



Modelling

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Strand Lead (Interim)



- Development of mathematical modelling techniques and tools
 - Stochastic processes
 - Stability assessment
 - Optimization



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Paulo Tubbert Semiao (RA)



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Colm Lowery (PhD)



Aonghus Shortt (PhD)

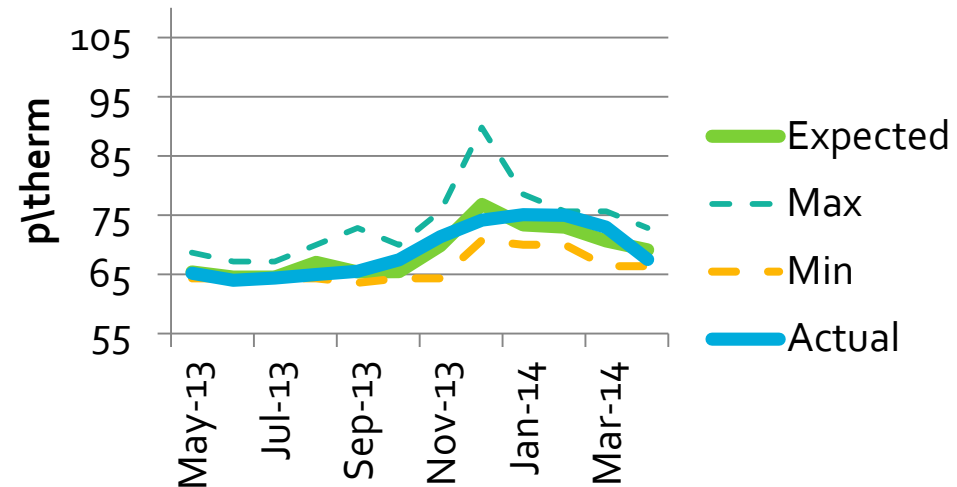
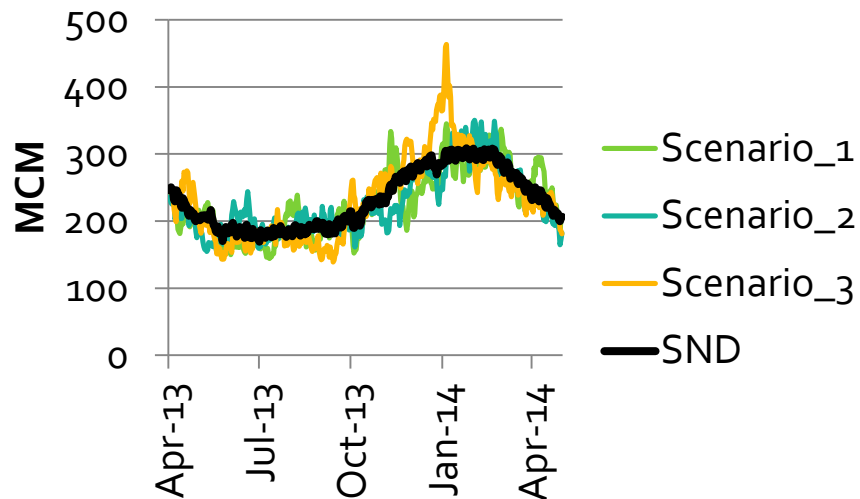


Niamh O'Connell (PhD)



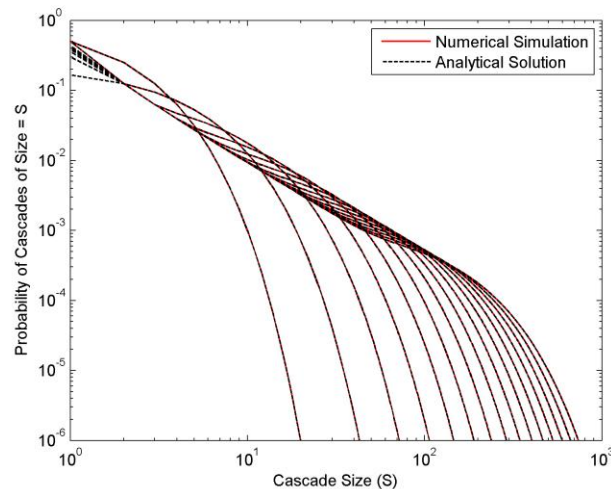
□ Stochastic processes

- Modelling markets
- Informing investment decisions
- Pricing financial options and REFIT



