

The Role of Wind in Enhancing Scotland's Energy Diversity and Security

A Mean-Variance Portfolio Optimization of Scotland's Generating Mix

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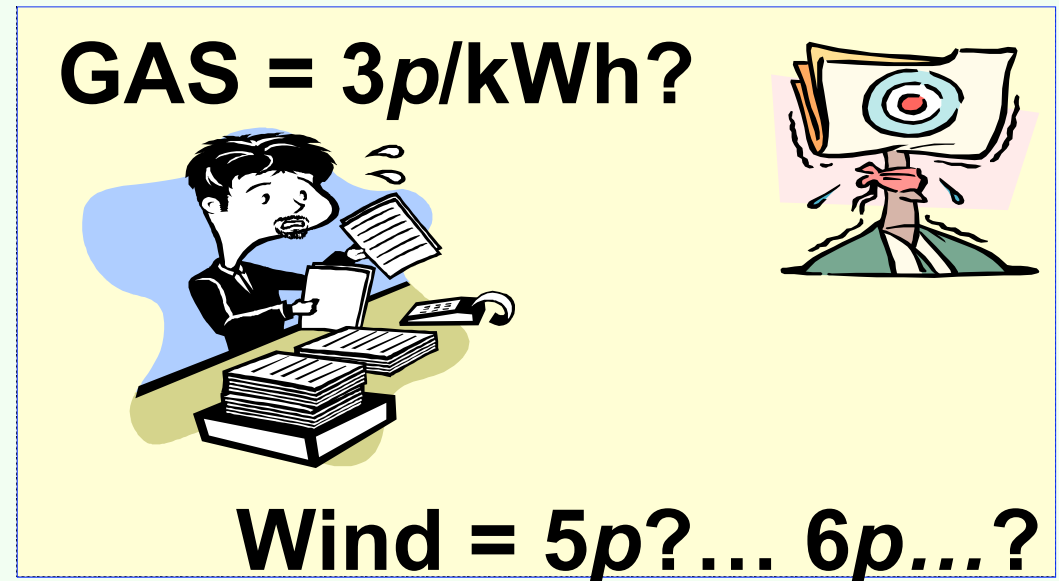
Outline

- **'Least-Cost' vs. Portfolio Optimization for Evaluating Scotland's Generating Capacity**
- **Projected 2010 *Business-as-Usual* Generating Mix**
- **Scotland 2010 Optimized Portfolios**
 - *'Outlook Gas' Case*
 - *'Accelerated Offshore Wind' Case*
 - Comparison of the Case Results: A 'No-Regrets' Policy
- **Conclusions**

Least Cost vs. Portfolio Optimization for Evaluating Scotland's Electricity Generating Mix

- Traditional '*least-cost*' electricity planning relies on kWh cost models developed around the time of the Model-T FORD

- Ignore market risk
- Rely exclusively on unpredictable fossil fuel projections
- Ignore co-movement between generating costs
- Produce unreliable results



