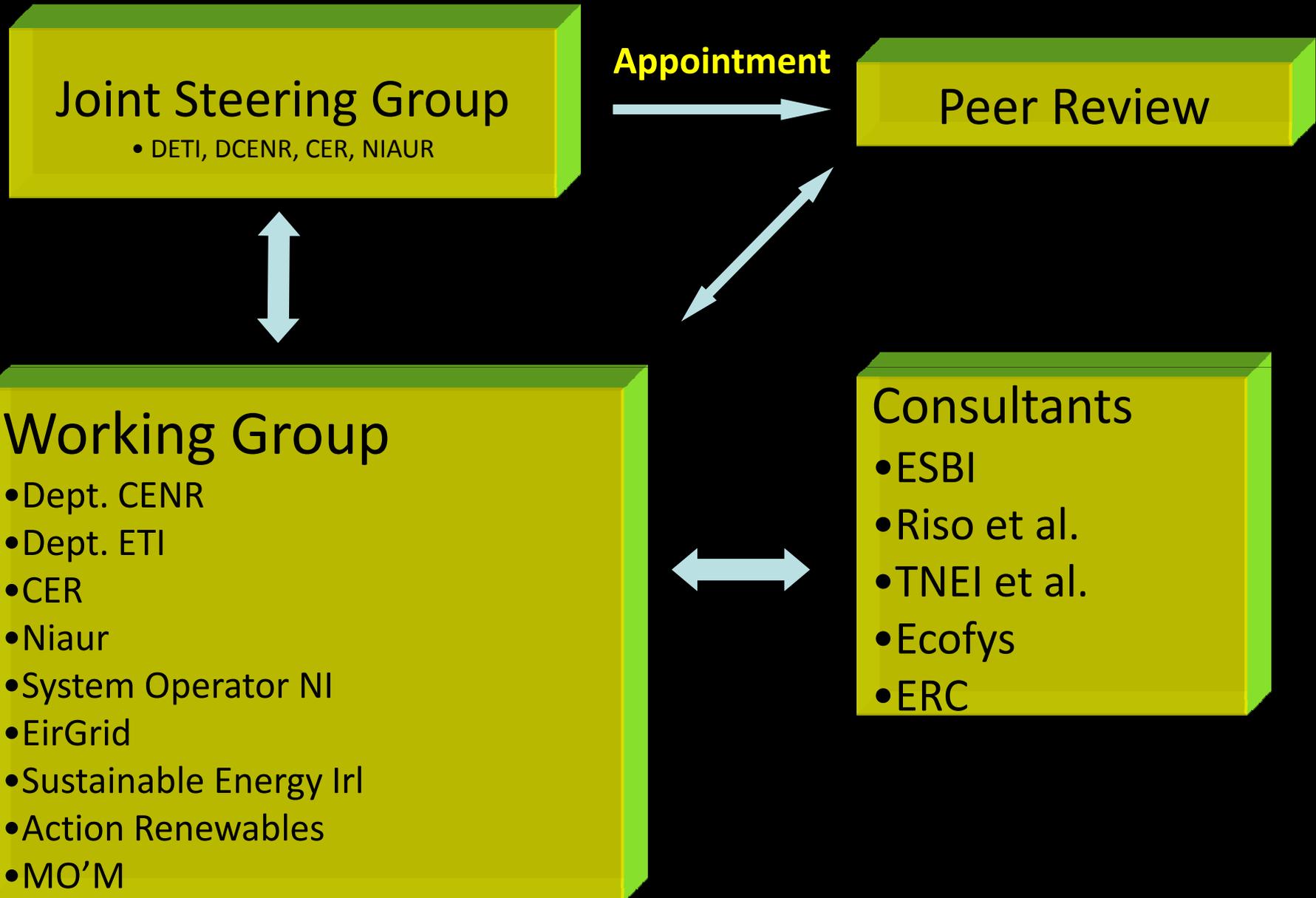




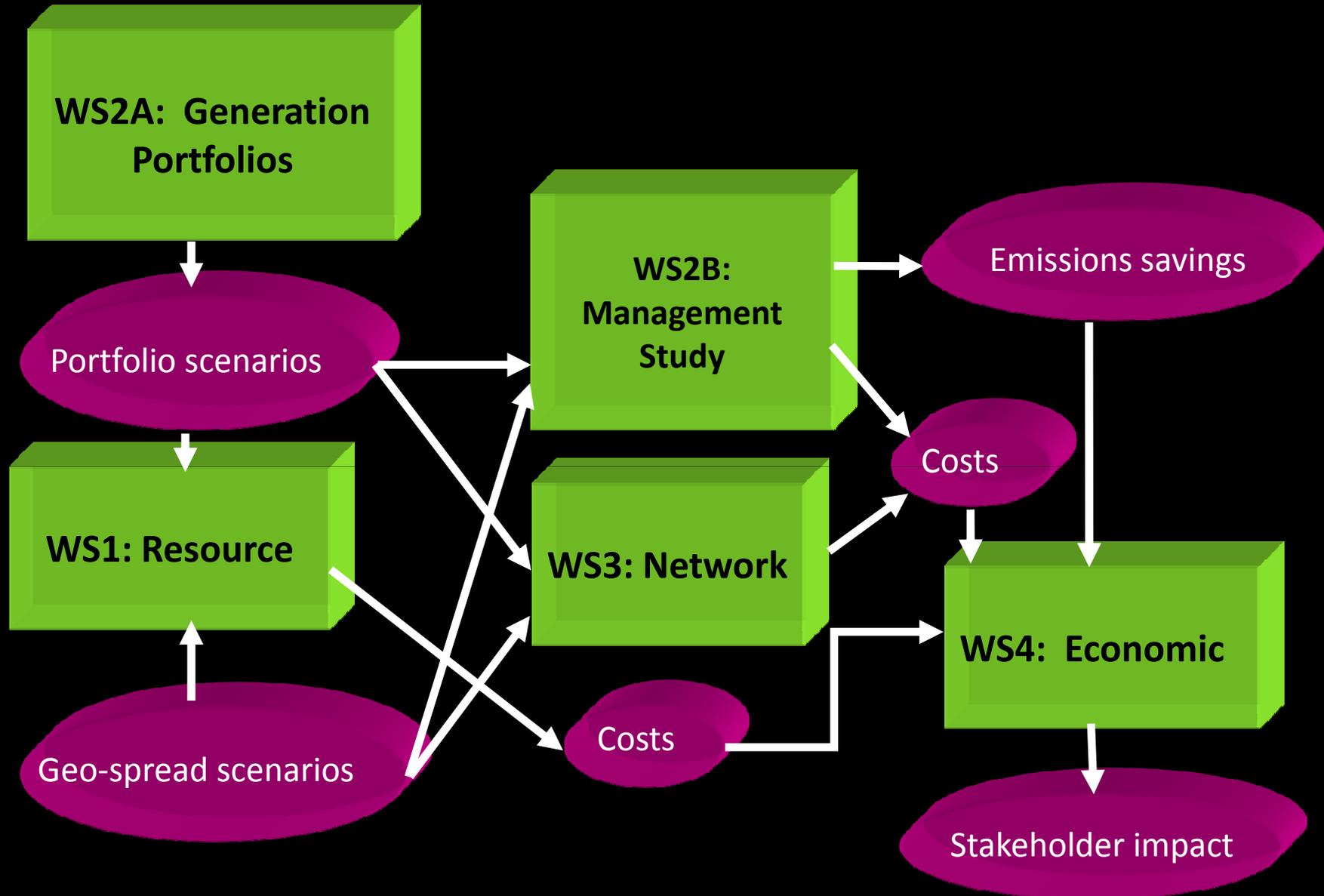
ALL-ISLAND GRID STUDY & some research results

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Governance

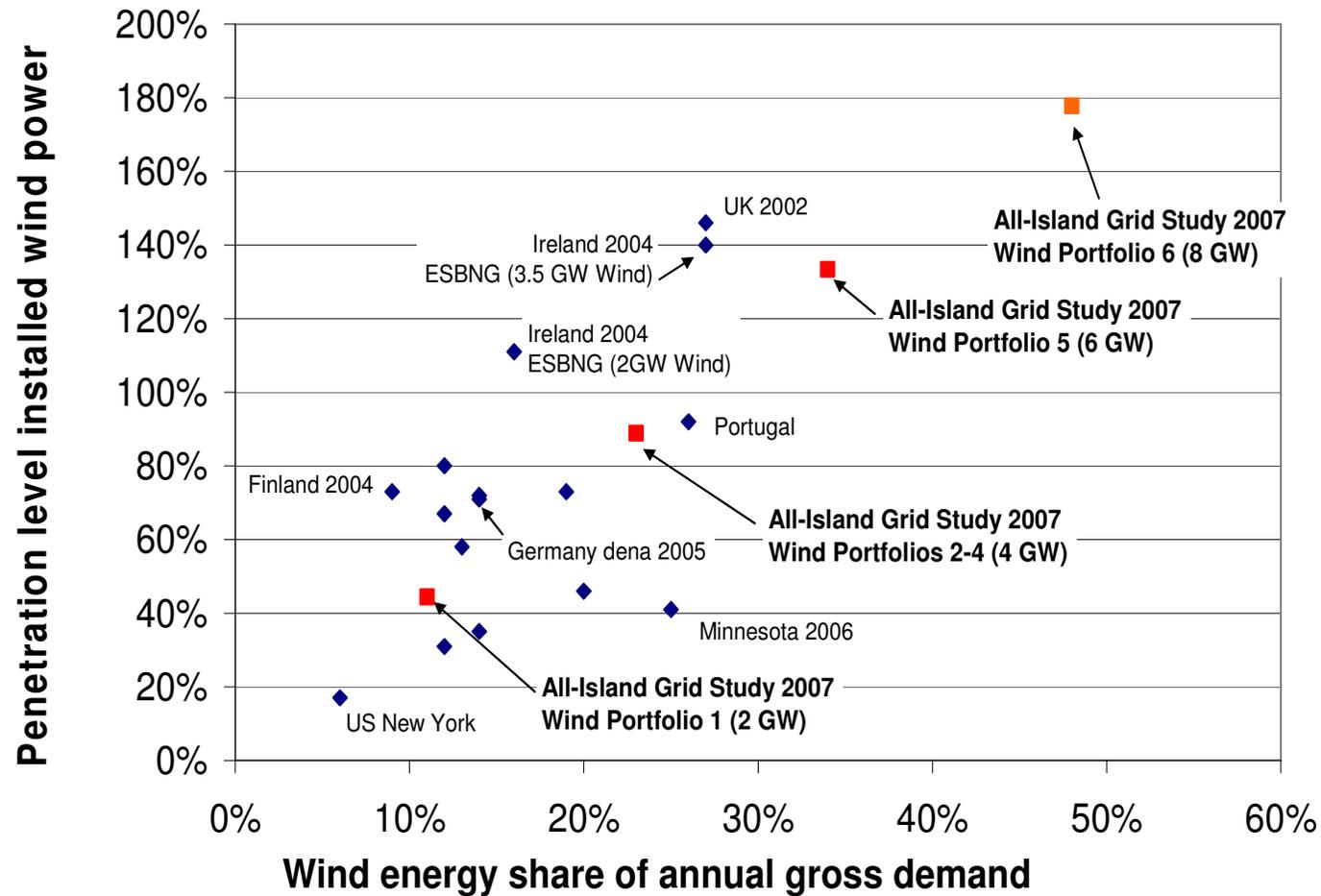


All-Island Renewable Grid Study- Overview



WS: Workstream

Contrast to other studies



High level assumptions

- Modelling exercise
 - One hour resolution
- Cost base study – simple view of the world !
- Market
 - Not Single Electricity Market & perfect
- Snap shot study – 2020 – based on scaled wind and load data



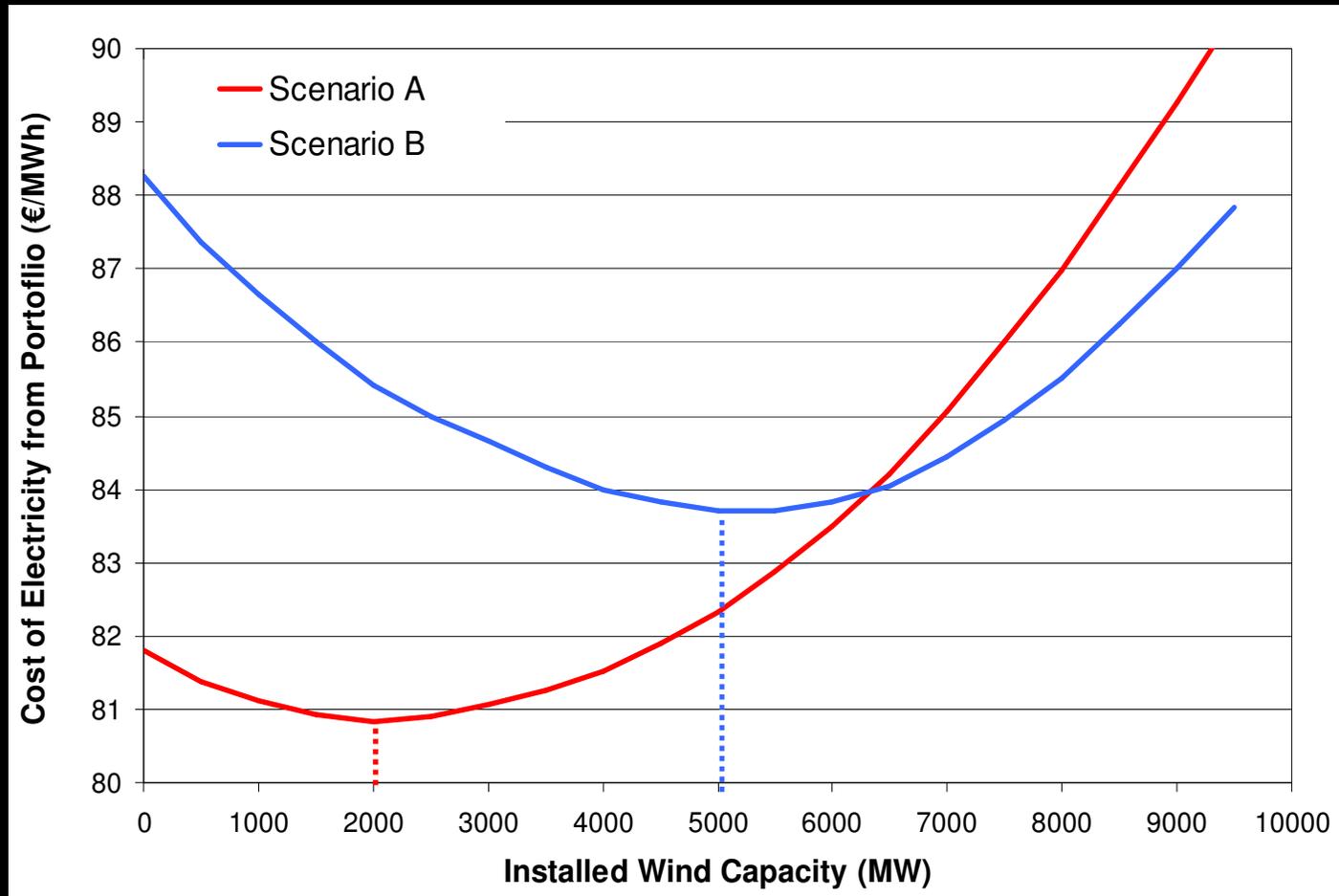
WS2A: High level assessment of suitable generation portfolios for the All-Island System in 2020