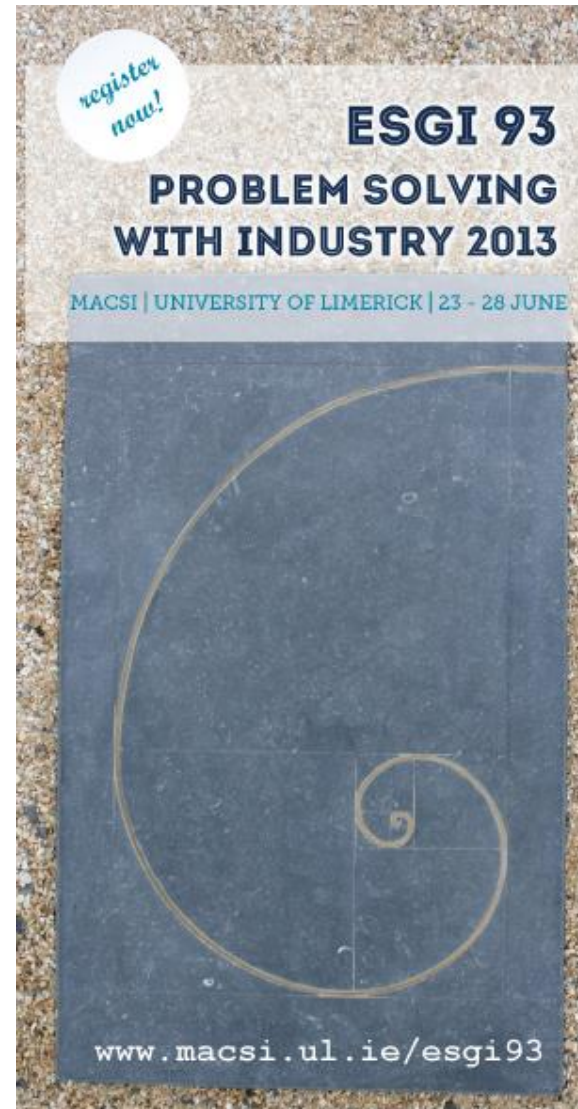
□ Branching processes

- Developing fundamental theory
- Modelling produce uptake (innovation diffusion)
- Cascade dynamics on networks