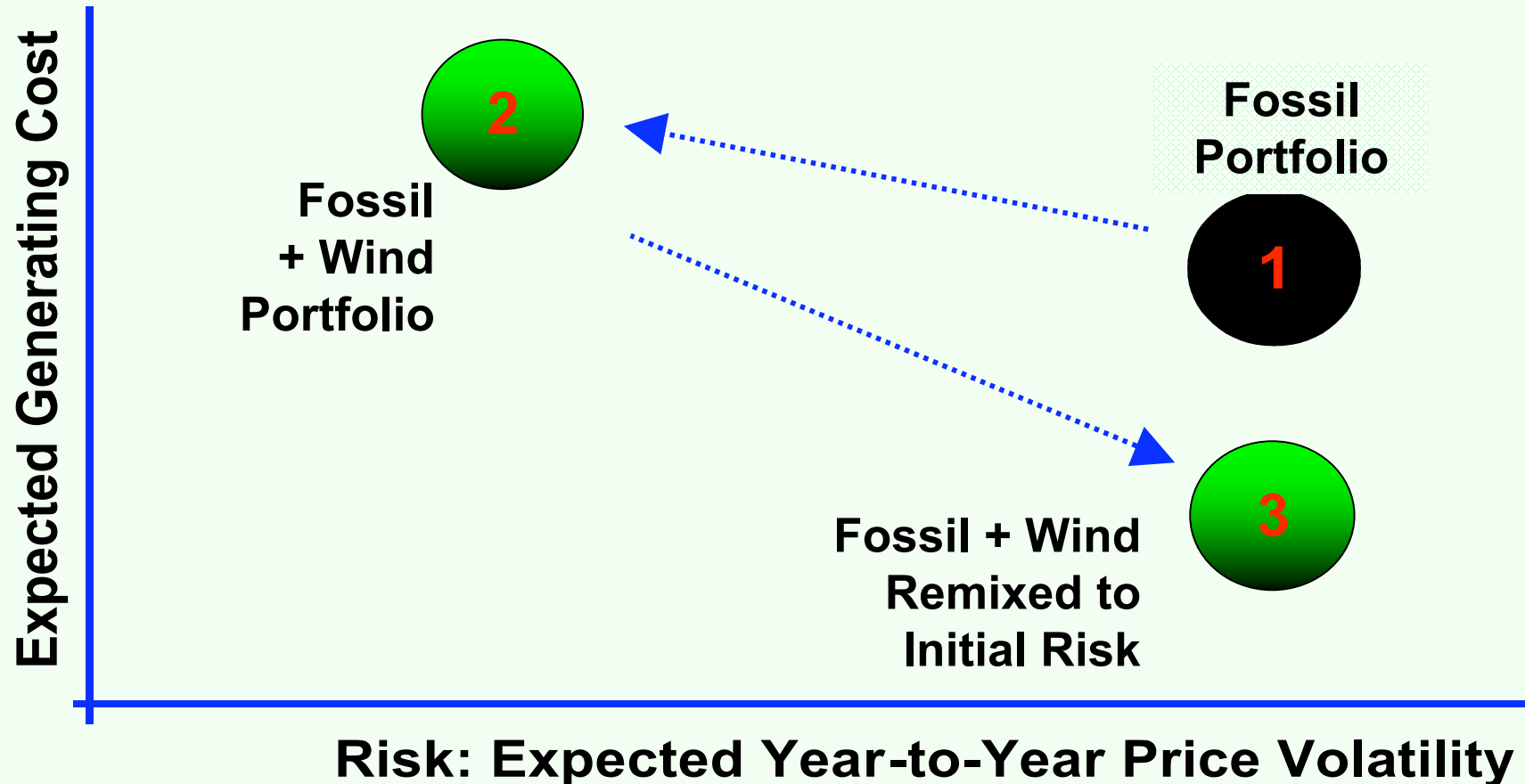
**Talking about kWh cost without also talking about risk is like watching a movie.....
With the sound turned off!**

“Least-cost” Approaches make little sense in today’s uncertain environment



- **Energy planning needs to take cue from financial investors who routinely deal with risk**
 - No one can predict stock markets or fossil prices
 - Must evaluate generating technologies based on their contribution to portfolio cost and risk
- **Investors hold efficient, diversified, balanced portfolios**
 - Best hedge against uncertain future
- **Is gas cheaper than wind?..... it matters little**
 - Even if true today, picture could change dramatically
- **Wind/Renewables: question not *if* – but only *how much***
 - Every optimal portfolio requires *some* fixed-cost technology

Wind Helps the Generating Mix It Affects Portfolio Cost *and* Risk



National Grid 2010 Scotland Energy Mix

- **NGC Mix Includes**

- 23% onshore wind (14 TWH)
- 6% hydro (4 TWH)

- **SE's 2010 Renewables Target**

- 18% (11 TWH) of total generation
- Implies 12% On-shore wind (7 TWH)