Consultant: ERC

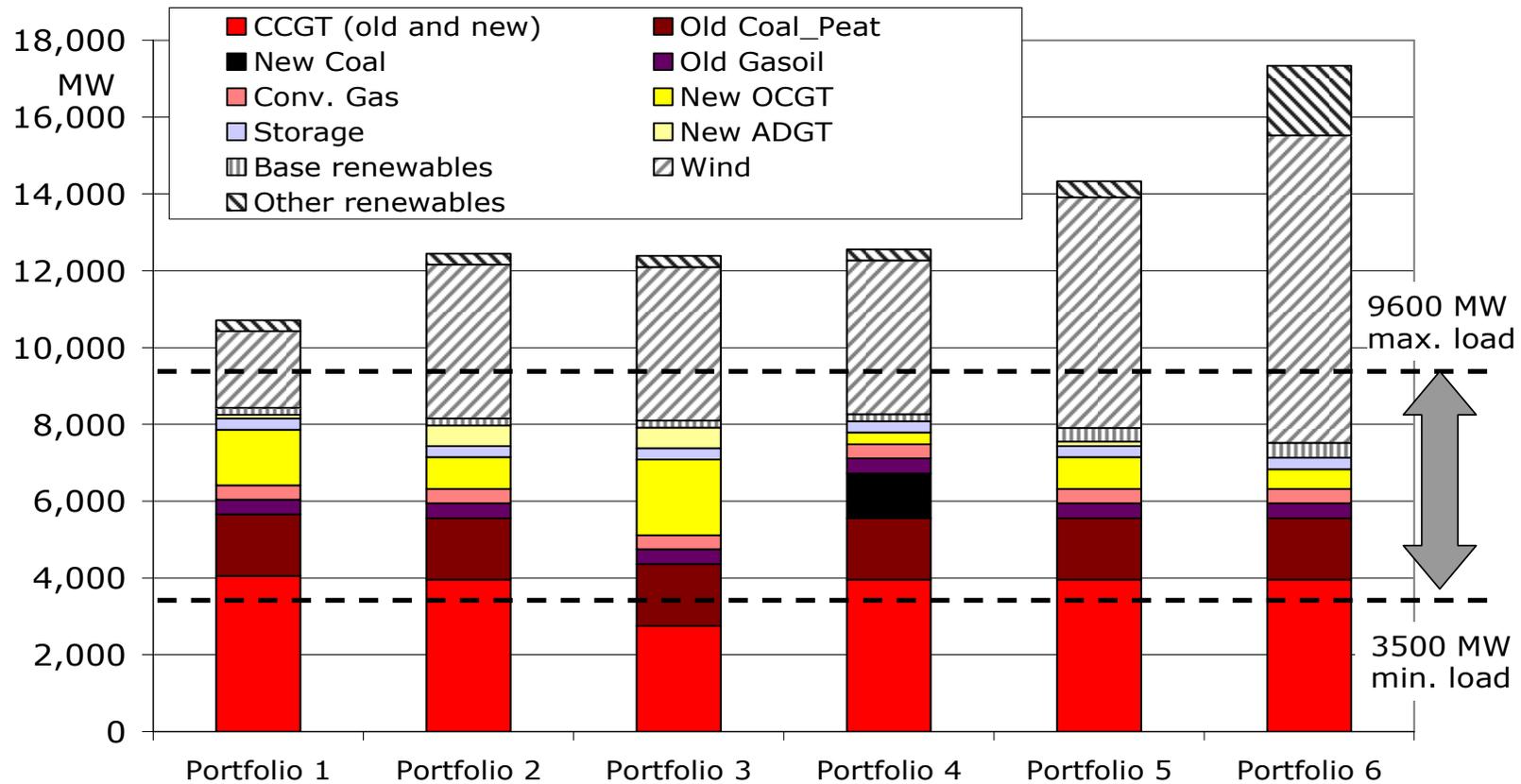
Role of WS2A

- To identify range of **optimal** portfolios for further study
 - Grid Study lite!
- Doherty, R. and O'Malley, M.J., "**Establishing the role that wind generation may have in future generation portfolios**", *IEEE Transactions on Power Systems*, Vol. 21, pp. 1415 – 1422 (2006)

Sensitivity to installed wind capacity



Portfolios



Share of Renewables

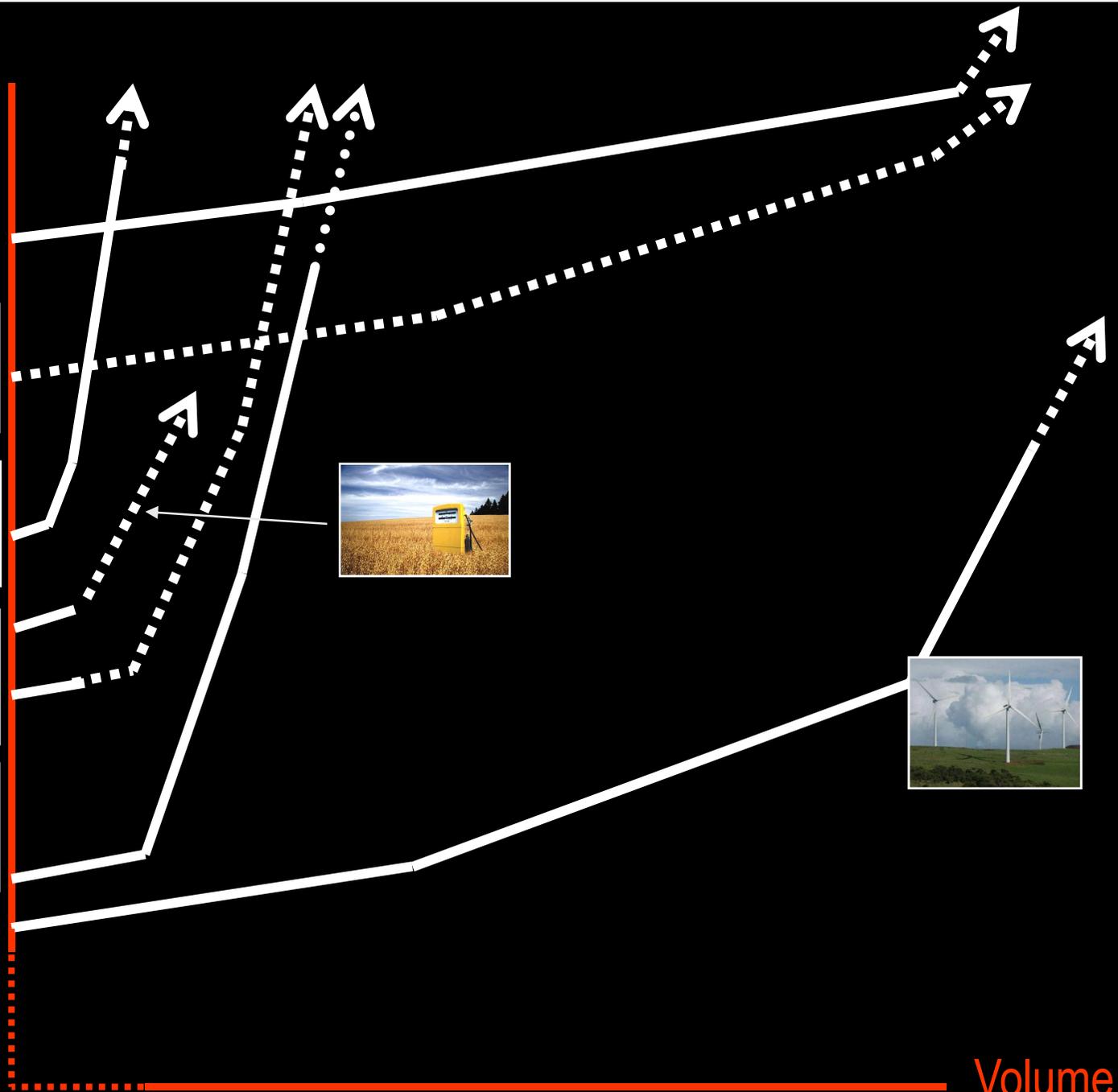
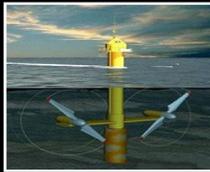
Capacity	23 %	36 %	36 %	36 %	47 %	59 %
Energy	16 %	27 %	27 %	27 %	42 %	59 %