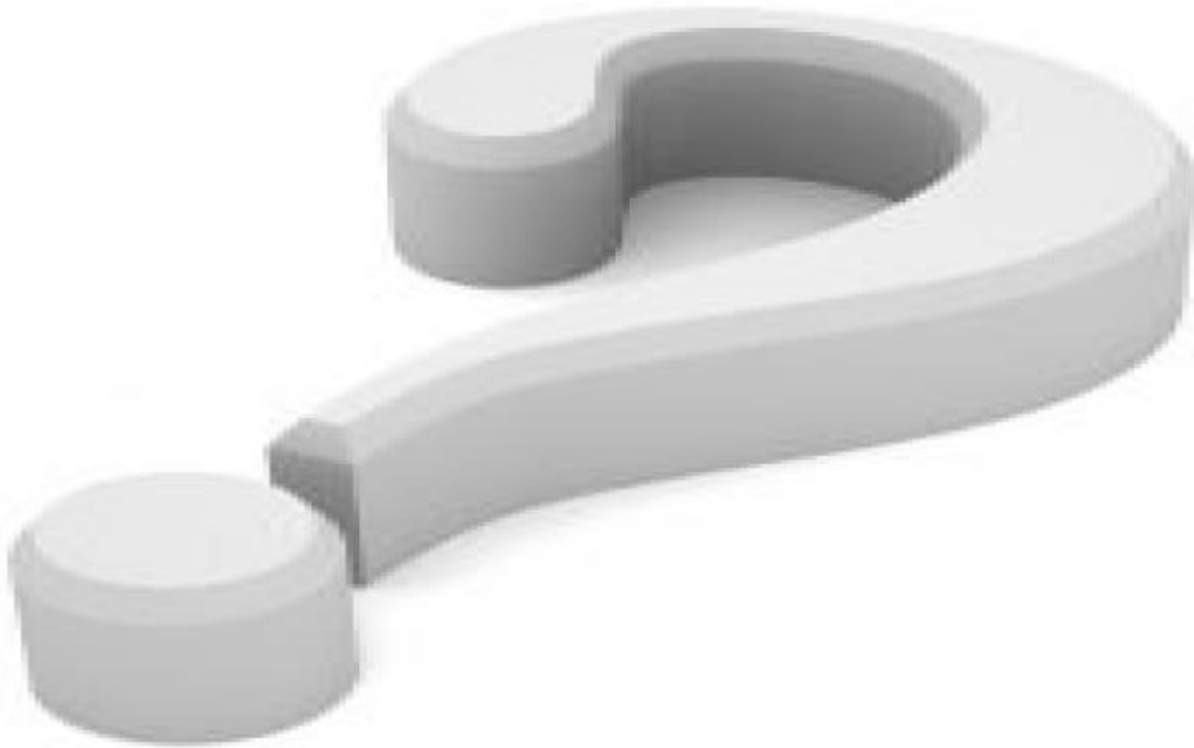


- ❑ 93rd European Study Group
with Industry
- ❑ 23-28 June 2013

- www.macsi.ul.ie/esgi93
- macsi@ul.ie



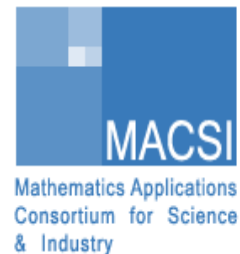
Questions





Modelling the UK natural gas market using a rolling optimisation model

Mel Devine



- Demand for gas in Ireland and the UK is becoming increasingly uncertain.
 - This is due to the increased levels of intermittent wind power available to be used to generate electricity.
- Ireland imports $\approx 90\%$ of its gas from the UK while these imports only make up $\approx 5\%$ of the UK demand.
- Natural gas is the largest source of energy used to generate electricity in Ireland.
- Aim:
 - Model the flows of gas in the UK gas market whilst incorporating the uncertain nature of demand.

- This model attempts to replicate the daily decisions that are made on how to meet gas demand under uncertain information about future demand.
- The exactly known demand on day zero (today) must be met by the different sources of supply at minimum cost while ensuring all the different possible future demands are also met at minimum expected cost.
- Once the demand is met on the first day the model is updated and moves forward to a new day where a new exactly-known demand must be met whilst taking into account future demands.

Rolling Optimisation Model of UK gas market 11

$$\min \sum_{p=1}^P (c_p Q_{p,d_0}) + \sum_{so=1}^{SO} (a_{so} I_{so,d_0} + b_{so} W_{so,d_0}) +$$

$$E_S \left[\sum_{d=d_0+1}^D \left(\sum_{p=1}^P (c_p Q_{p,d}^s) + \sum_{so=1}^{SO} (a_{so} I_{so,d}^s + b_{so} W_{so,d}^s) \right) \right]$$