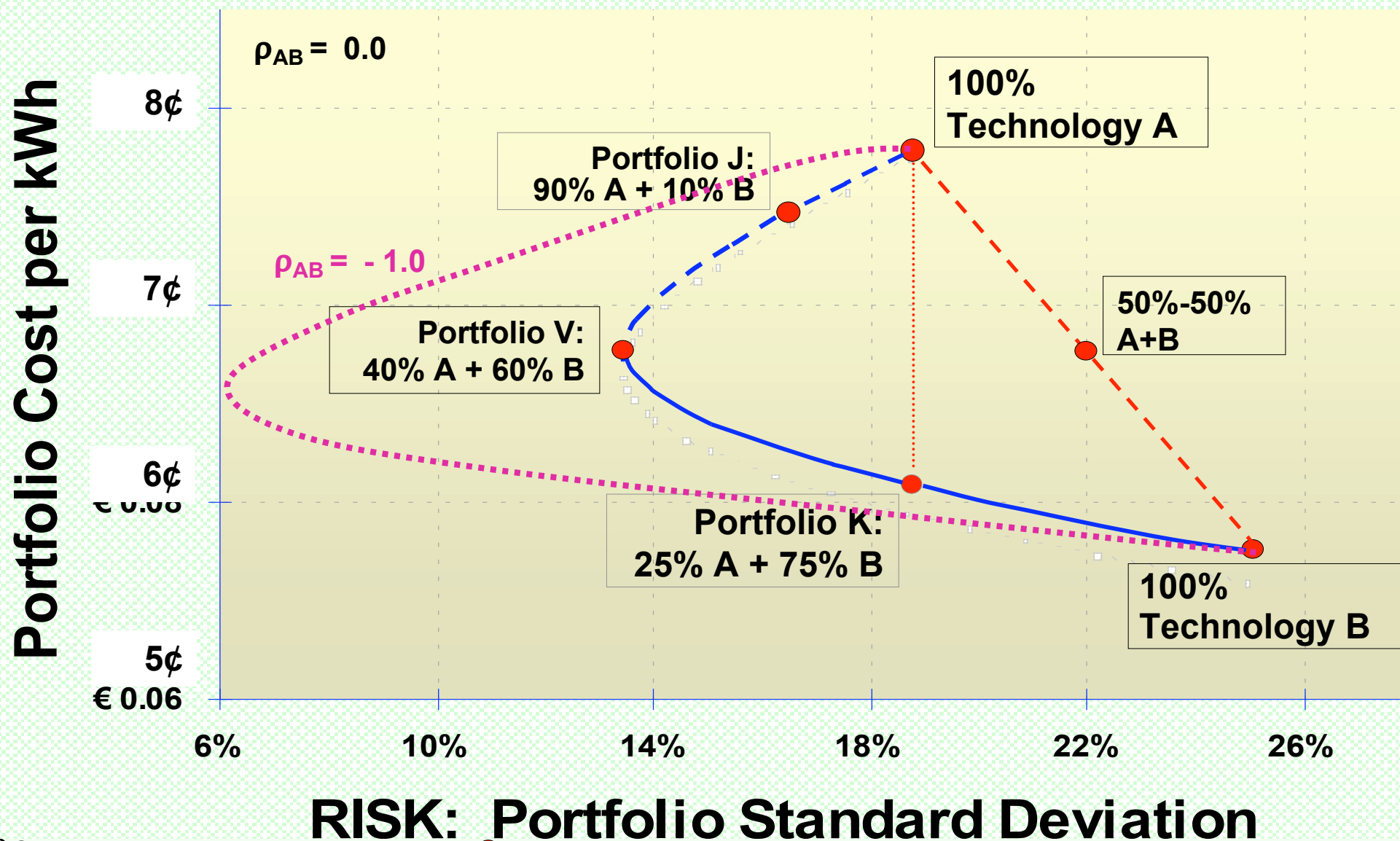
- **Compares to Scotland's 49% wind potential** (30 TWH - Garrad-Hassan)
 - Portfolio analysis arbitrarily constrains on-shore wind to 31% of total energy

Portfolio Optimization of the 2010 Scotland Electricity Generating Mix

- **Locates generating mixes with lowest expected cost at every level of risk**
 - Risk is the year-to-year variability of technology generating costs
- **NGC's Projected 2010 generating mix serves as a benchmark**
- **Results: Compared to NGC-2010 mix, there exist 'optimized' generating mixes with equal or lower *expected* costs that have larger wind shares**