WS1: Renewable energy resource assessment

Consultant: ESBI

Cost



Renewable Resources

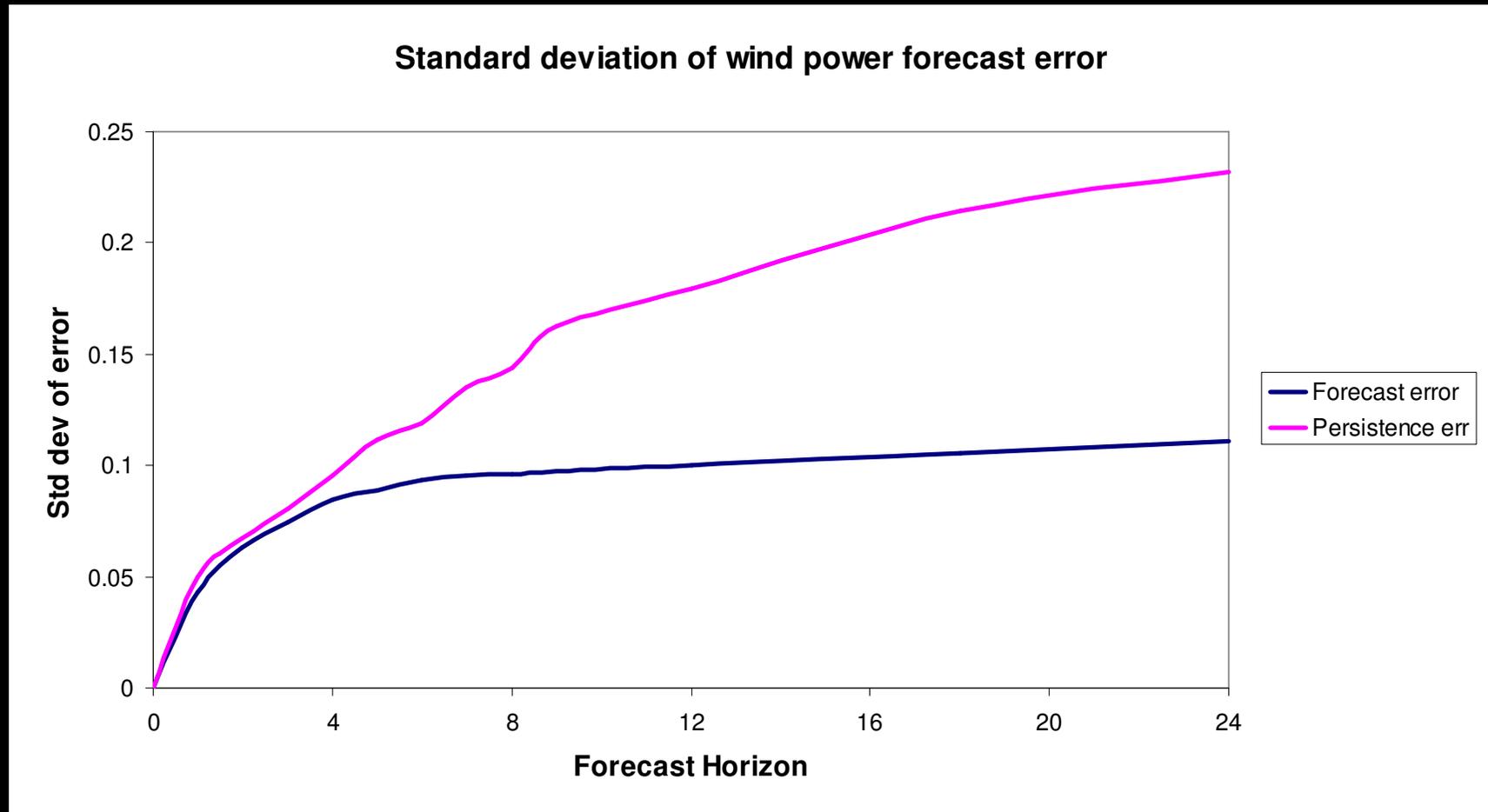
Volume



WS2B: Wind variability management study

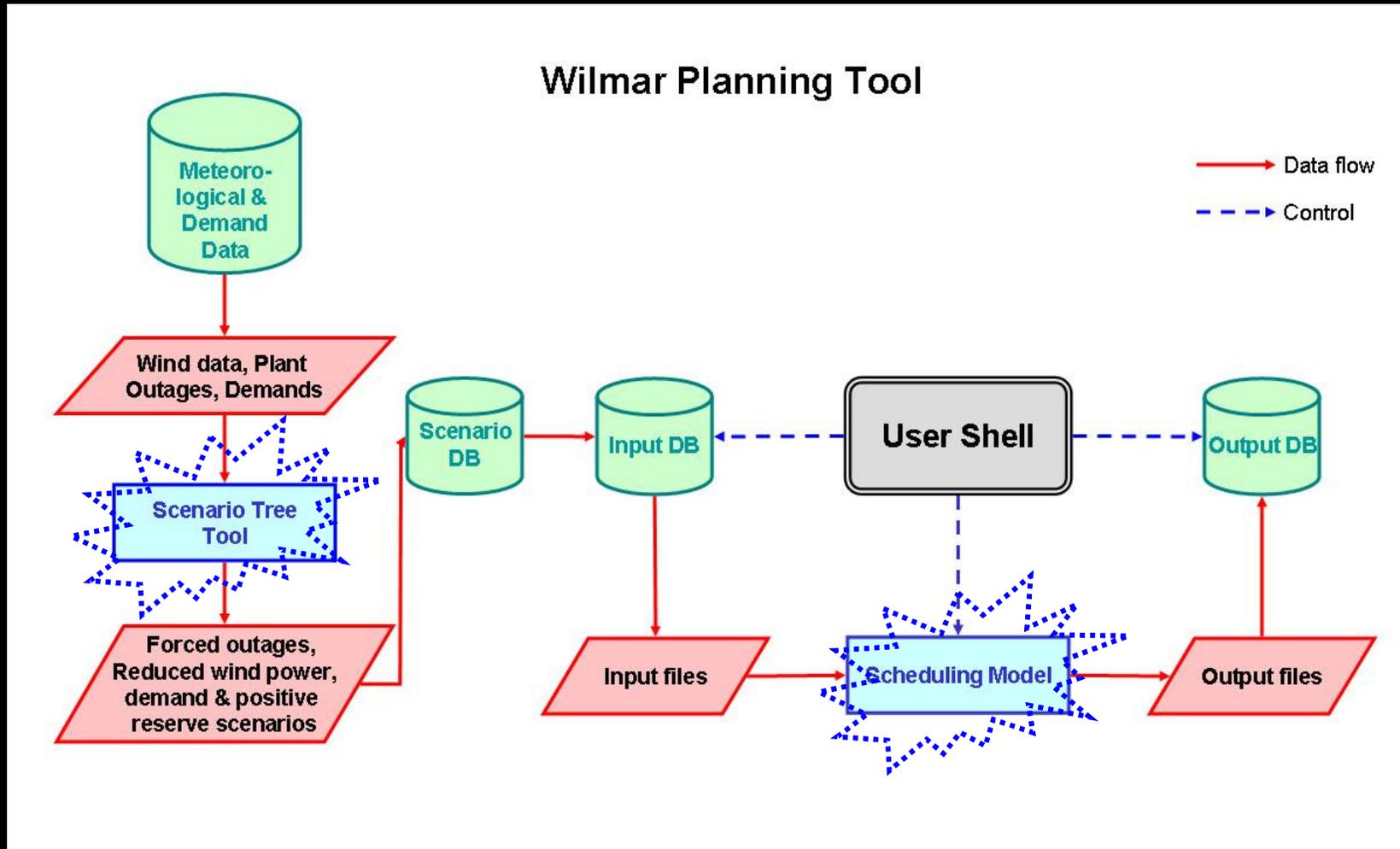
Consultant: RISO *et al.*

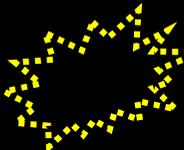
Forecast Uncertainty



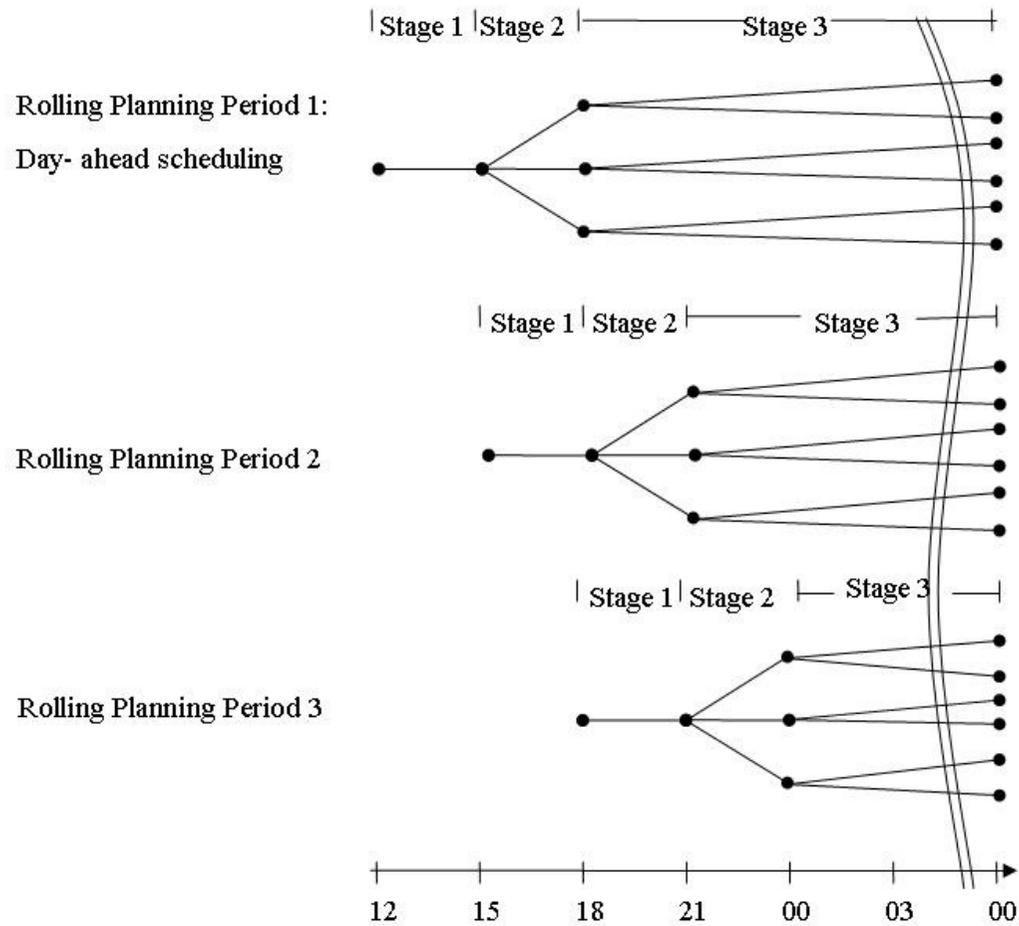
Overview of Wilmar

Wilmar Planning Tool

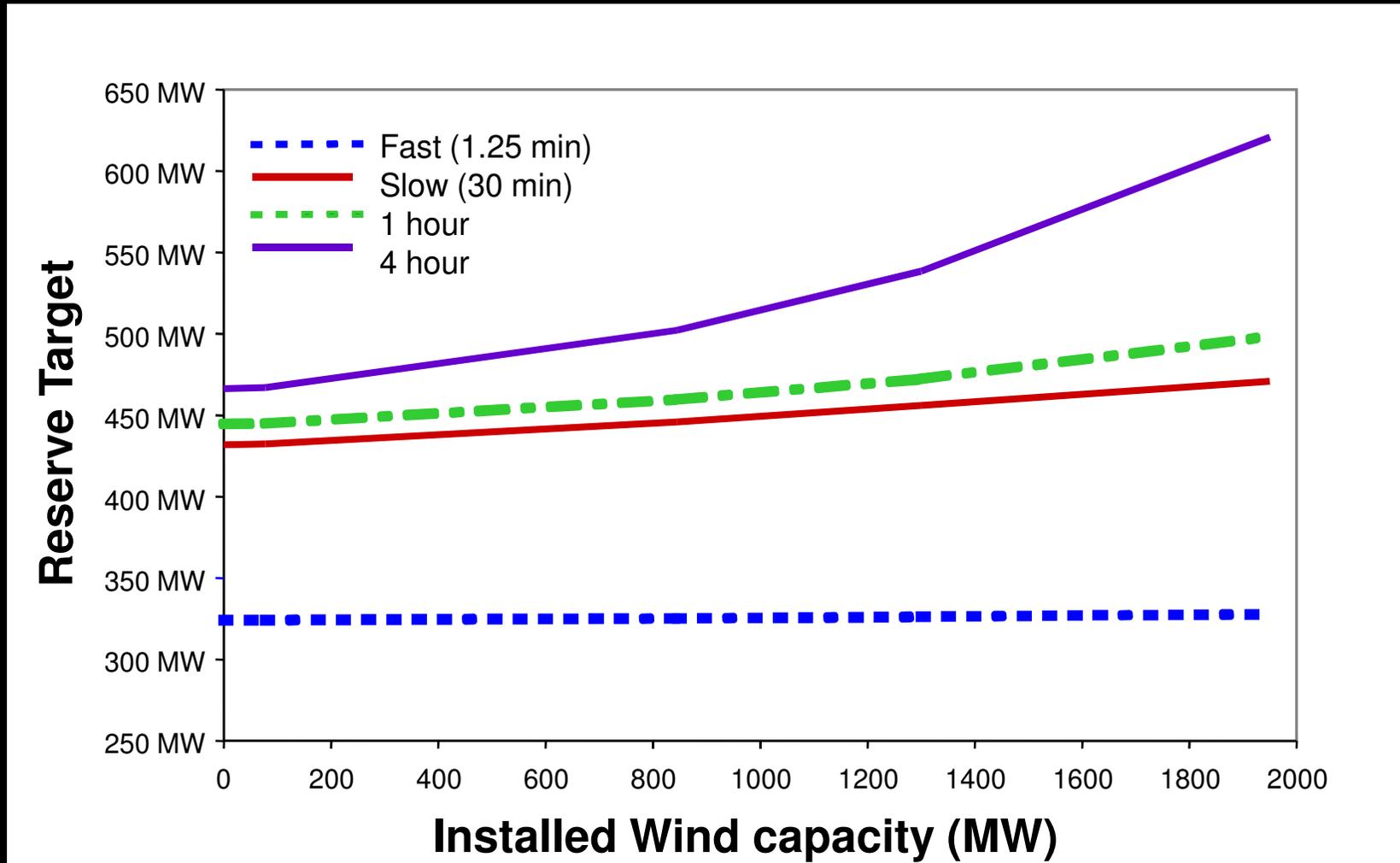


 = main model functionality

Functionality Scheduling Model (SM)

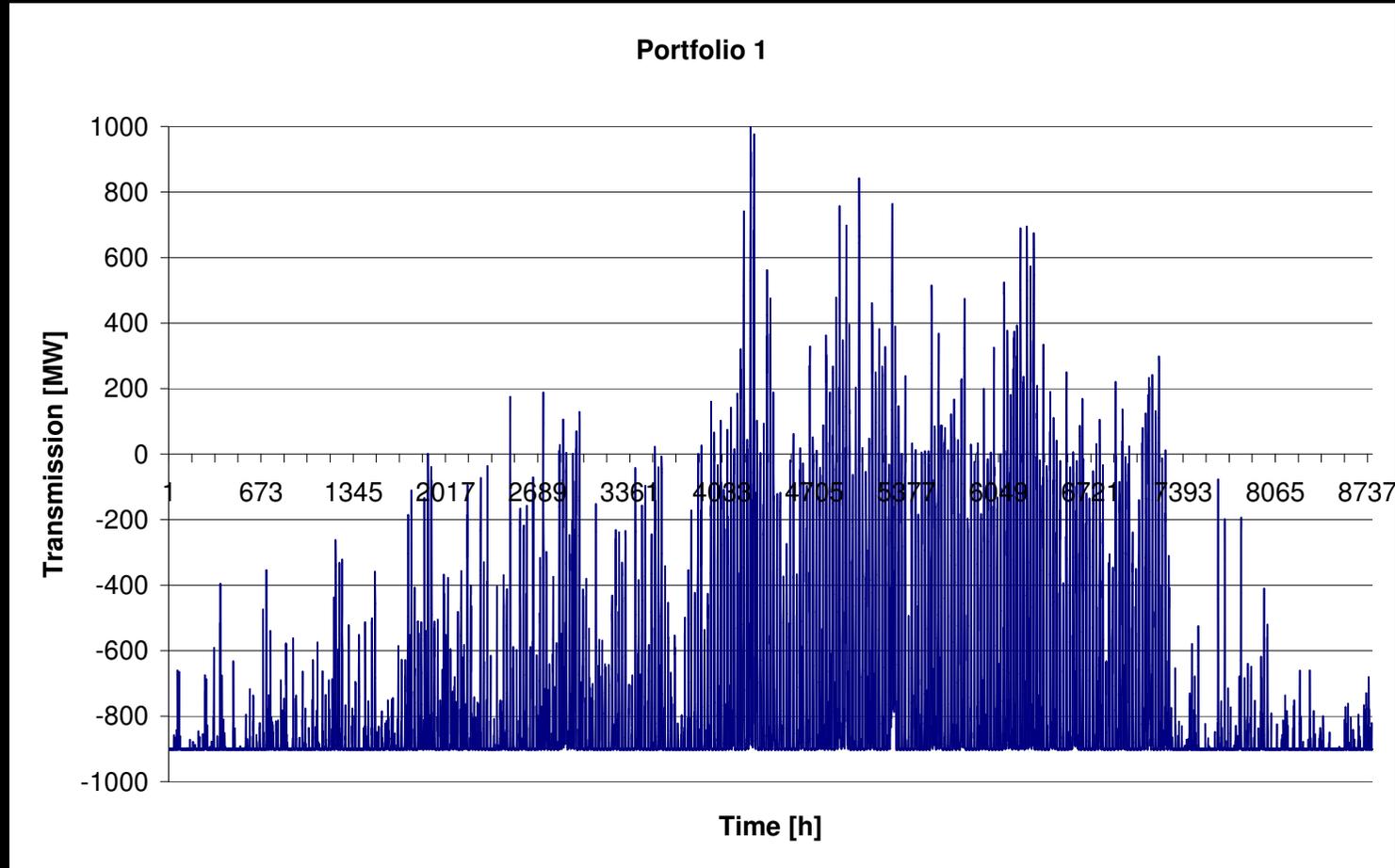


Reserve targets

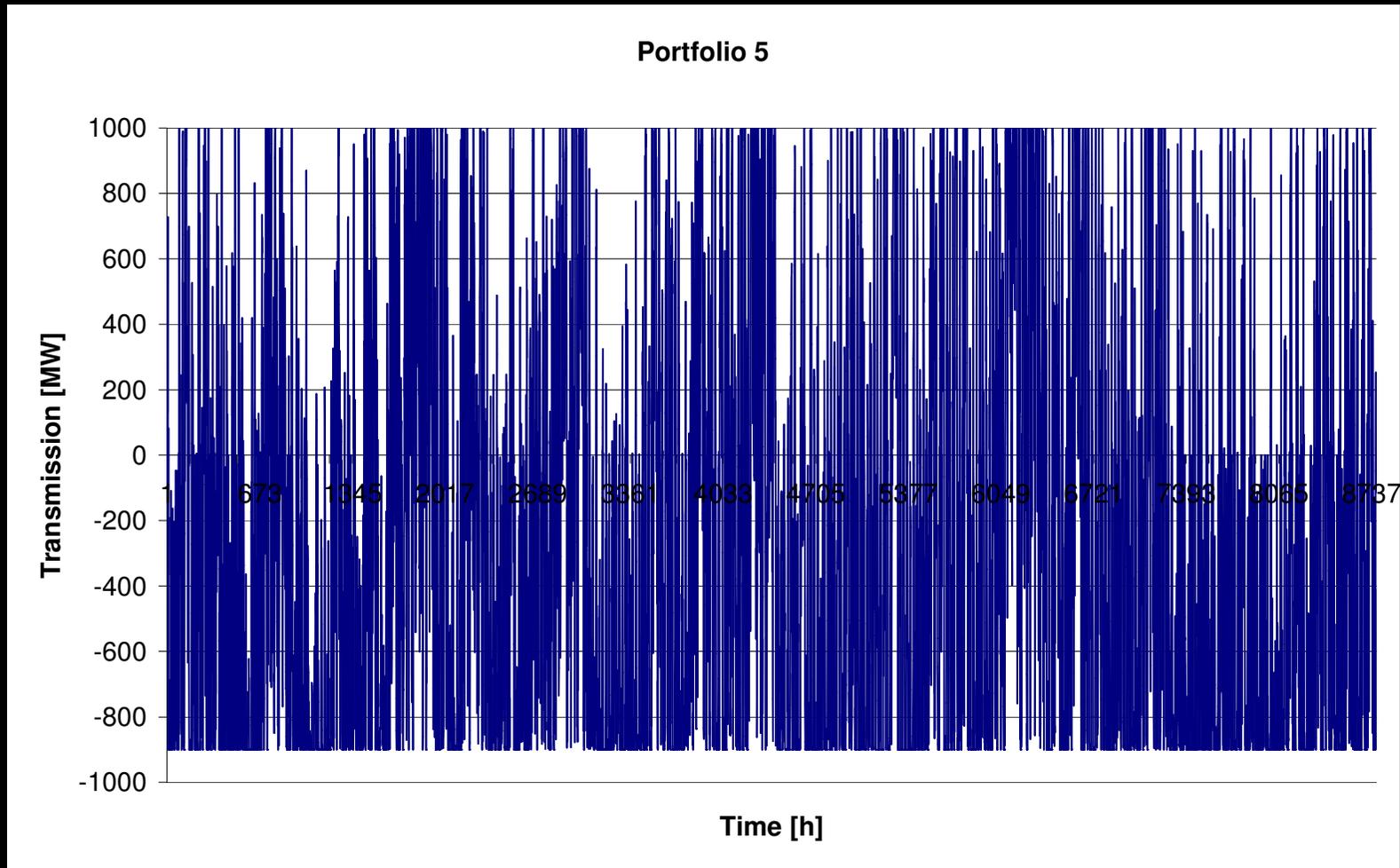


ILEX Energy, UCD, QUB and UMIST, "Operating reserve requirements as wind power penetration increases in the Irish electricity system", Sustainable Energy Ireland (2004)