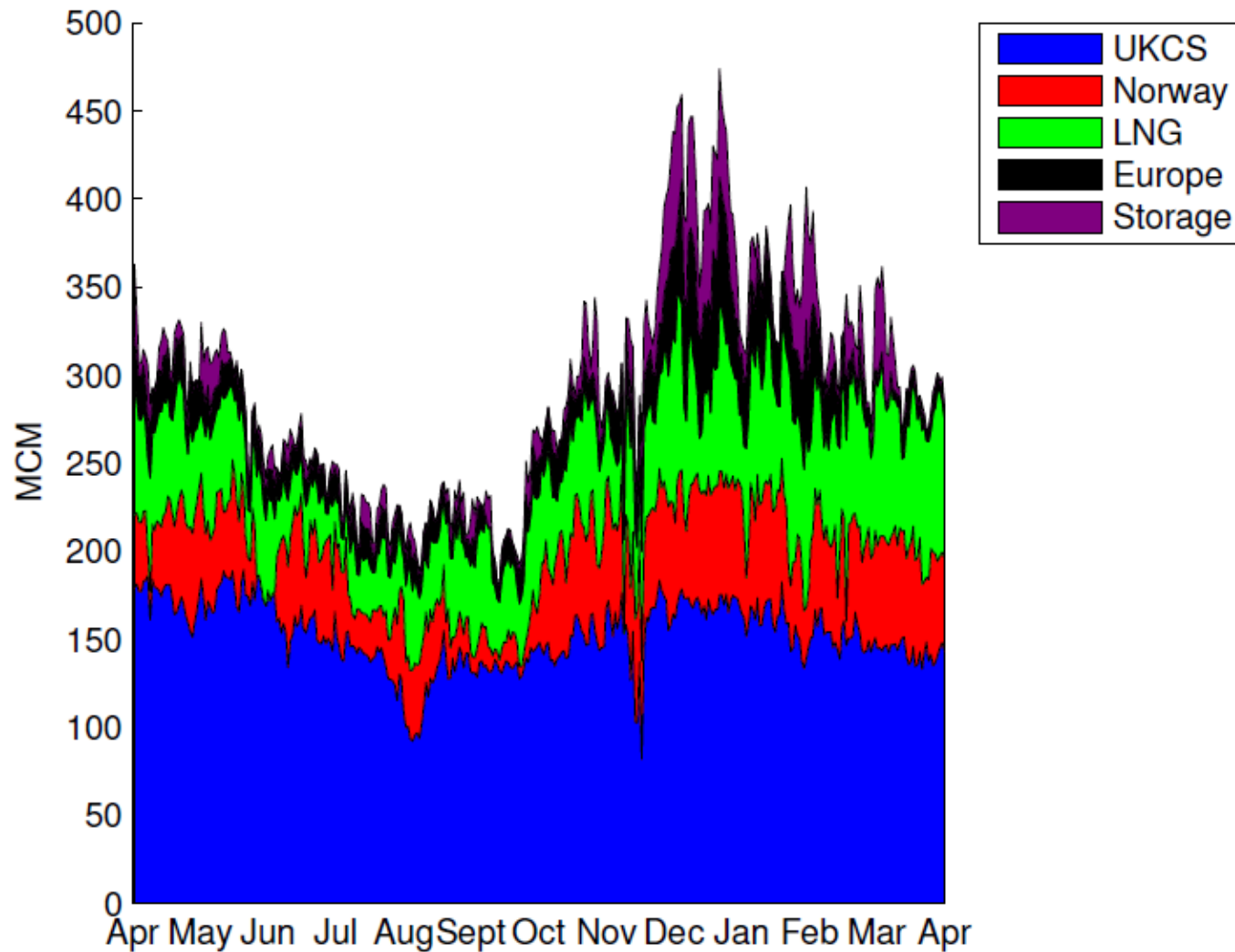
subject to:

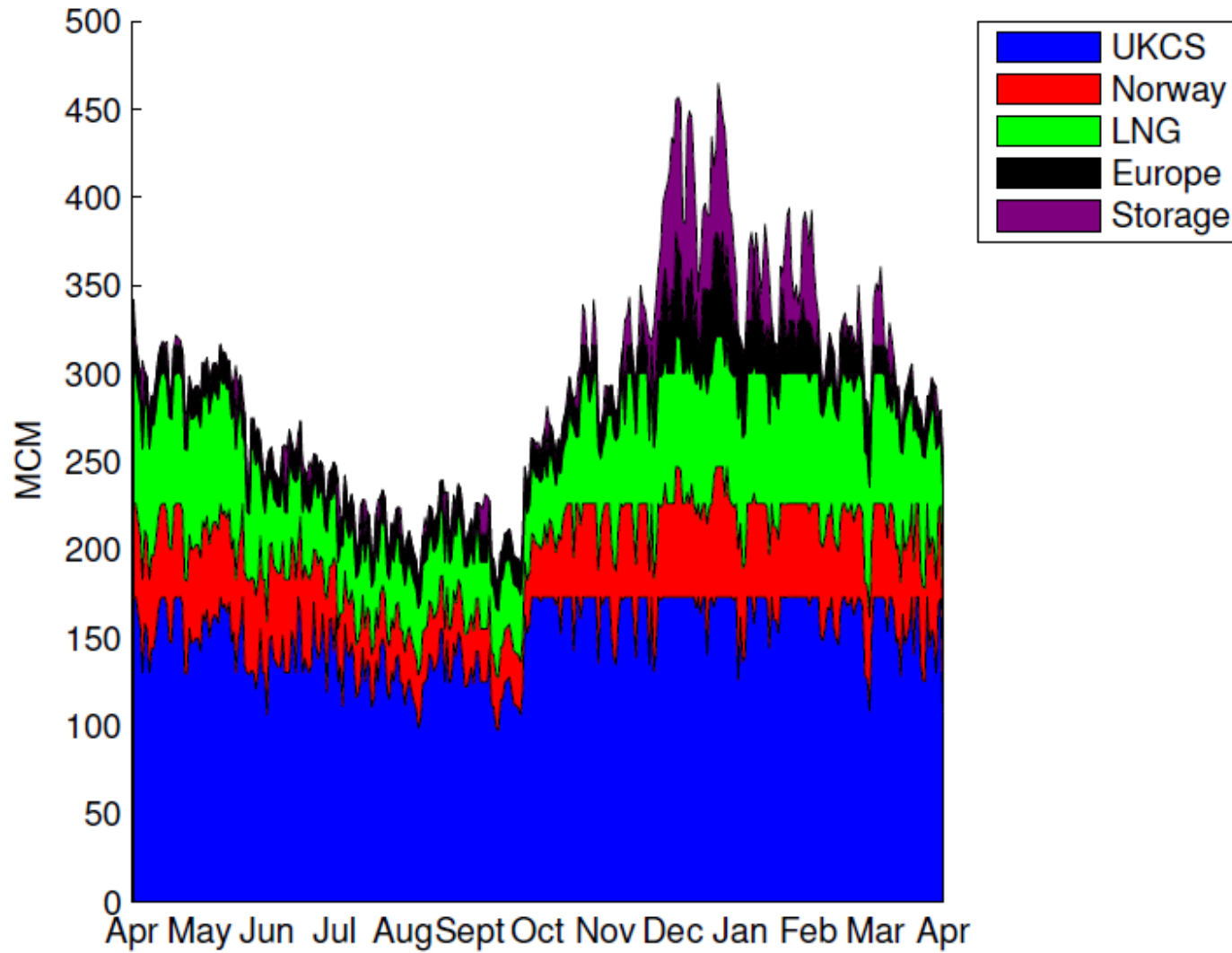
$$\sum_{p=1}^P Q_{p,d_0} + \sum_{so=1}^{SO} (W_{so,d_0} - I_{so,d_0}) = demand_{d_0} \quad (1)$$

$$\sum_{p=1}^P Q_{p,d}^s + \sum_{so=1}^{SO} (W_{so,d}^s - I_{so,d}^s) = demand_d^s \quad \forall s, d > d_0, \quad (2)$$