**Wind enhances the Scotland Mix –
in spite of higher assumed *stand-alone* costs**

The Portfolio Effect: The Only 'Free Lunch' in Economics



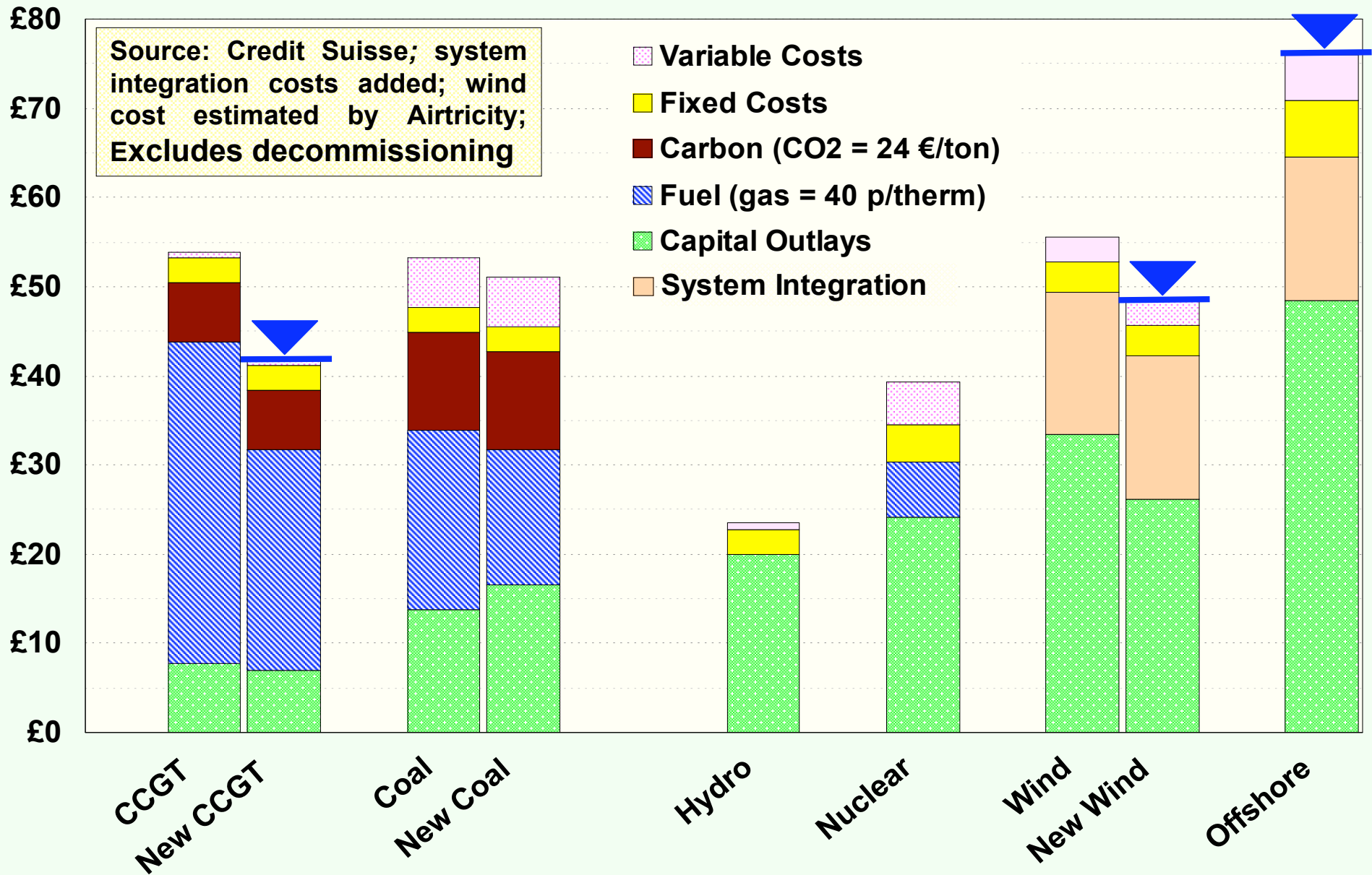
Case I: 'Outlook Gas'