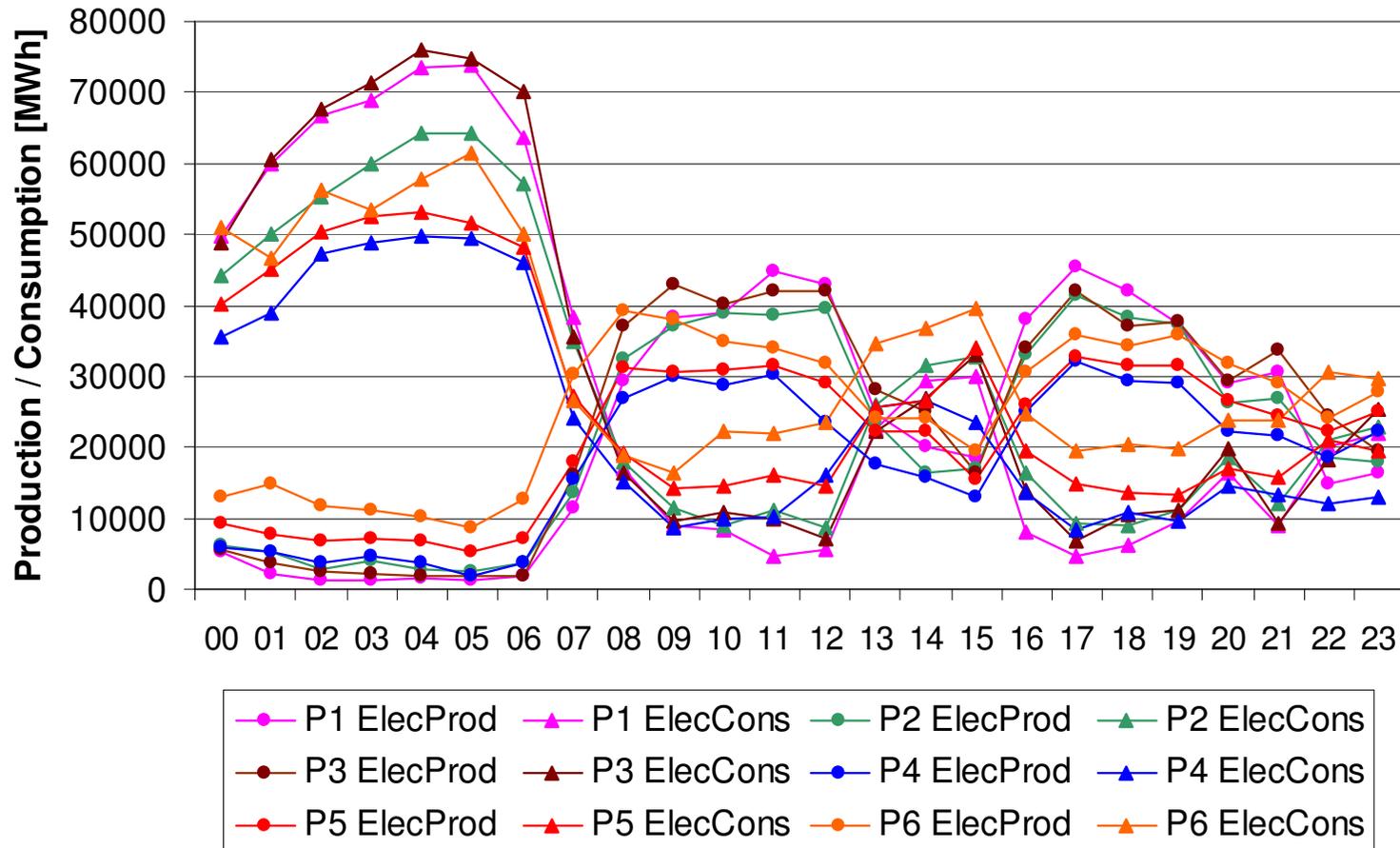
Import/export GB (portfolio 1)



Import/export GB (portfolio 5)



Pump storage utilisation



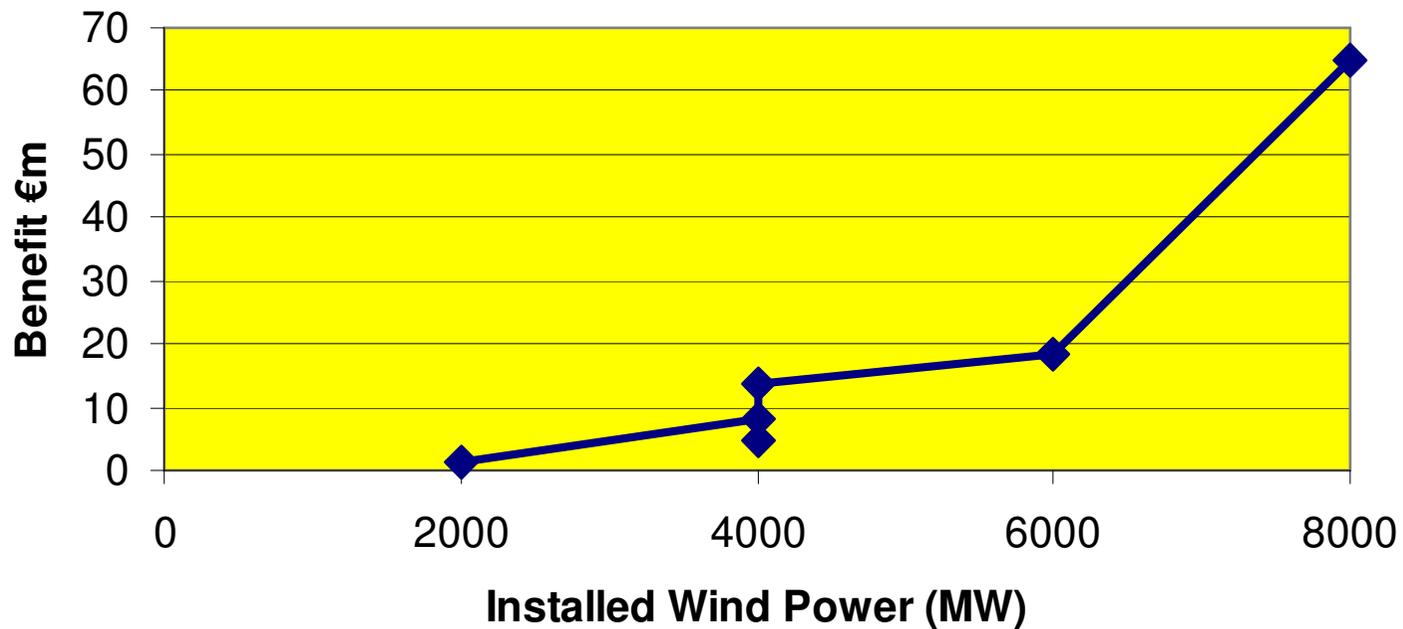
The yearly electricity production and electricity consumption of Turlough Hill distributed on the hours during a day in MWh

Improved forecasting

	P1	P2	P3	P4	P5	P6
Absolute cost reductions due to perfect forecast [MEuro]	1.2	8.0	4.8	13.6	18.5	65.0
Relative cost reductions due to perfect forecast [%]	0.05	0.4	0.2	0.7	1.2	3.6

Benefits of Forecasting

Benefit of Perfect Forecasting over Stochastic Model





WS3: Networks

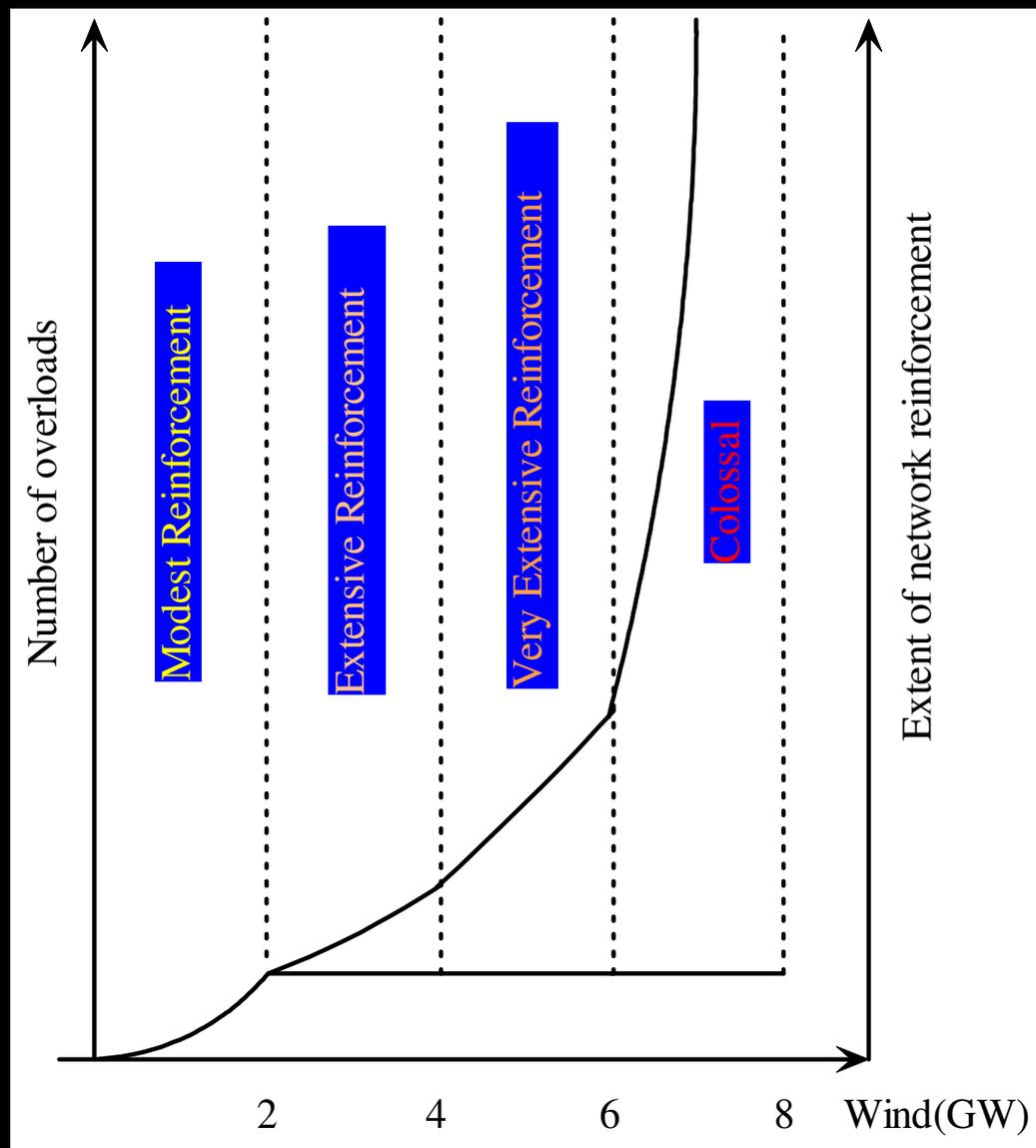
Extent and cost of engineering implications including likely network reinforcements to accommodate the specified renewable generation

Consultant: TNEI

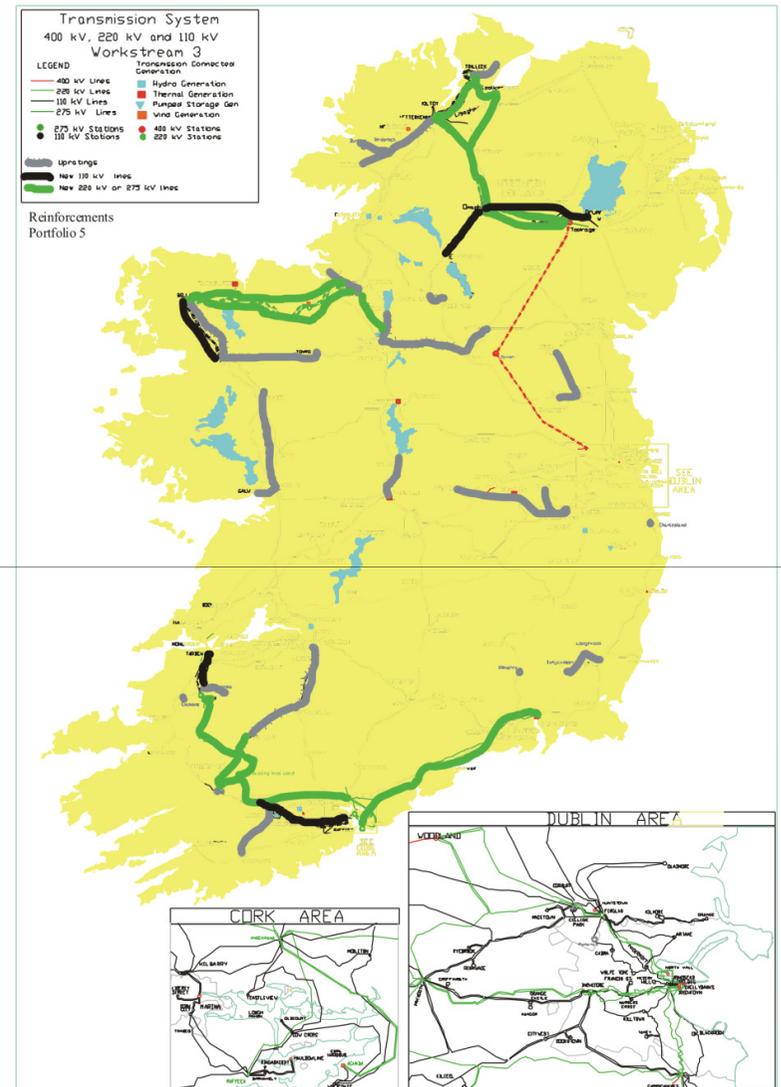
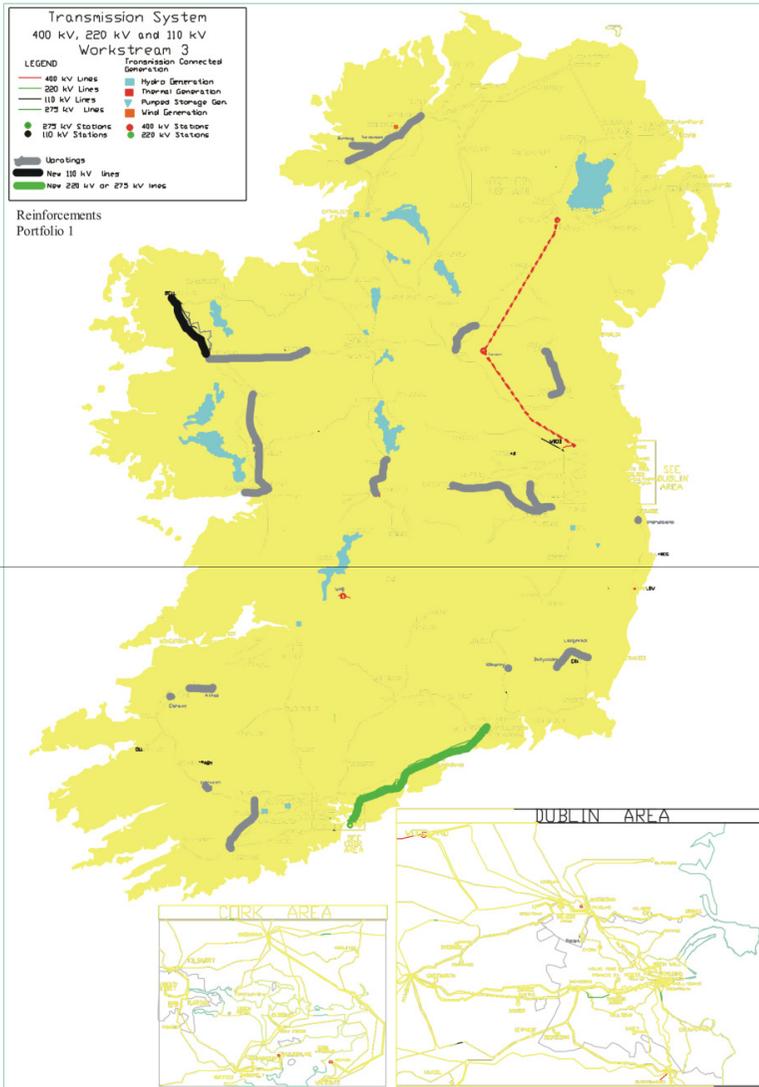
Network protests



