

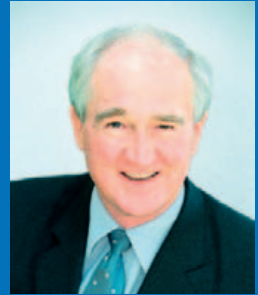


Wind Provides Competitive Advantage for Scotland

A Report on Scotland's Electricity Mix

Forward

It has never been more important to understand the facts about the true cost of energy. Decisions based on these facts will shape the competitiveness of our economy for the next 25 years. To improve our understanding, I am delighted to bring to your attention important new research which demonstrates that increasing the proportion of Scotland's electricity generated from wind will mean an overall reduction in Scotland's future electricity bill. Commissioned by Airtricity, one of Scotland and Europe's leading renewable energy companies, the study has been compiled by Dr Shimon Awerbuch, Senior Fellow of SPRU Energy Research Group, University of Sussex. His research has overturned many previously held assumptions about the optimal electricity generation mix. Dr Awerbuch's work shows that by taking account of the relative risk of different generating technologies, adding more wind (even though it is more expensive than some gas technologies) to the total generation portfolio will actually reduce the overall cost of Scotland's electricity, to the benefit of all Scottish businesses and consumers. His work demonstrates that failure to fully exploit Scotland's wind resource will actually add cost and increase future electricity prices.



By considering Scotland's electricity generation as a mix, or portfolio of different generation technologies, Dr Awerbuch's analysis shows us that:

- Scotland can reduce its energy costs by increasing the share of wind generation in the portfolio.
- Failure to fully exploit Scotland's wind resource will raise the cost and risk of energy generated in Scotland.
- Even though wind generation, as a *stand-alone* product, is more expensive than Combined Cycle Gas Generation, when mixed in a portfolio of generation products, it reduces risk and cost.
- The addition of wind diversifies the electricity generation mix and improves security of supply.
- Given the depth and strength of Scotland's wind resource, it delivers competitive advantage to Scotland relative to all its European neighbours.
- Offshore wind, which is more expensive than onshore wind, can rise to 10% of total generation in Scotland by 2010 without raising overall costs or risk.

This brochure summarises a more in-depth report on this important work from Dr Shimon Awerbuch. The full version of the report is available on our website (www.airtricity.com). I hope you will find this report informative, revealing and relevant to Scotland's debate on the competitiveness and security of its future energy supply.

A handwritten signature in black ink, appearing to read 'Eddie O'Connor'.

Eddie O'Connor
Chief Executive, Airtricity

Increased Wind Generation reduces Scotland's Energy Costs

This study uses portfolio theory to demonstrate that **increasing the share of wind reduces Scotland's expected electricity costs**. Such an outcome is consistent with modern portfolio theory widely used by investors to manage risk and maximise asset performance under a variety of unpredictable economic outcomes.

Wind and other renewables provide clean electricity. They offer an effective mechanism for climate change mitigation along with enhanced energy supply security. Yet, policy makers are concerned that increasing the deployment of wind will raise electricity-generating costs. Much to its credit, the Scottish Executive is pushing forward on the adoption of wind and other renewables in spite of perceptions that they cost more. Although the idea that adding a potentially more costly technology to the generation mix will raise overall generating cost may seem obvious and compelling, it does not hold.

Wind generating costs do not correlate or 'co-move' with fossil prices. Wind helps diversify the generating mix and improves its cost-risk performance the way diversification improves the expected performance of a financial portfolio. Year-to-year, the operating costs of a generating mix containing 30% wind will fluctuate significantly less than a mix comprising 100% fossil fuel generation.

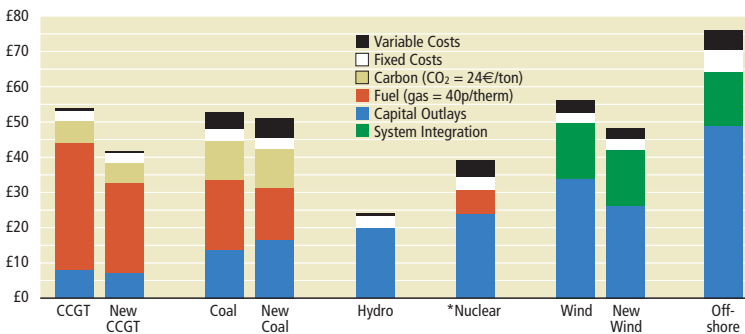
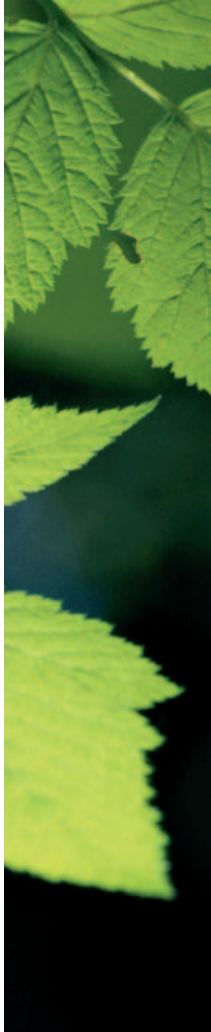


Figure 1: New Entrant Costs – 'Outlook Gas' Scenario

Based on Credit Suisse First Boston, 2005

*Nuclear does not include the cost of decommissioning

Contrary to traditional approaches, portfolio optimisation techniques do not focus on *stand-alone* cost. Rather, they evaluate a generating alternative on the basis of its *portfolio cost* – its cost contribution to the generating portfolio relative to its risk contribution. At any given point, some options in the portfolio cost more and others less, yet over time, the astute combination of resources





serves to minimise overall expected generation cost relative to their risk. Deploying wind improves Scotland’s generating mix (even under the assumption that wind costs more than other alternatives). **Wind reduces overall generating costs while enhancing energy security.**

Implications for Scotland’s Capacity Planning

The Scottish portfolio analysis examines several scenarios, using a highly cautious set of assumed wind generating costs that include system integration charges (Figure 1). The optimised results are compared to the 2010 Scotland generating mix projected by National Grid Transco, (NGC). The NGC-2010 *Business as Usual* mix has an expected risk¹ of 4%, and overall generating cost of £47.5 per MWh (4.75p/kWh). It includes 23% onshore wind and no offshore wind.