**Optimized Portfolios Assuming Current
Gas Price Expectations**

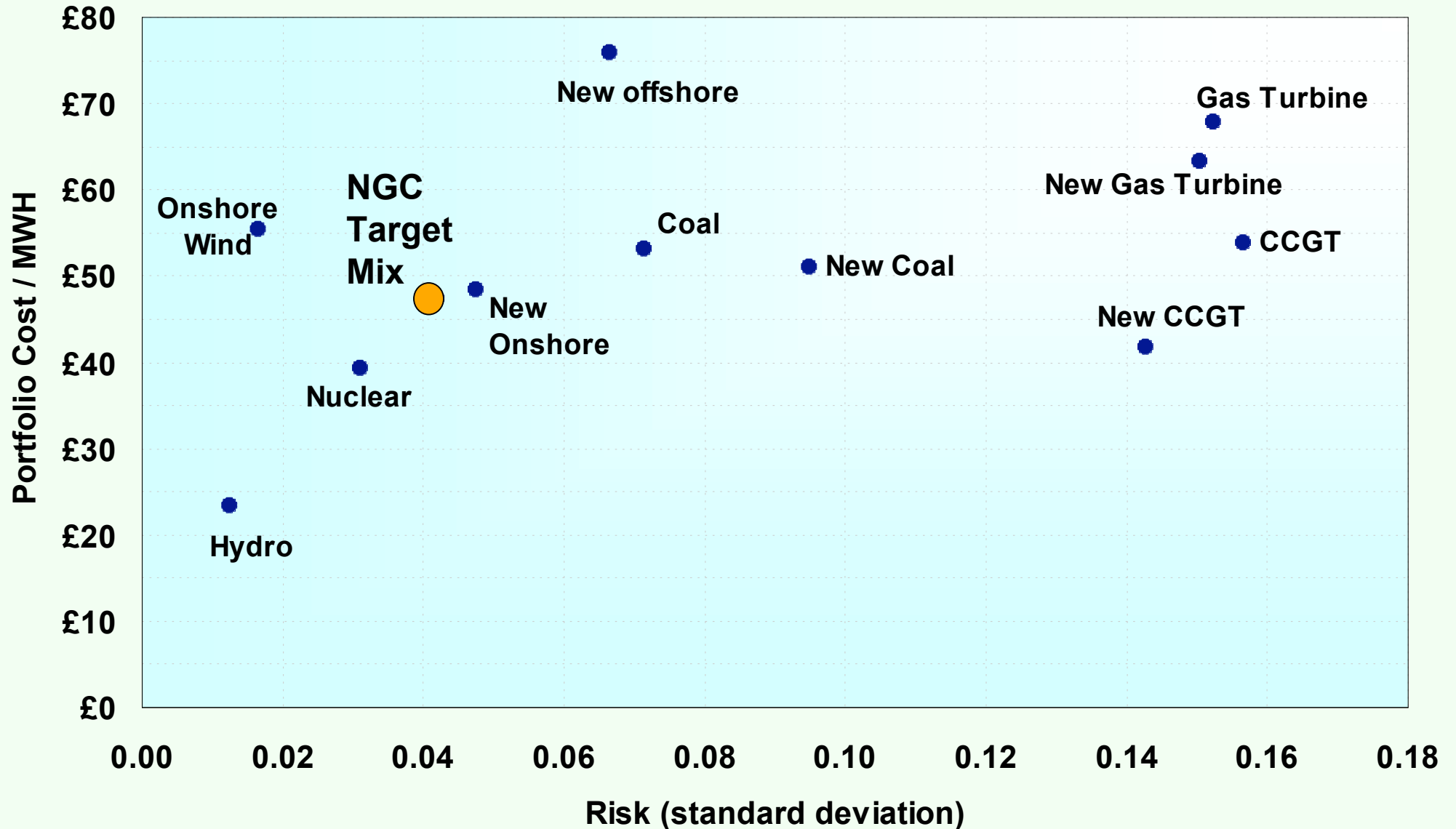
'Outlook Gas Prices'

- **'Outlook Gas' Assumptions:**
 - Natural Gas @ 40p/therm – cost of 4-year gas forward
 - Carbon @ €24/tonne – in line with recent prices
 - Other generating costs per *Credit Suisse*, Jun-2005
- **Portfolio analysis uses a *highly cautious* set of costs for wind**
 - Assumed offshore wind cost: £76/MWH
 - Nearly 50% higher than costs used in the Netherlands and elsewhere
 - Includes System Integration ('Intermittency') Costs @ £16/MWH