An Overview



Upgrades P1 and P5

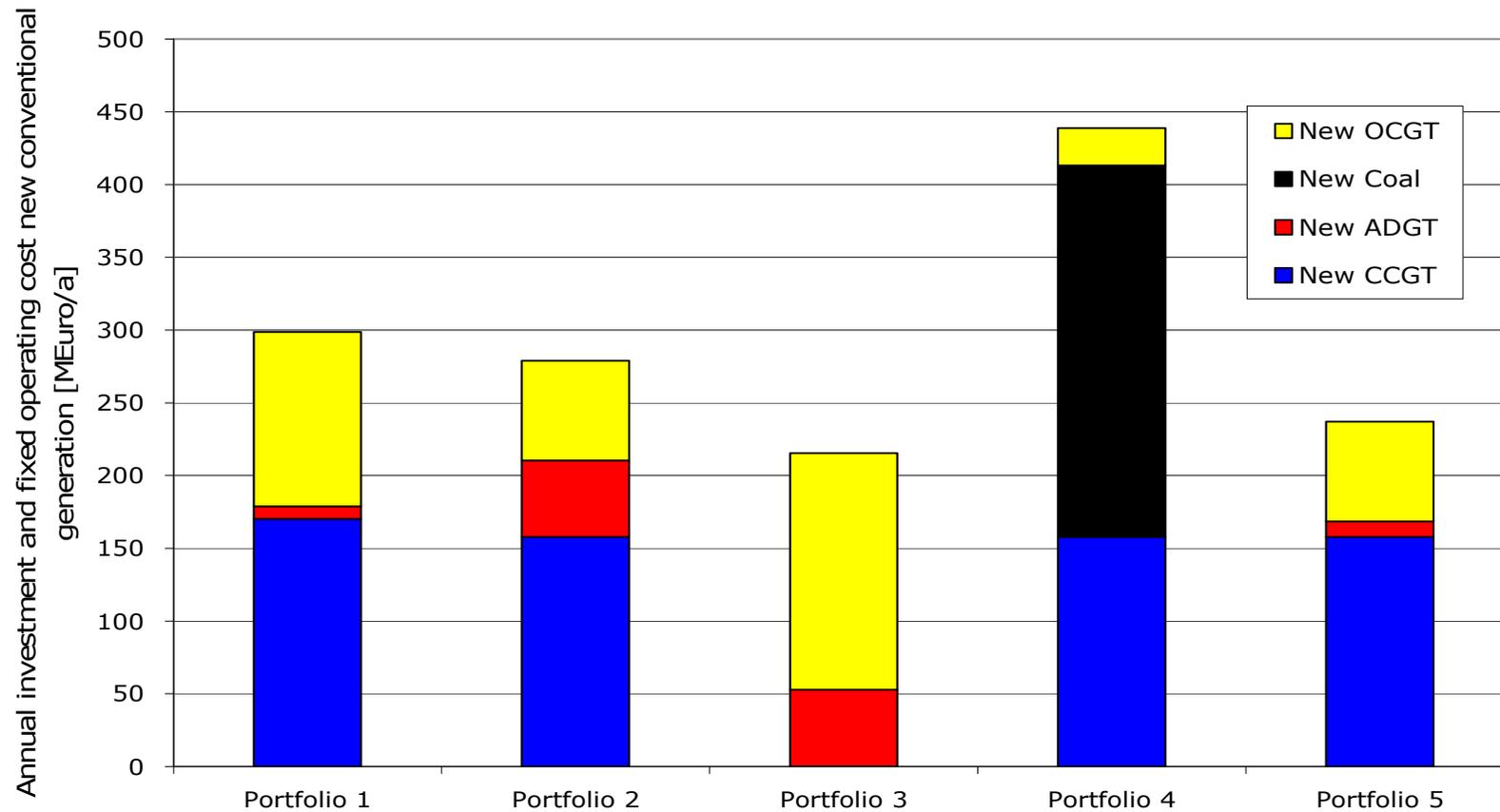




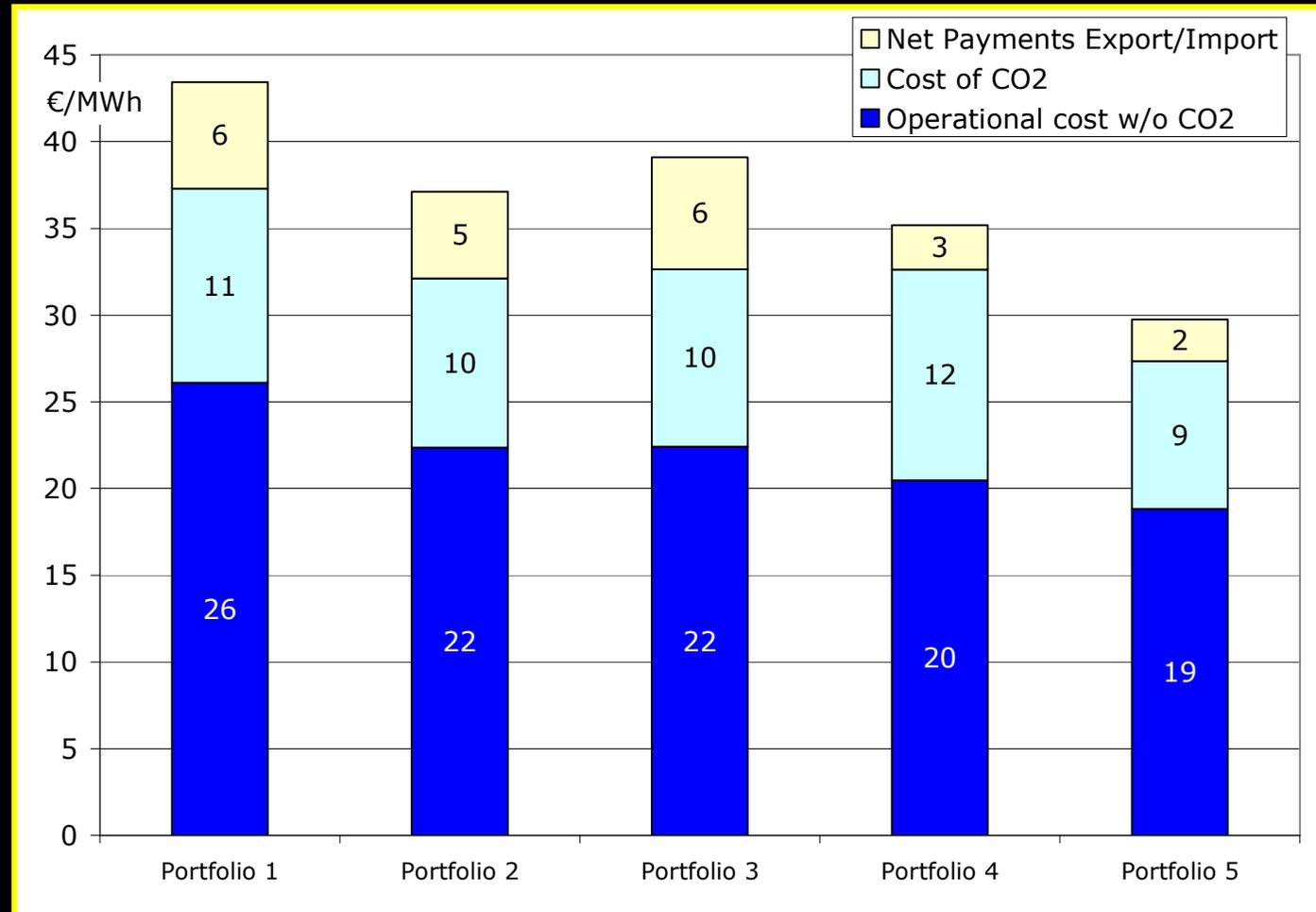
WS 4: Analysis of Impacts and Benefits

Consultant: Ecofys

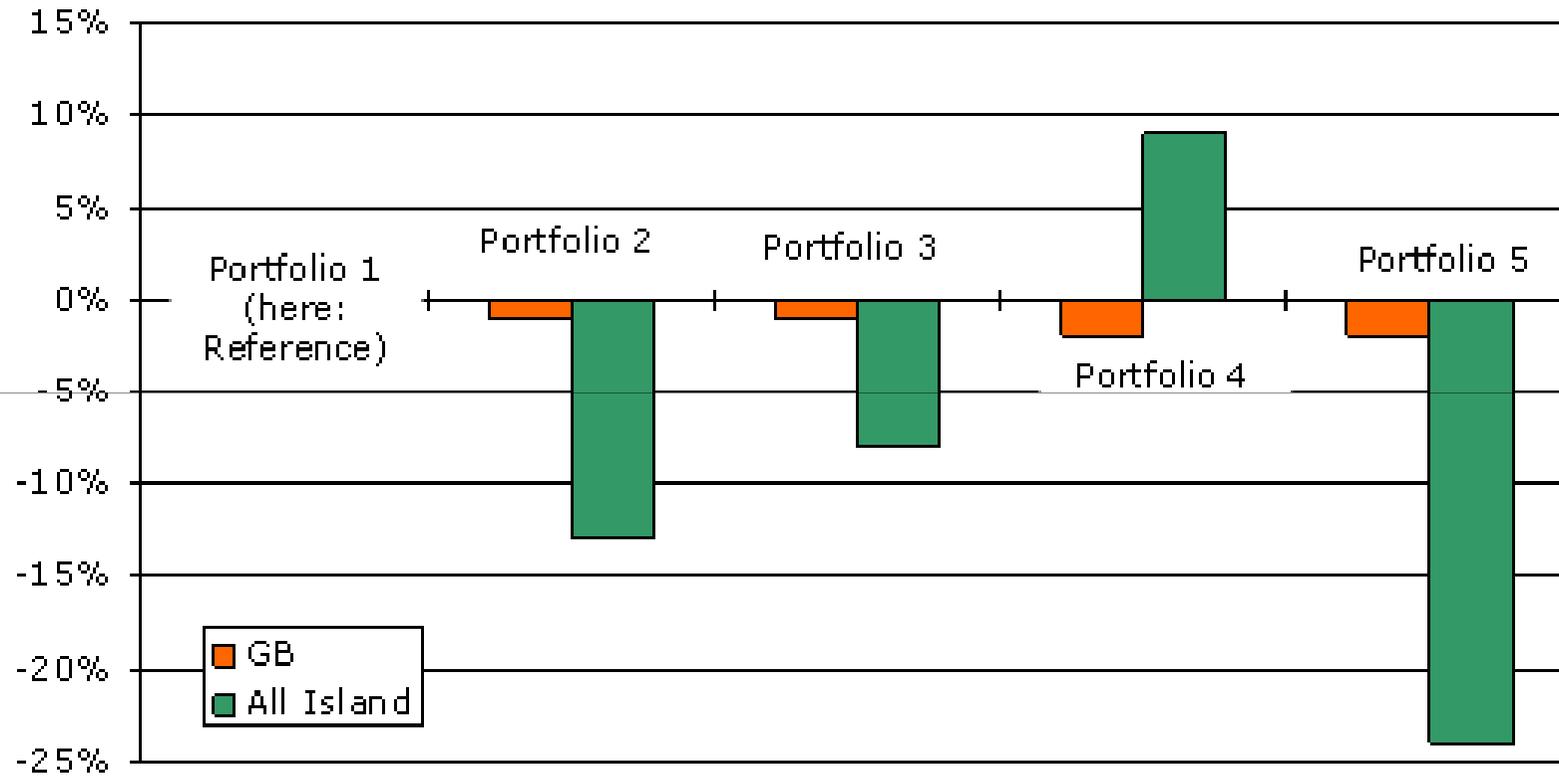
Annual investment and fixed costs for new conventional generation



