment–planning models lack the capability to represent the intermittent nature of renewable and the impact of correlations in wind power output on total wind portfolio output and variability. This paper introduces a new modelling approach - Mean Variance Portfolio Theory - borrowed from the financial literature which captures the benefits of geographical diversification of wind farms to reduce output variability. The paper uses historical wind production data from five European countries (Austria, Denmark, France, Germany, and Spain) and applies Mean-Variance Portfolio theory to identify cross-country portfolios that minimize the total variance of wind production for a given level of production.

Theoretical unconstrained portfolios show that countries (Spain and Denmark) with the best wind resource or whose size contributes to smoothing out the country output variability dominate optimal portfolios. The methodology is then elaborated to derive optimal constrained portfolios taking into account national wind resource potential and transmission constraints and compare them with the projected portfolios for 2020. Such constraints limit the theoretical potential efficiency gains from geographical diversification, but there is still considerable room to improve performance from actual or projected portfolios.

Although highly simplified, our modelling approach provides a number of interesting insights relevant to the current policy debate. We find that projected portfolios for 2020 for the five European countries are far from the efficiency frontier representing optimal cross-country portfolios, suggesting that there could be large benefits in a more coordinated European renewable deployment policy providing incentives for location of new wind farms so as to maximise the efficiency of the overall European wind portfolio.

E·S·R·C ECONOMIC & SOCIAL RESEARCH COUNCIL

UNIVERSITY OF CAMBRIDGE
Electricity Policy Research Group

These findings are relevant to the current policy debate on the burden sharing of the European Commission renewables deployment targets to 2020, and suggest that the national deployment targets should take into account the benefits arising from geographical diversification, as well local wind resource constraints. Our findings suggest that there would be large system efficiency gains in a flexible approach to national deployment targets by putting in place a mechanism for renewable credit trading across countries.

Second, our results demonstrate how optimal cross-country wind portfolios differ depending on whether the focus is on minimising overall wind power volatility or whether the focus is on maximising the contribution of wind power to system reliability during peak hours. These two objectives can be interpreted respectively as minimising system balancing costs or maximising the contribution of wind power to system reliability. Policy makers should therefore consider which objective is more relevant for wind power development across Europe and orientate support policies in order to drive investment toward efficient geographical location of wind farms.

Finally, coordinating national renewables support schemes is critical to create a level playing field that would lead investors to integrate the portfolio effects associated with locational aspects in the deployment of wind power. This in turn would require renewable support schemes that make a link between revenue and electricity market price in order to give incentives to portfolio improvements (e.g. green certificates, premium, etc.), provided that electricity market design incorporates locational pricing. More ambitious policies could also consider introducing some locational incentives in the European coordinated support schemes, such as for example a feed-in-tariff (or premium) with a locational component that would integrate geographic portfolio optimisation benefits, or a European green certificates trading scheme which would integrate these geographic portfolio effects.

Contact fabien.roques@cantab.net
Publication March 2009
Financial Support French Energy Council and R2DS