Outlook Gas Case: New Entrant Generating Costs

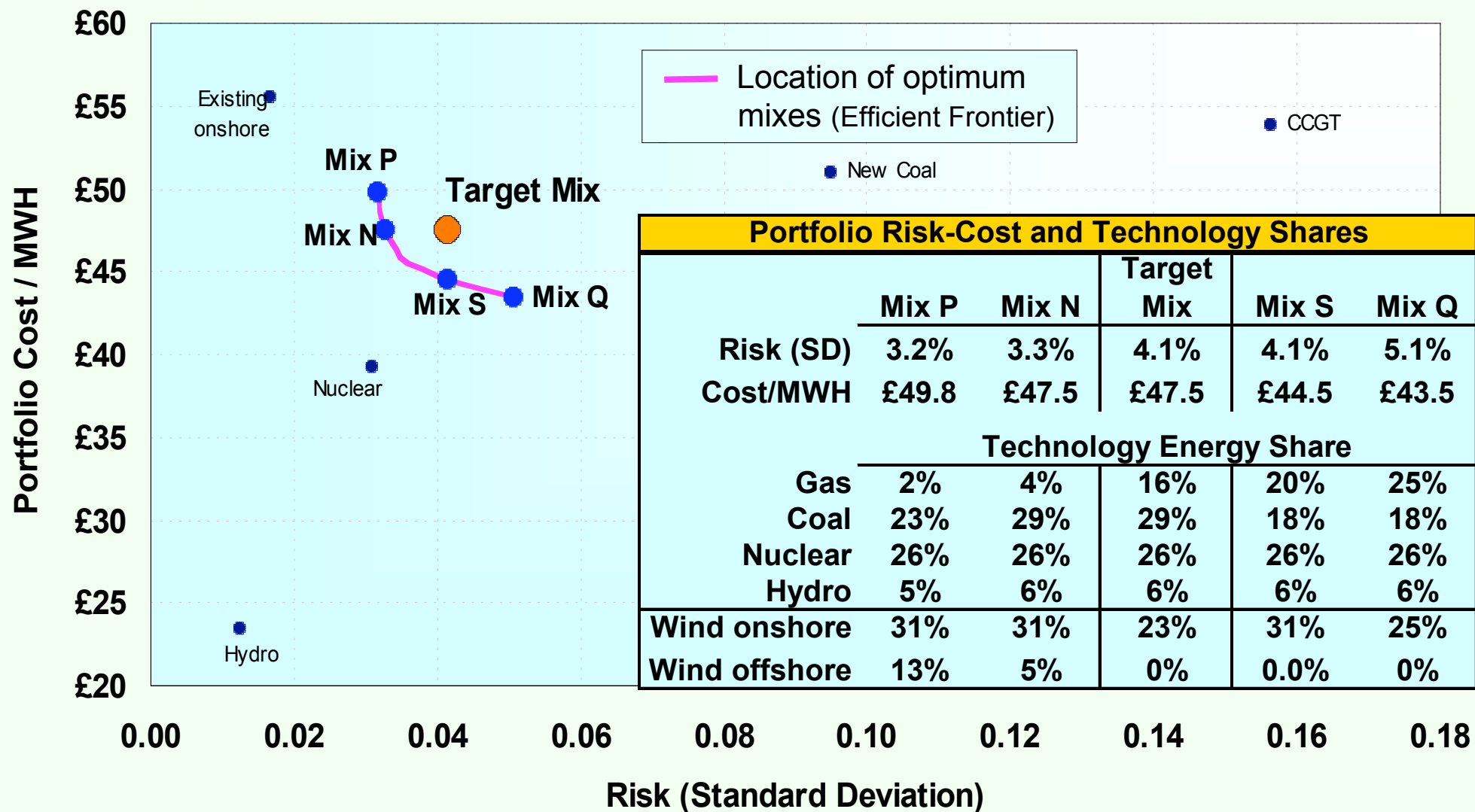


'Outlook Gas' Case: 2010 Technology Cost and Estimated Risk



'Outlook Gas' Case

- 2010 Optimized Portfolio Results -



Case II: Accelerated Offshore Wind Deployment

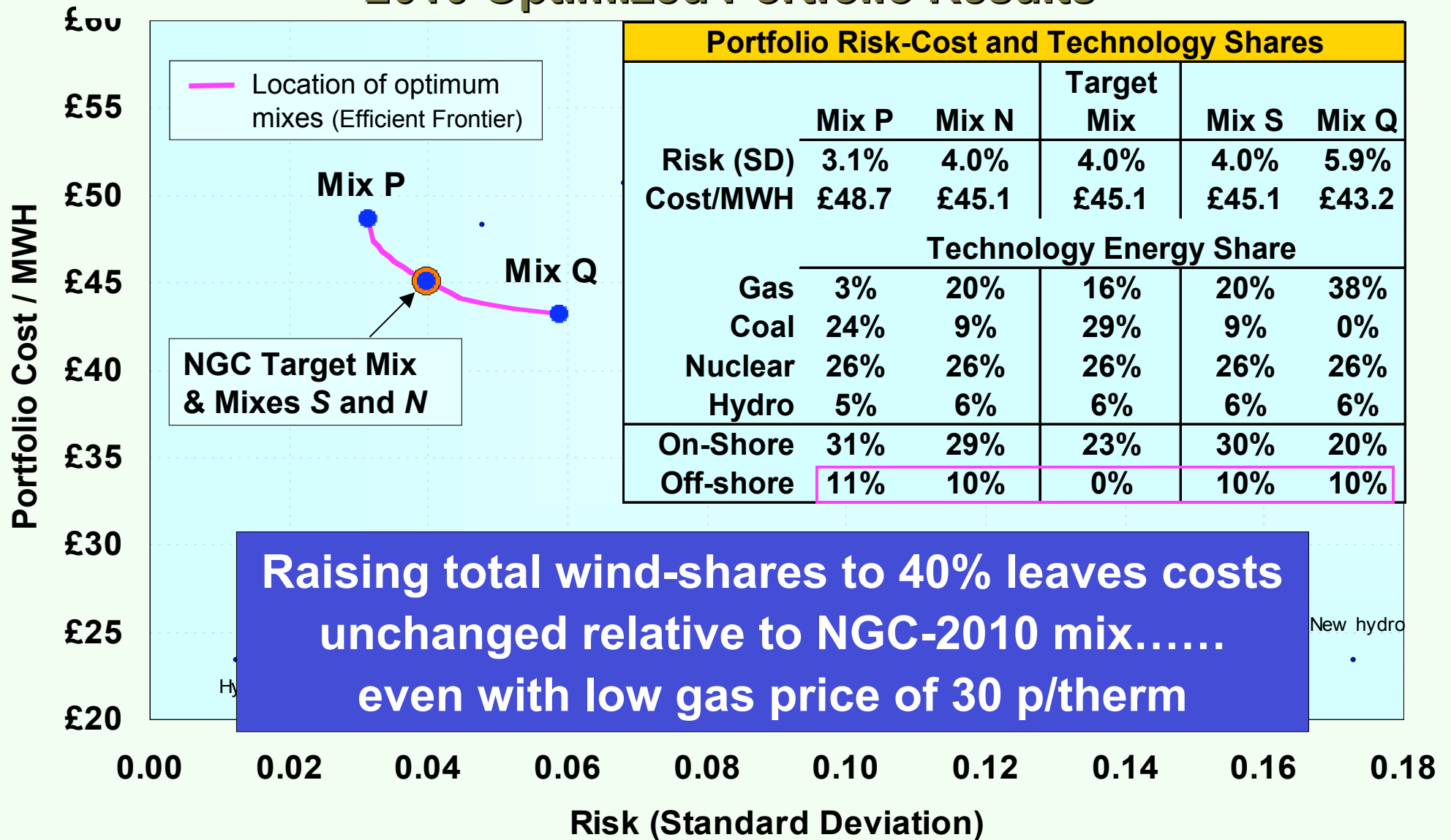
Minimum 10% Offshore Wind

Accelerated Offshore Wind Deployment

- **Mixes S and Q in ‘Outlook Gas’ Case contain no offshore wind**
- **Portfolio theory suggests there likely exist many other mixes at the same risk levels that do contain off-shore wind**
 - Portfolio Optimization now locates generating mixes that contain an arbitrary Off-shore wind share of at least 10%
 - Assume natural gas price @ 30 p /therm
- **Evaluate: “What happens if we promote off-shore wind only to find that gas prices retract?”**

'Accelerated Offshore Wind'