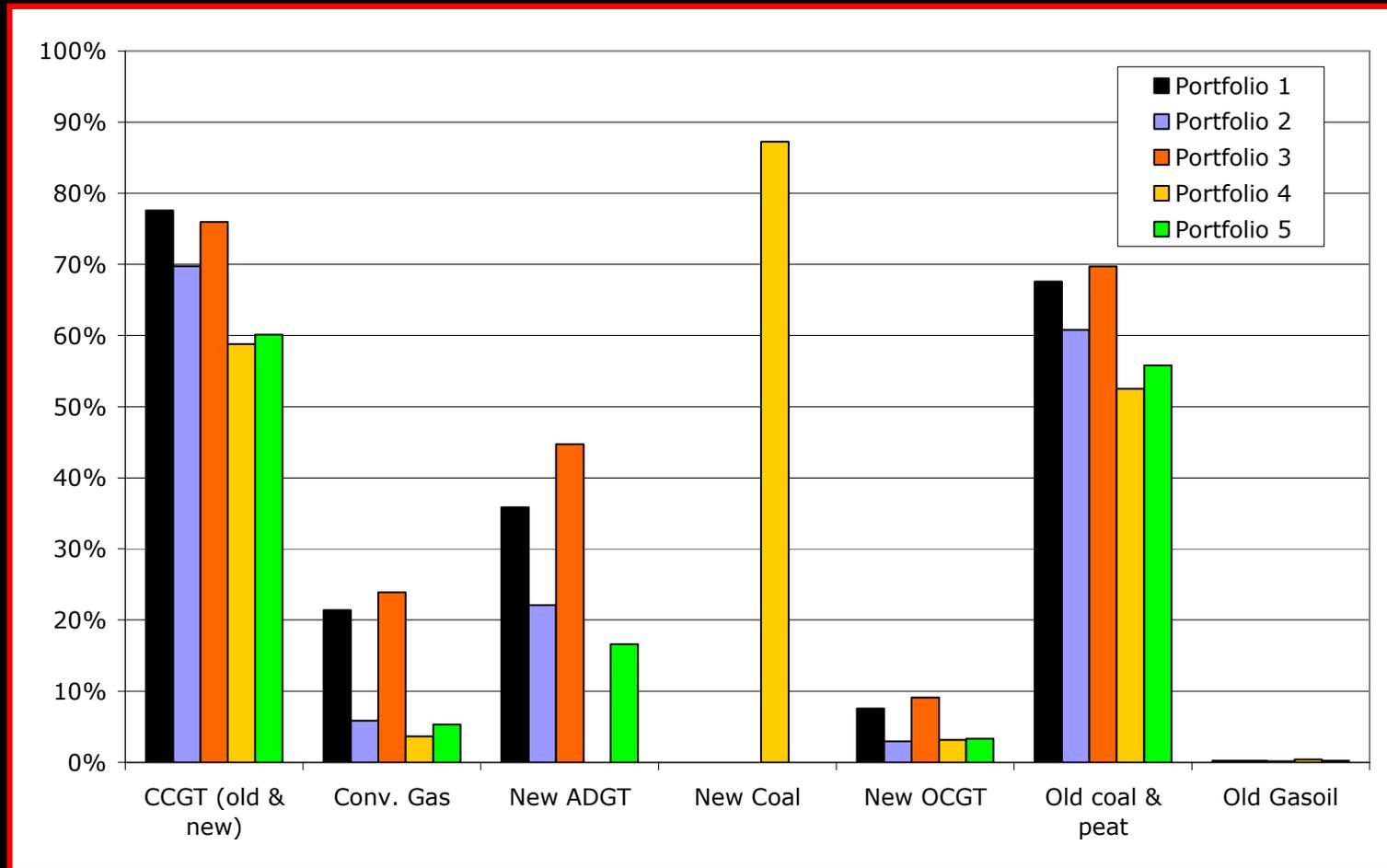
Operational Costs – Conventional Generators



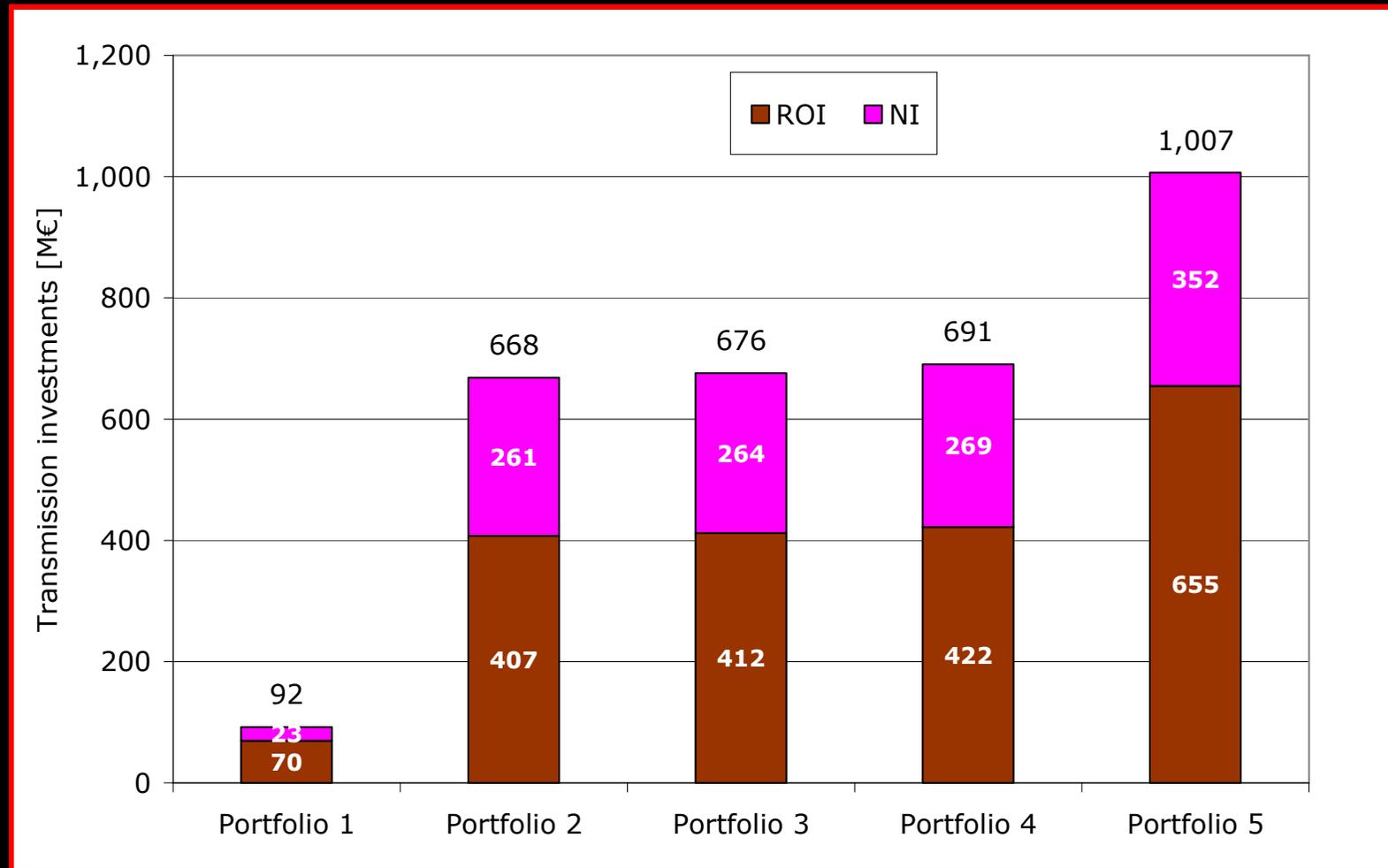
Relative CO₂ Emissions Impact



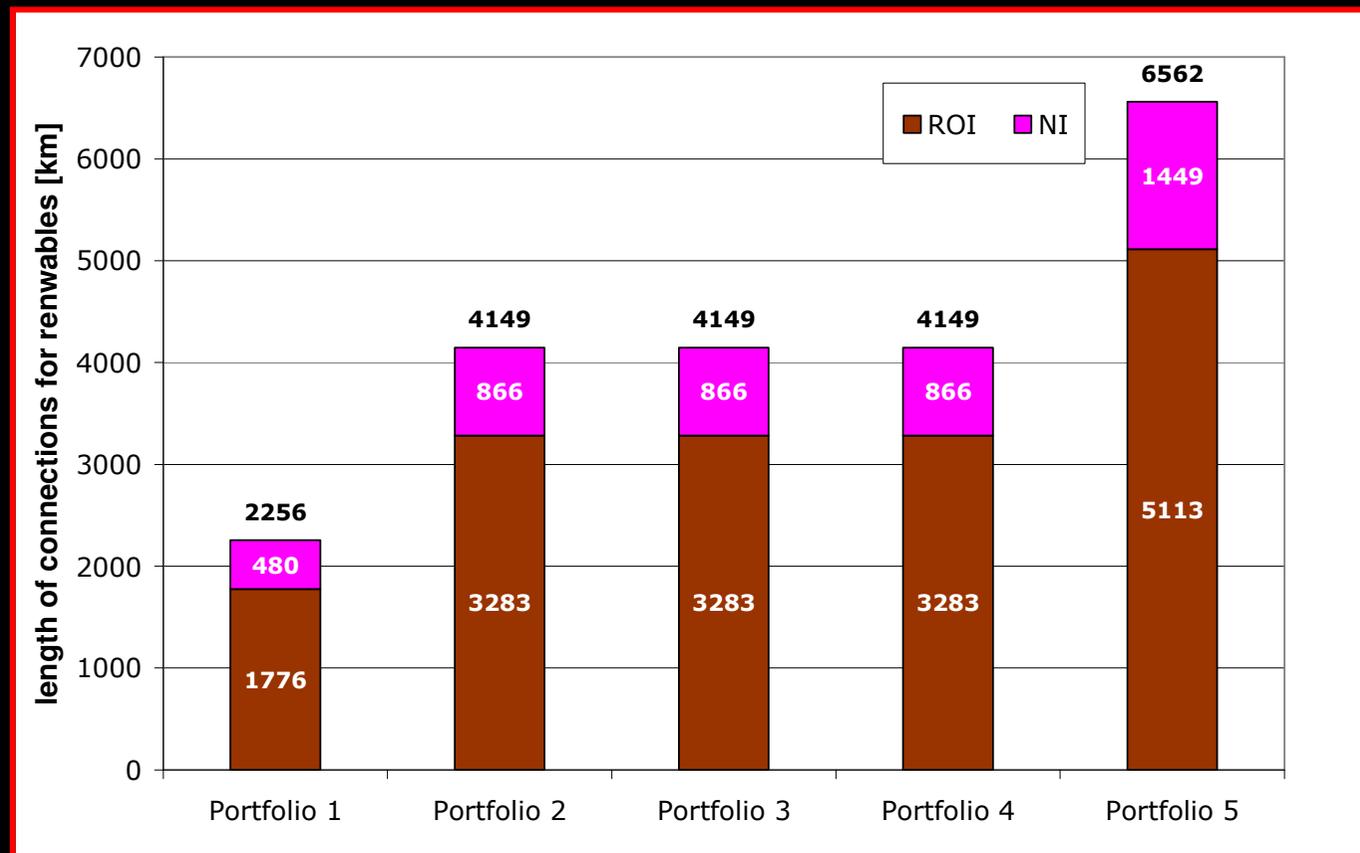
Impact on thermal generation



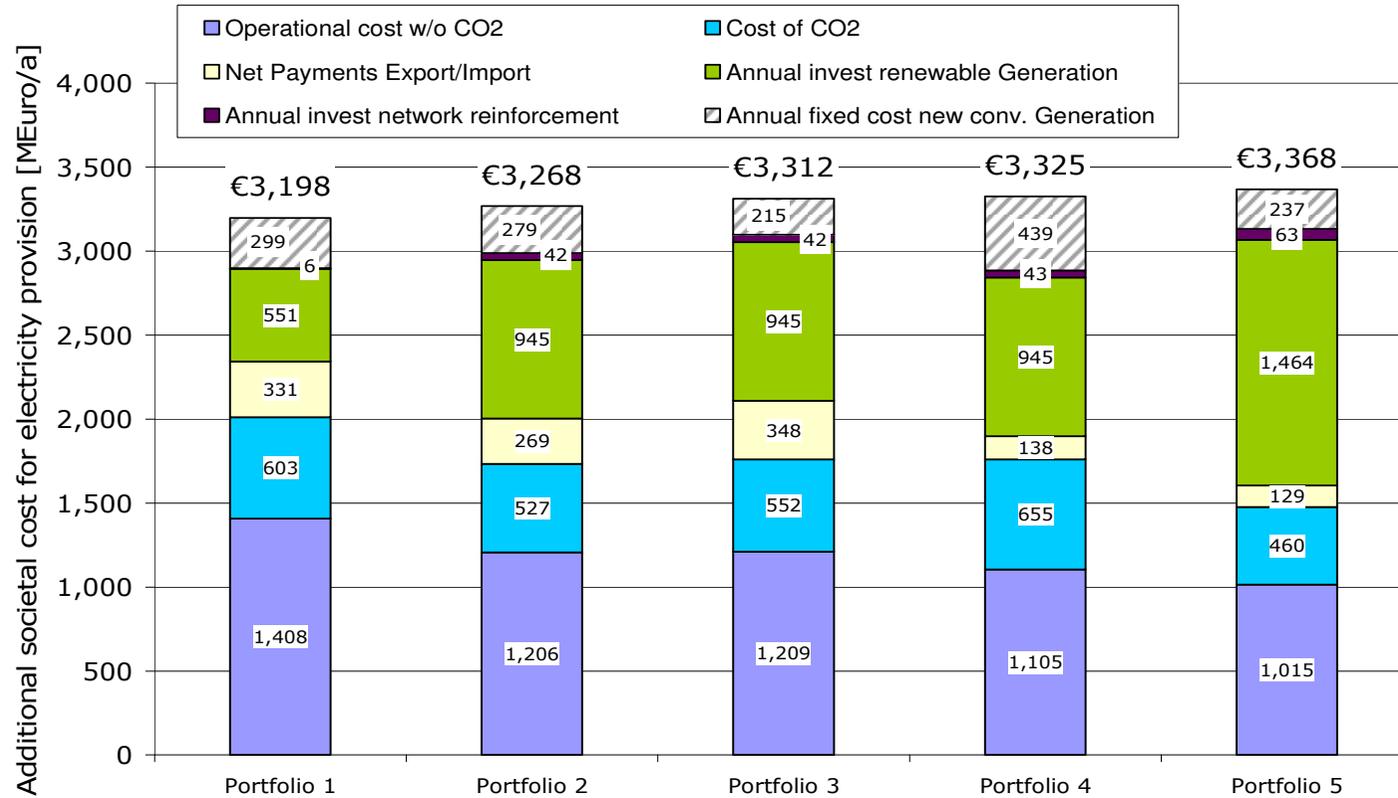
Cost of Transmission System Reinforcement



Other network impacts



Societal Costs of Adopting Portfolios



RE share of demand	16%	27%	27%	27%	42%
CO ₂ emissions [Mt/a]	20	18	18	22	15

Conclusions

- Up to **42% renewables is feasible** (Portfolio 5), requires less imported fuels, and provides CO₂ saving of 25% compared to Portfolio 1
- **Costs to society** of additional renewables (7 %, Portfolio 1 to 5)
 - may change for different fuel and carbon prices
 - these costs are probably underestimates
- Principal form of renewable generation will be **wind**

Conclusions contd.

- Relatively large amount of **high voltage transmission required**
 - low cost but may be difficult to deploy
- Improved **forecasting** and additional **storage** appear not to give significant economic benefit

Limitations etc.