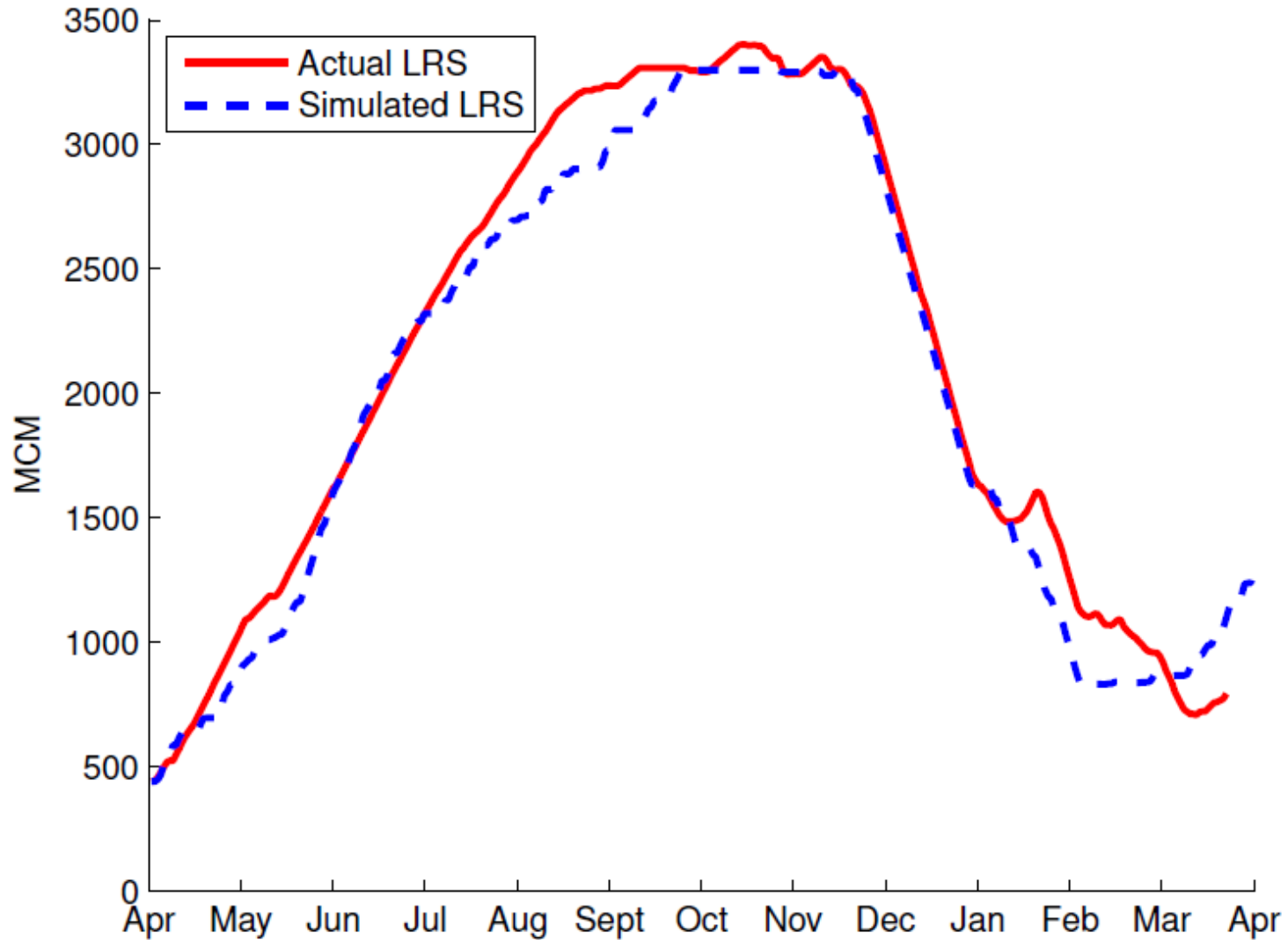
▶ plus production, storage and importation constraints.