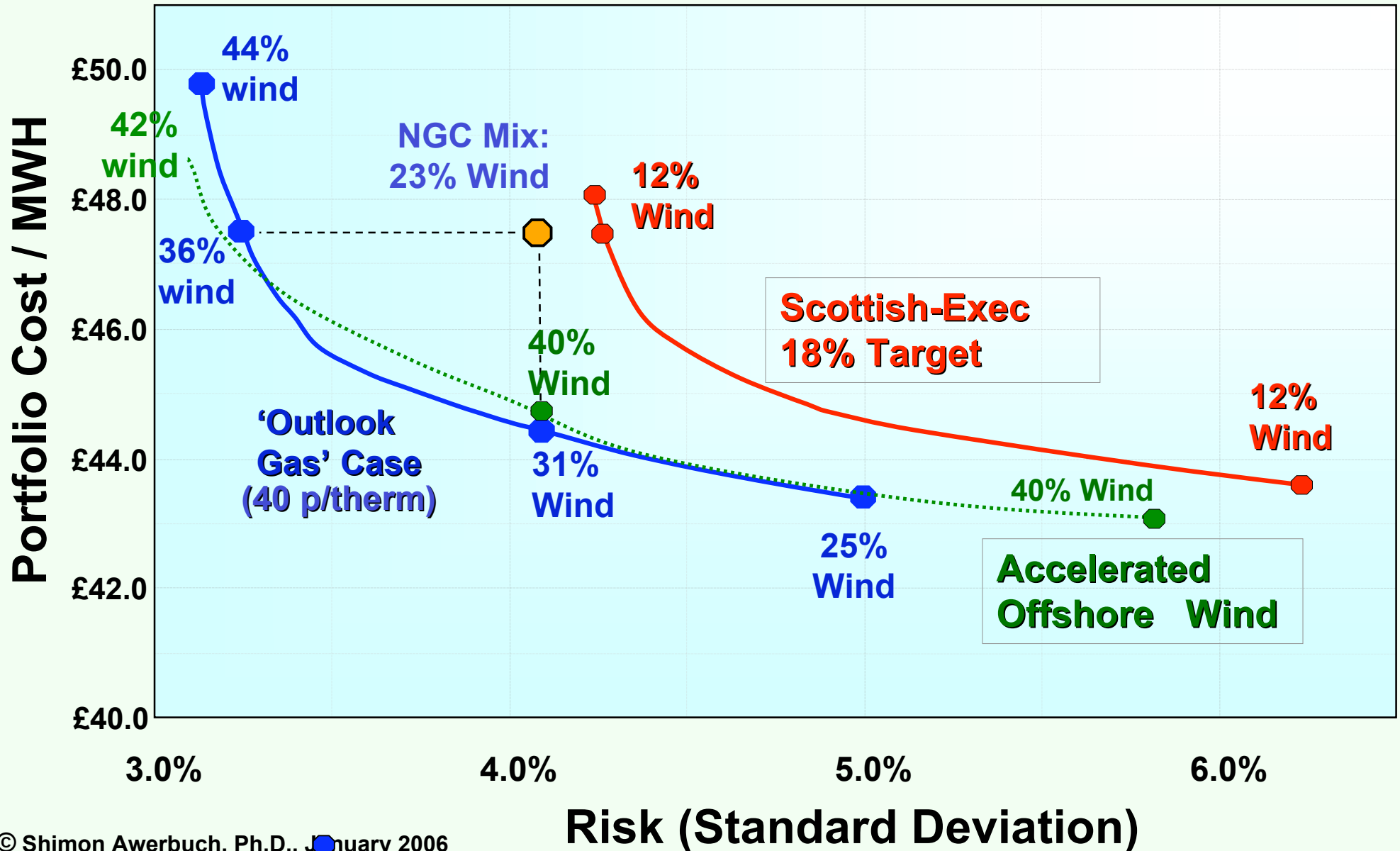
- 2010 Optimized Portfolio Results -



Summary:

**Optimal Wind Shares and
Portfolio Cost
for Different Cases**

Summary: A 'No-Regrets' Policy for Scotland



Conclusions and Implications for Scotland

- **Larger wind shares enhance security and *reduce* generating costs even if wind is assumed to cost more**
 - Larger wind shares insulate mix from fossil price volatility
- **Without Increasing Overall Portfolio Generating Cost-Risk:**
 - Onshore wind generation can rise to 31%+
 - Offshore can rise to 10%
 - Basis for *no-regrets* policy if gas price expectations materialize
- **Scottish Exec's 18% 2010 Targets do not fully exploit Scotland's wind resources**
 - Could increase portfolio cost-risk

Final Thought..... where markets do not function

- **Wind investors cannot capture risk-mitigation benefits they provide to the generating portfolio**
 - Leads to *under*-investment in wind relative to optimal societal levels
- **Gas investors generally seem to have sufficient market power to externalize fuel risk to consumers**
 - Creates *over*-investment in gas relative to optimal societal levels
- **Market imperfection -- Creates economic basis for supporting wind**

STOP