- Interactions
- Market model
- Inefficiency in support mechanism
- Costs not included
- Impact on thermal generation
- Detail transmission network design
- Constraining off
- Sensitivities
- Offshore and wave
- UK system modelling



Further work

- Intra hour operation and dynamics
 - curtailment
- Strategic network planning
 - distribution network
- Operational paradigm
 - forecasting etc.
- Long term data (e.g. wind time series)

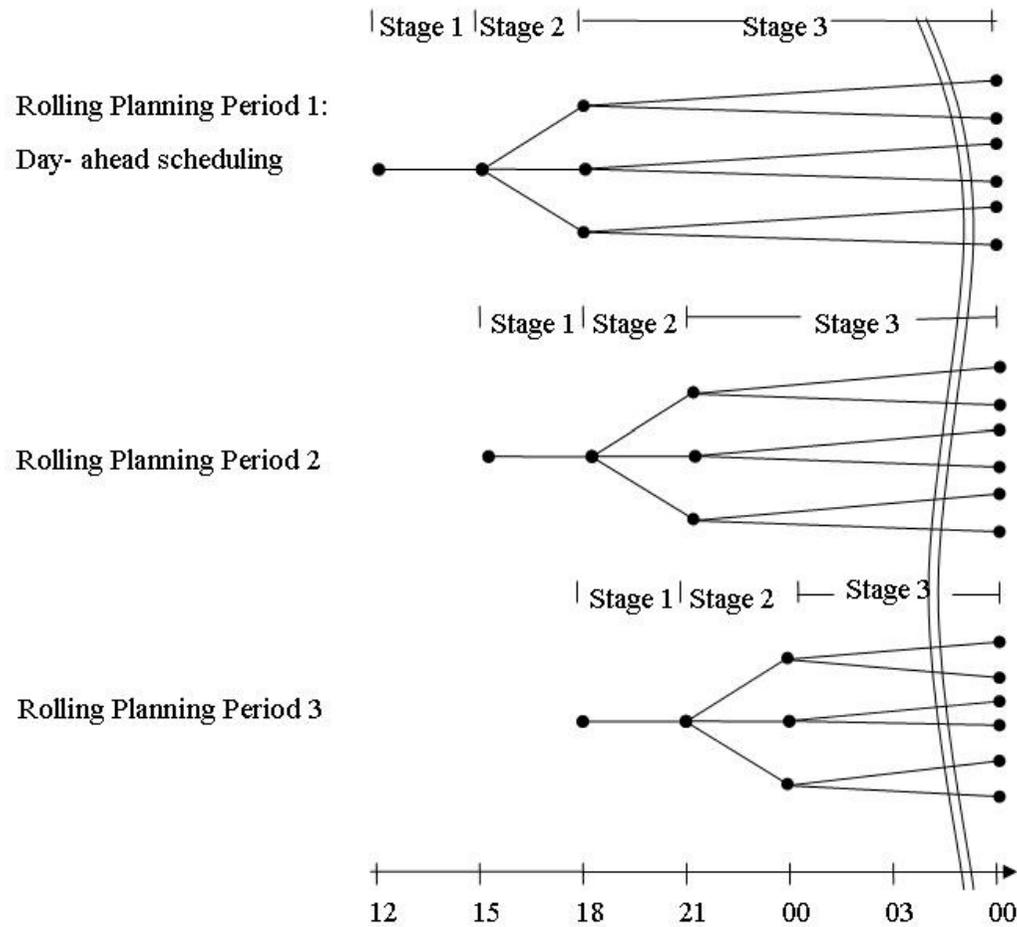
Further work

- Plant mix
 - OCGT/CCGT, storage, demand side management, interconnection
- Market study
 - Electricity market SEM
 - Support mechanism
 - Wider market impacts e.g. gas

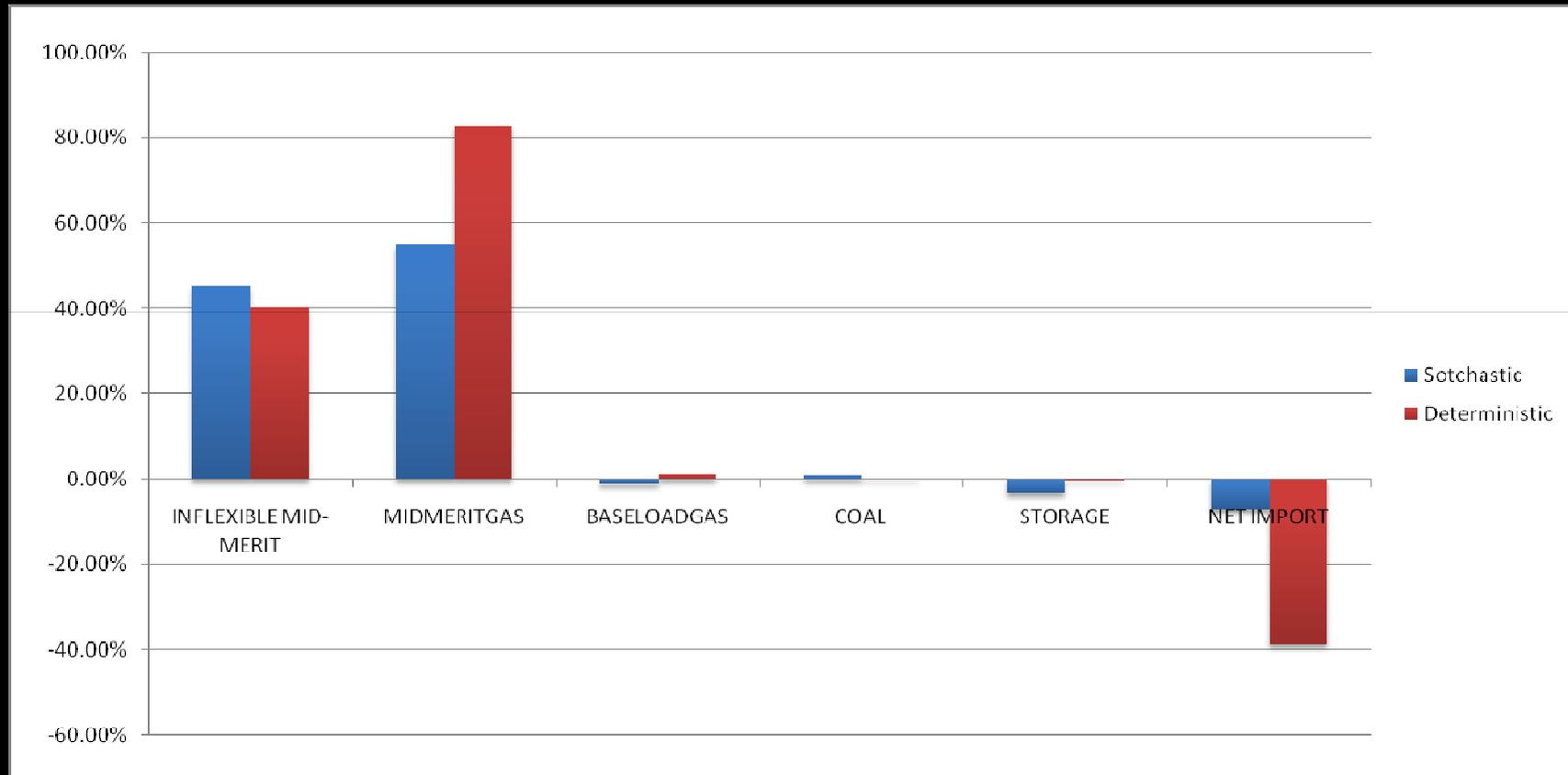
Research Results

Stochastic Unit Commitment
Using the wind forecasts

Wilmar Scheduling Model

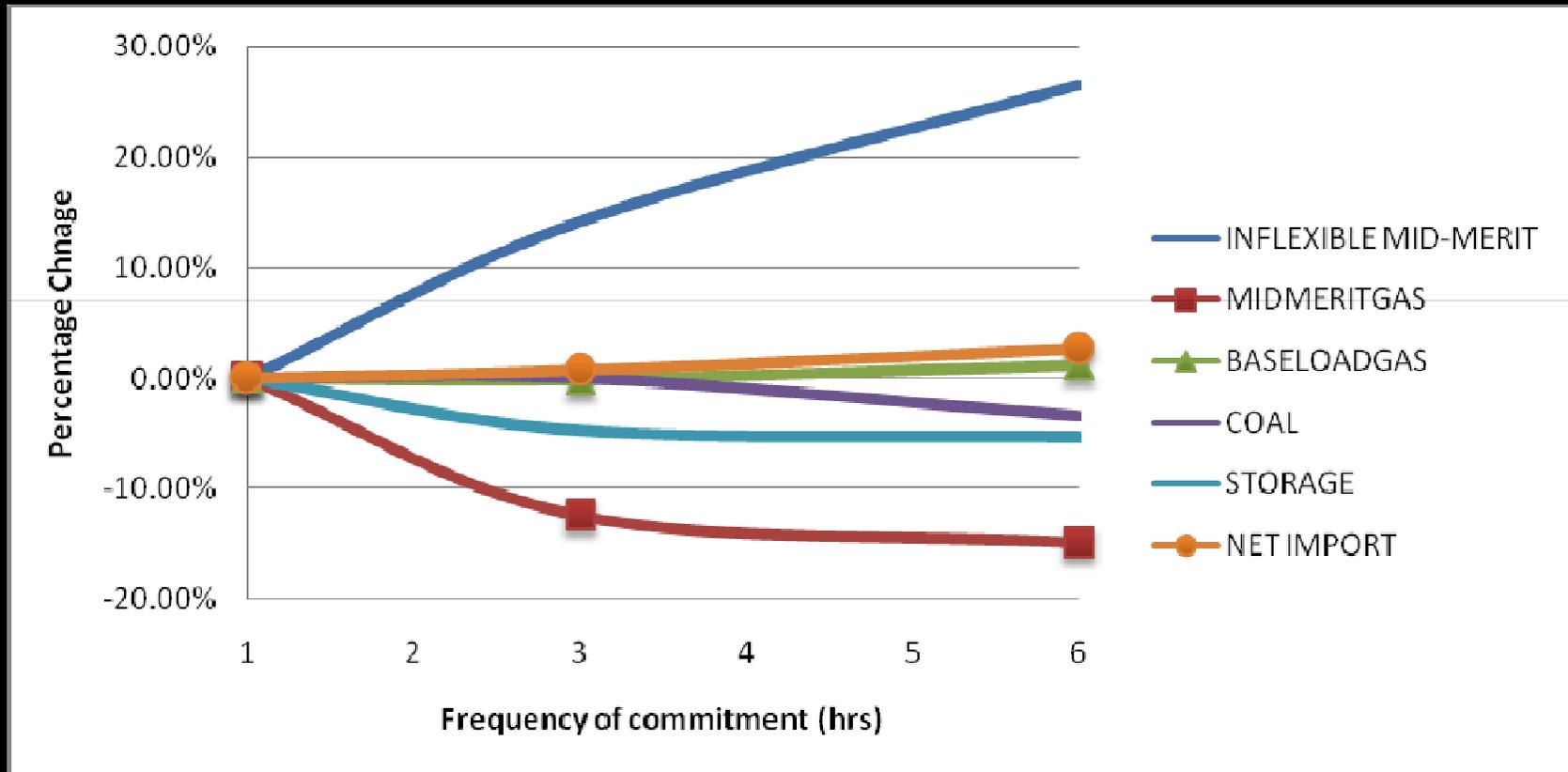


Production by unit type



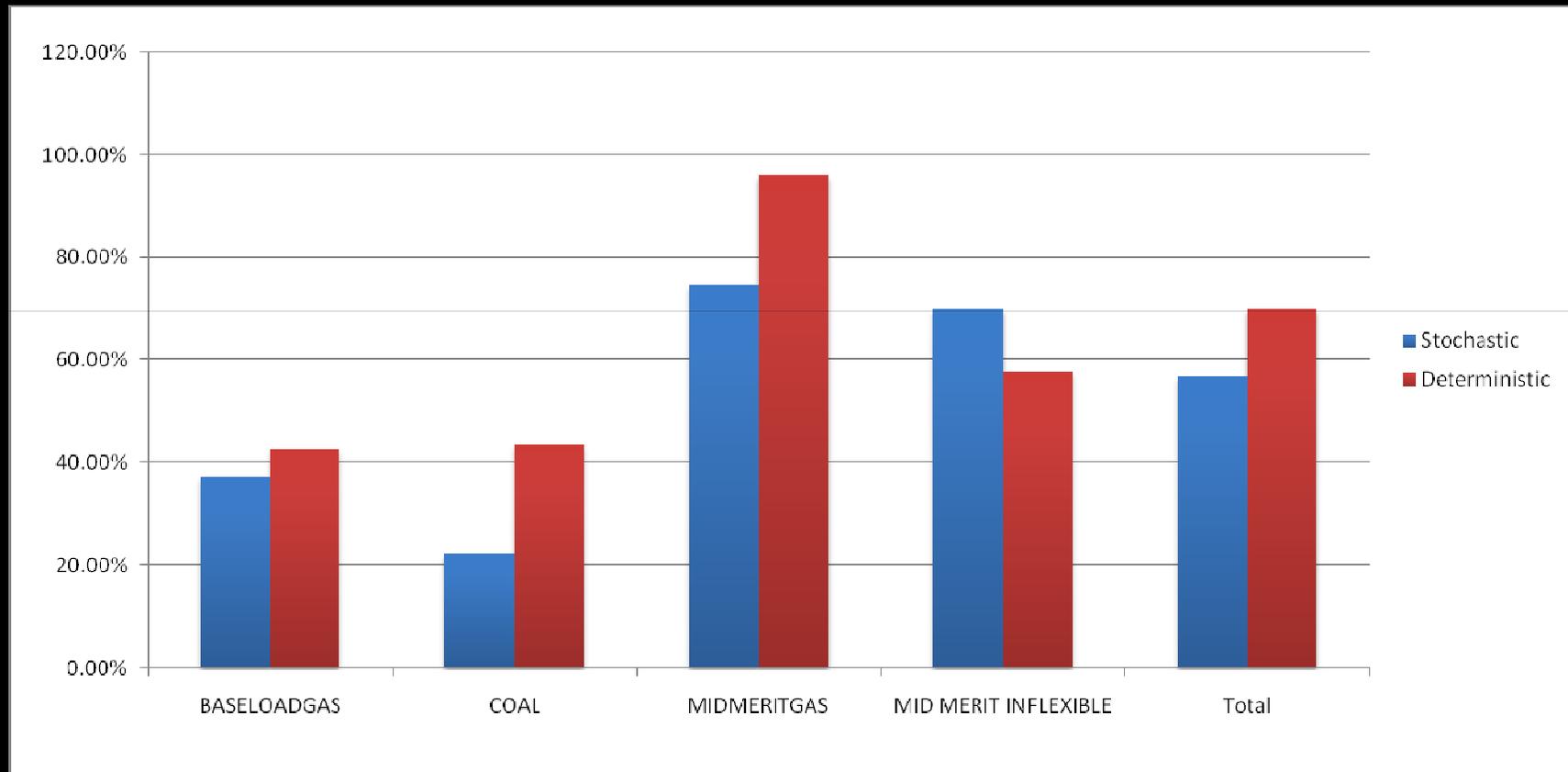
One hour frequency of commitment & base case is perfect forecasting