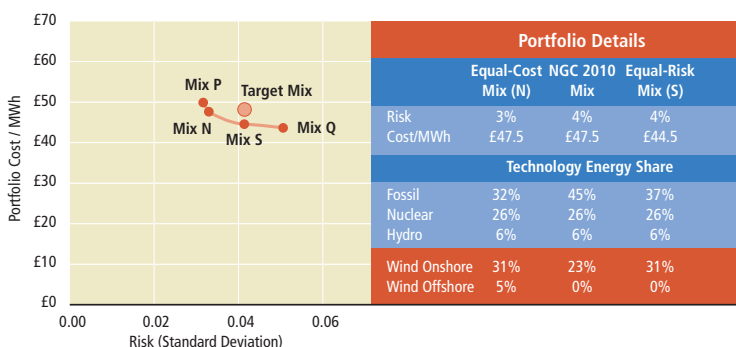


Figure 2: Scotland Generating Portfolios Under an 'Outlook Gas Scenario'

Figure 2 also shows two optimised solutions: an *Equal Cost* mix, which exhibits the same expected cost as NGC Mix but has lower risk, and an *Equal Risk* Mix (same risk, lower cost). **The equal-cost mix (Mix N) reduces risk by 25% while it raises wind shares from 23% to 36% of total generation.**

Mix S, the equal-risk mix, reduces generating cost by 6% relative to the NGC mix, from £47.5 to £44.5 per MWh, while raising the wind share to 31% onshore, with no-offshore wind². These results suggest that without raising expected cost or risk, onshore wind can be increased to at least 31% of electricity generation – that’s 50% more than the NGC mix and nearly 75% above the Scottish Executive’s 2010 targets.

¹ Risk is measured as the statistical *standard deviation* of annual rates of change

² Onshore wind is constrained to 31% of total generation, which represents half of Scotland’s total onshore wind resources.



Other optimised mixes (Table 1, below) show that in spite of its high assumed cost, **offshore wind shares can rise to as much as 10% of total generation (Representing 2 GW of capacity) without increasing cost.** Given the high degree of uncertainty about future energy prices, the relative value of generating technologies must be determined not by evaluating alternative resources, but by evaluating alternative resource portfolios.

No Regrets

If natural gas prices remain in the range of 40p/per therm, as the futures markets indicate, generating portfolios consisting of about 31% onshore and 10% offshore wind will generally outperform the NGC-2010 mix and will perform at least as well as portfolios with less wind. This provides the basis for a *no-regrets* wind policy for Scotland.

Against this backdrop, the Scottish Executive's 18% 2010 renewables targets may not be sufficiently aggressive. Indeed the portfolio analysis indicates that reducing wind shares from their optimised levels (31% onshore, 5-10% offshore) significantly increases the cost and risk of the Scottish mix. While the Scottish Executive has set renewables *targets* (not limits), the message of the portfolio analysis is clear: **failure to exploit Scotland's wind resources significantly raises cost and risk.**

**Table 1
Portfolio Details**

10% Offshore Wind Scenario

	NGC 2010 Mix	Optimised Mix
Risk (SD)	4%	4%
Cost/MWh	£45.1	£45.1
Energy Share		
Fossil	45%	29%
Nuclear	26%	26%
Hydro	6%	6%
Wind Onshore	23%	31%
Wind Offshore	0%	10%



Portfolio Risk and Optimal Investment

In deregulated environments, investment decisions are made by individual power producers who evaluate their own direct costs and risks but do not consider the effects their investments may have on overall generating portfolio performance. **Wind investors, for example, cannot capture the risk-mitigation benefits they produce for the overall portfolio. This leads to under-investment in wind relative to levels that may be more optimal from a customer or societal perspective.** By contrast, some investors prefer the risk menu offered by fuel-intensive technologies such as gas turbines, with their low initial cost. Given sufficient market power, these investors will not bear the full risk they impose onto the generating mix. This produces over-investment in gas relative to what is more optimal from a total portfolio perspective.



Diverse Generation Portfolios Provide Stable Platforms for Growth

Energy policymakers face a future that is technologically, institutionally and politically complex and uncertain. In this environment, **portfolio optimisation techniques provide the analytic basis that policymakers need to devise efficient renewables targets that produce generating mixes which maximise security and sustainability.**

Portfolio optimisation shows that attaining these objectives reduces cost. **In the case of Scotland, increasing the share of wind reduces portfolio cost-risk and enhances energy security** thereby ensuring a competitive base for Scotland's future economic growth.

Today's dynamic environment requires portfolio-based techniques that reflect the market risk of technologies. Portfolio analysis reflects statistical cost-risk inter-relationship among generating alternatives, which is crucial for correctly evaluating the generating mix. The results suggest that larger wind shares better insulate the generating mix from fossil price volatility, while enhancing the objectives of energy diversity and independence.



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