Production - frequency Commitment



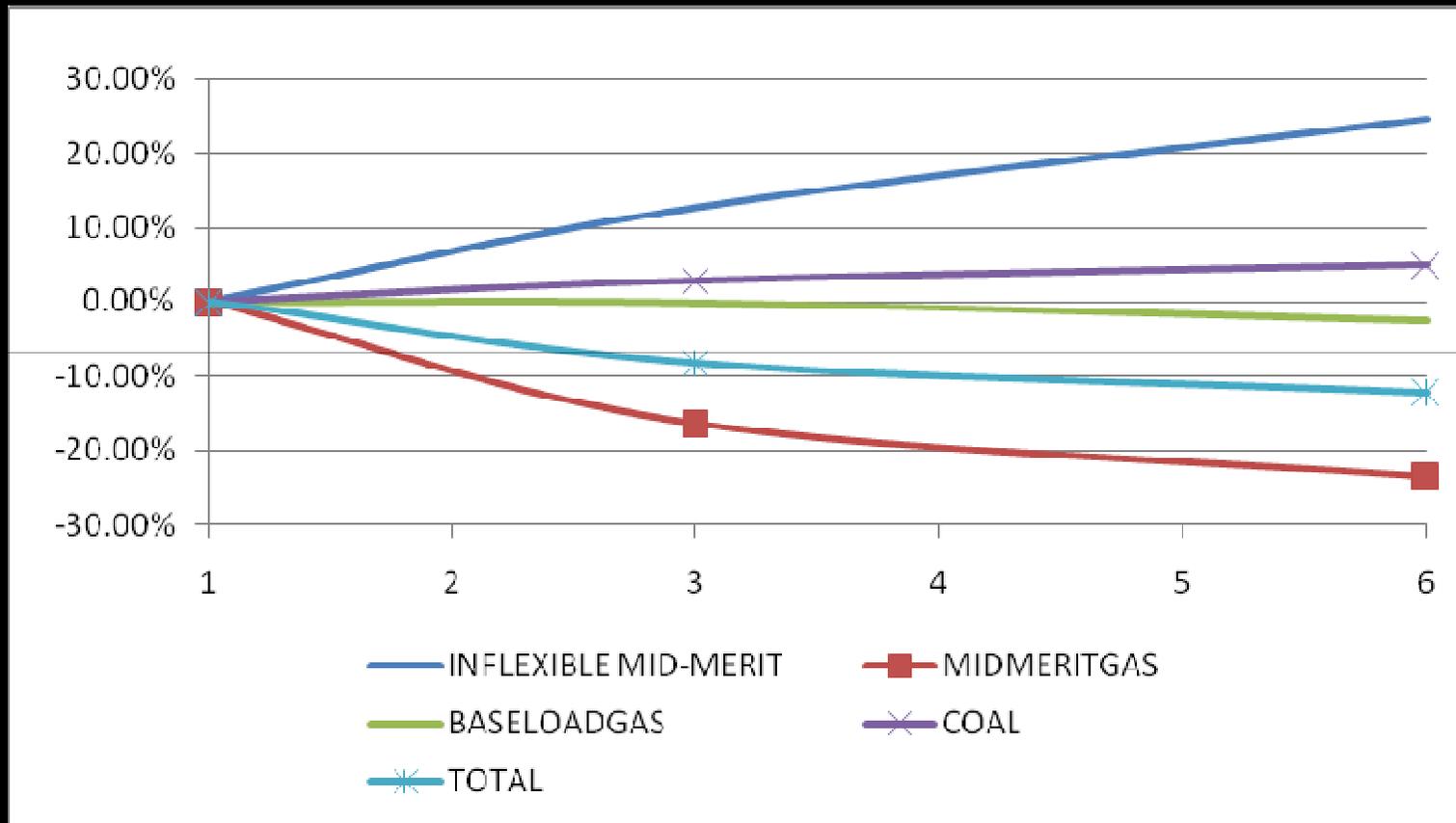
Stochastic

Start-ups by unit type



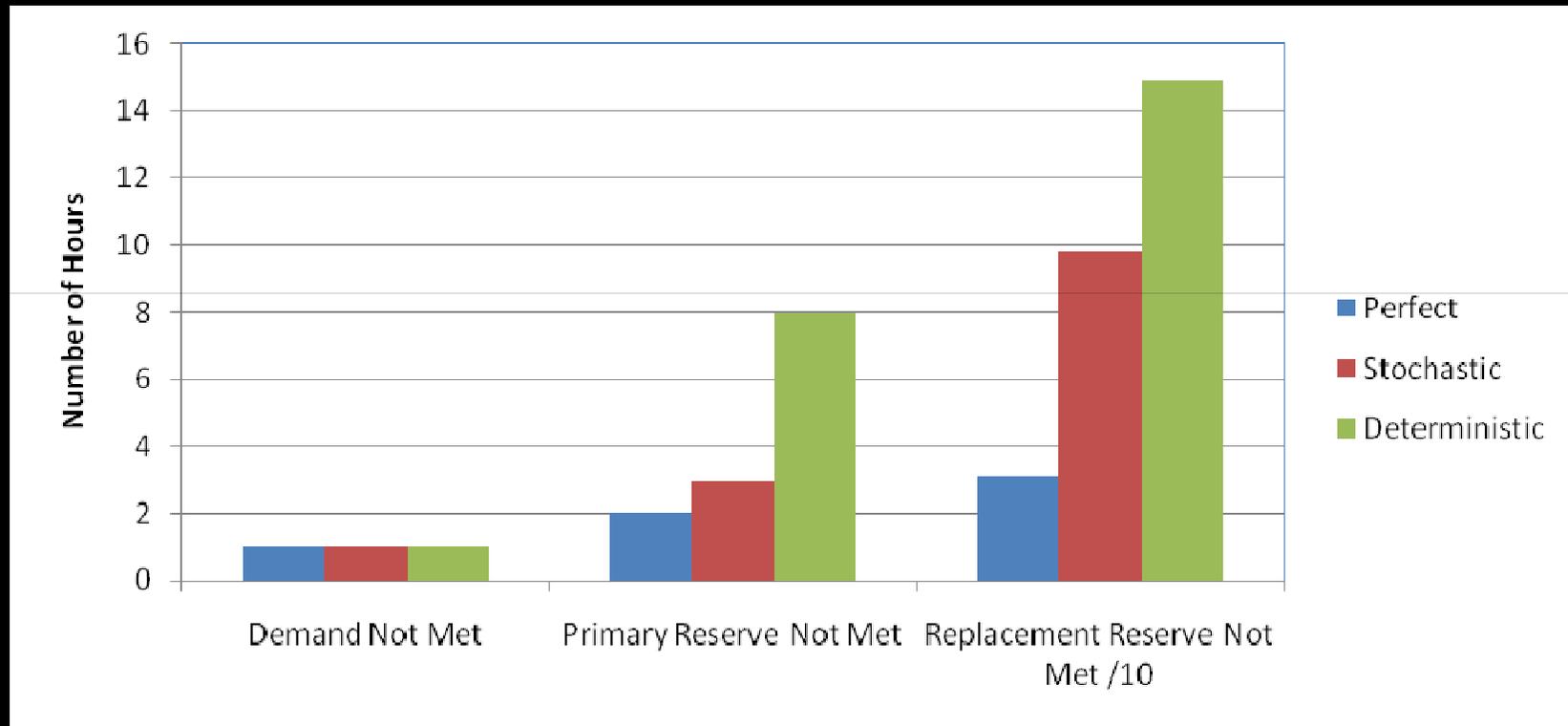
One hour frequency of commitment & base case is perfect forecasting

Start-ups – frequency of commitment



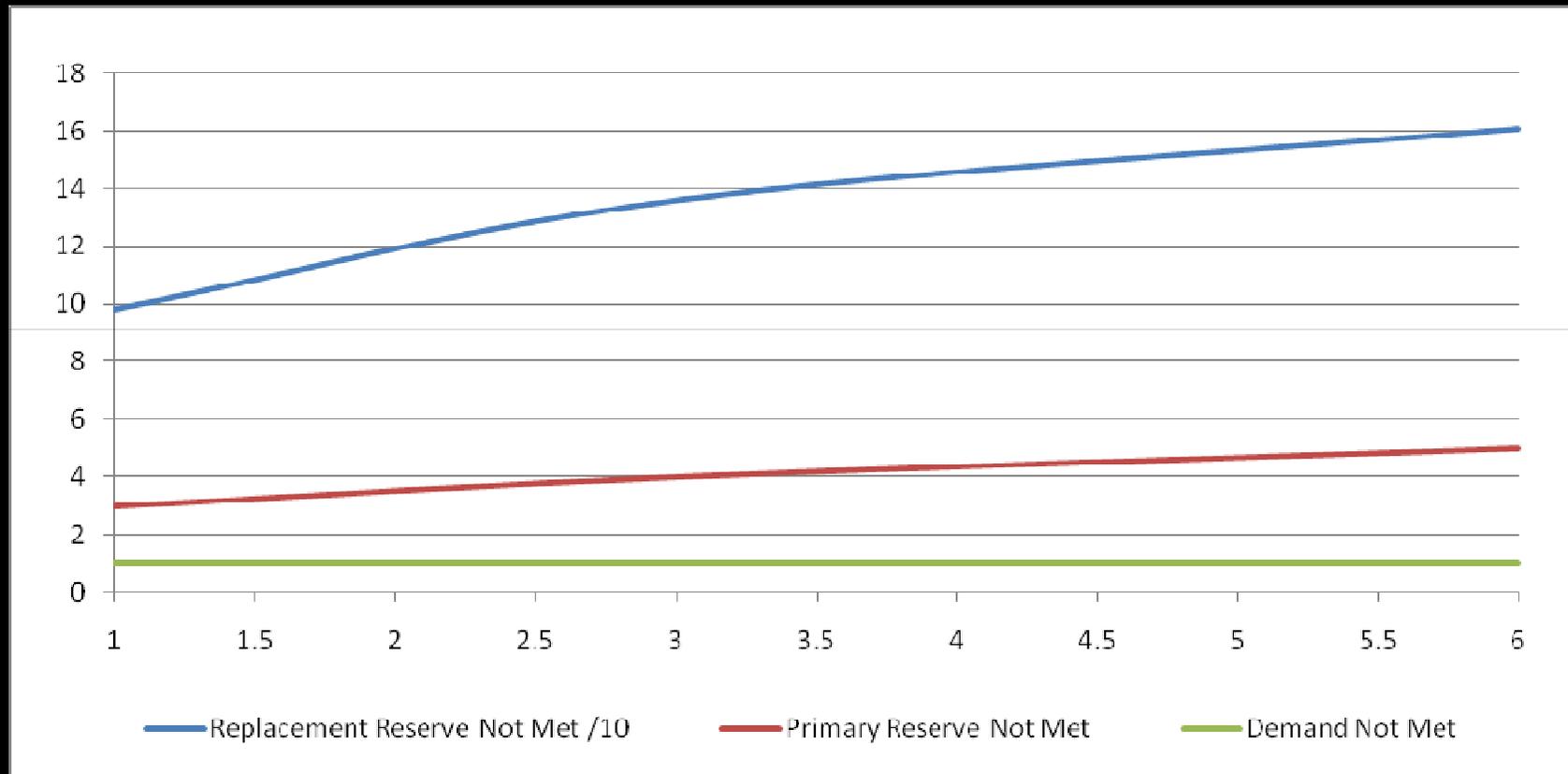
Stochastic

Performance



One hour frequency of commitment

Performance – frequency of commitment

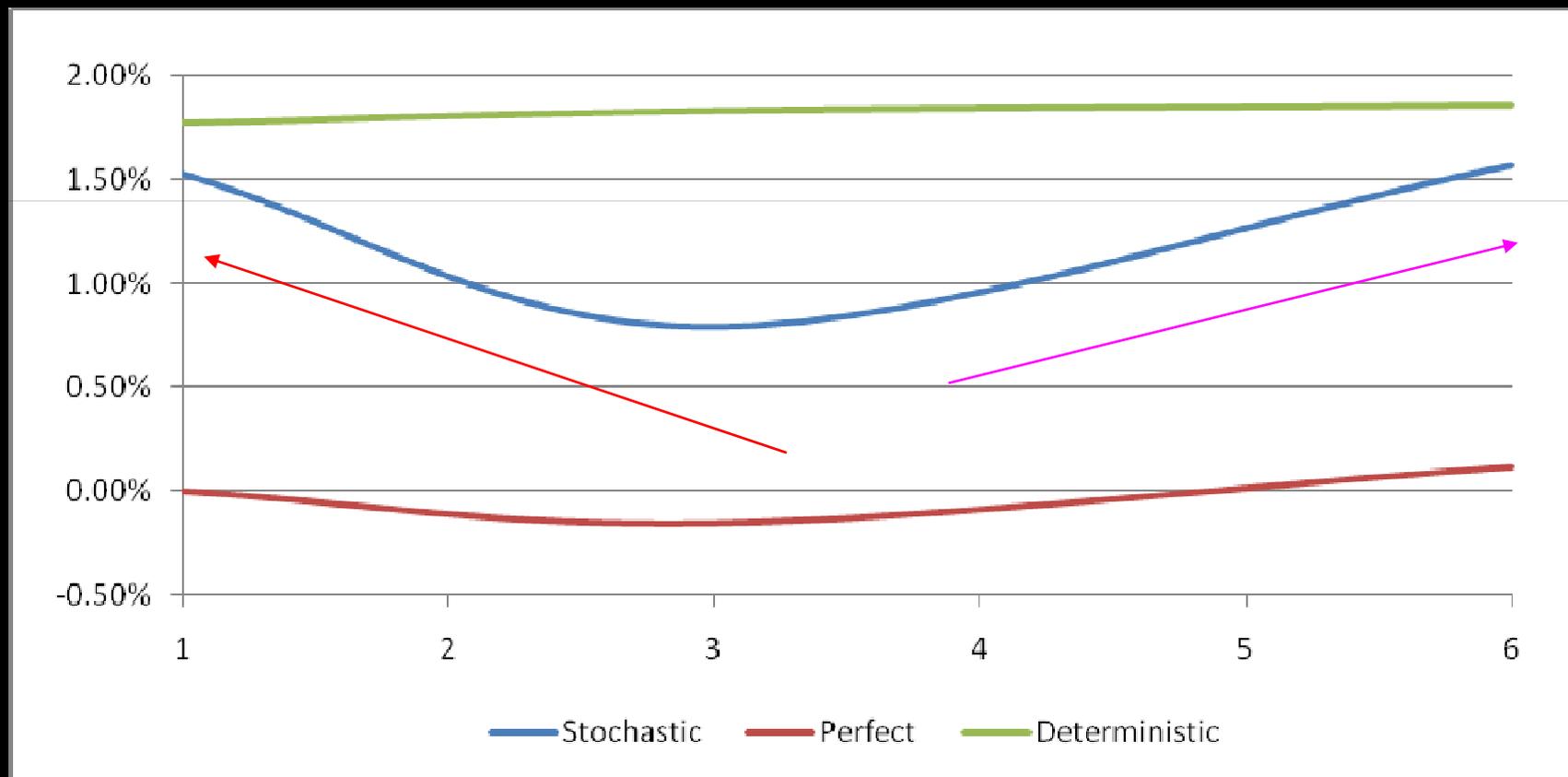


Stochastic

Costs

Uncertainty

Reserve



Conclusions

- Stochastic unit commitment is an obvious step with large wind penetrations
- Need a range of forecasts
- Lower cost & reliability