Actual demand profile for April '10 - '11

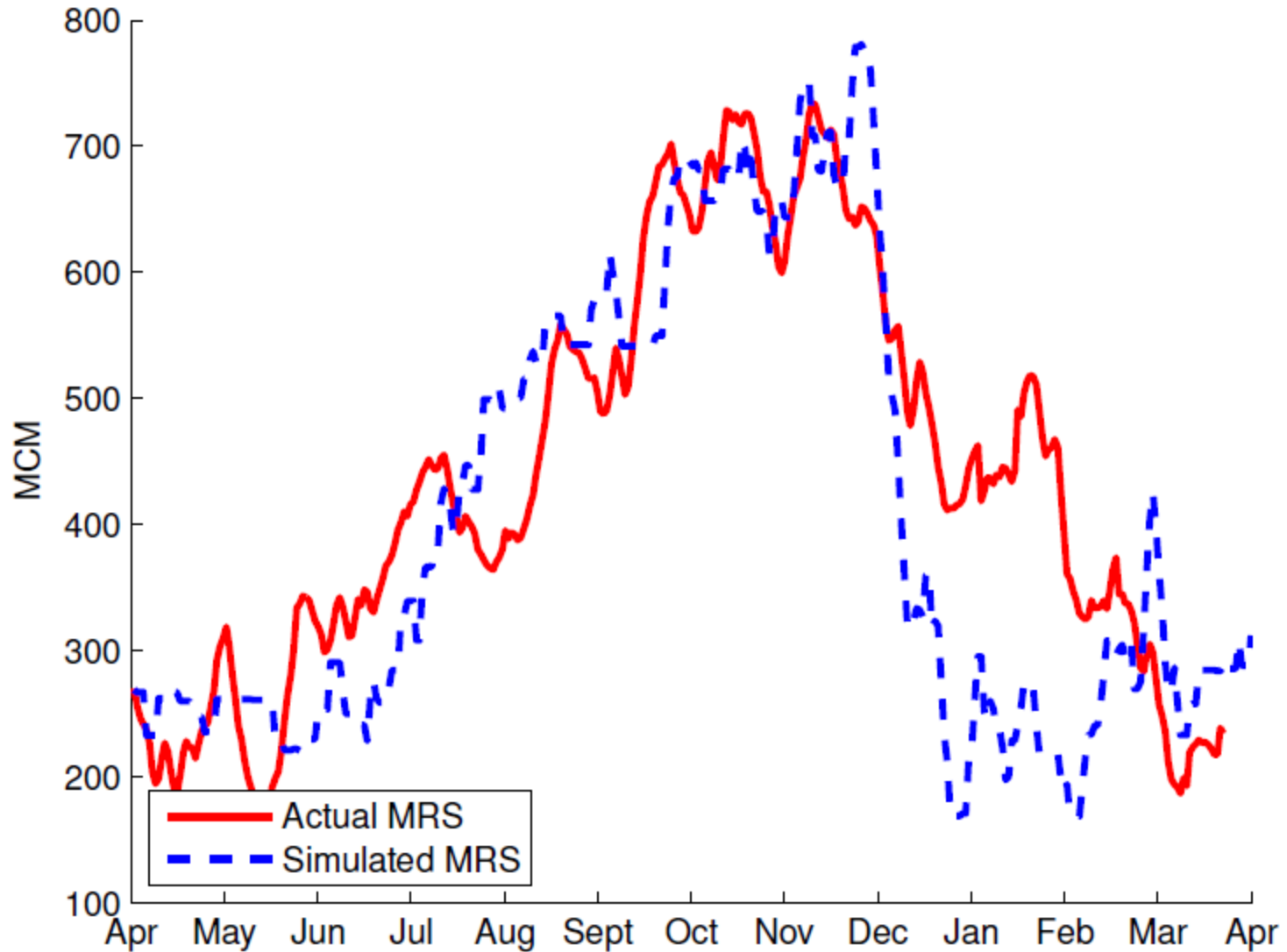


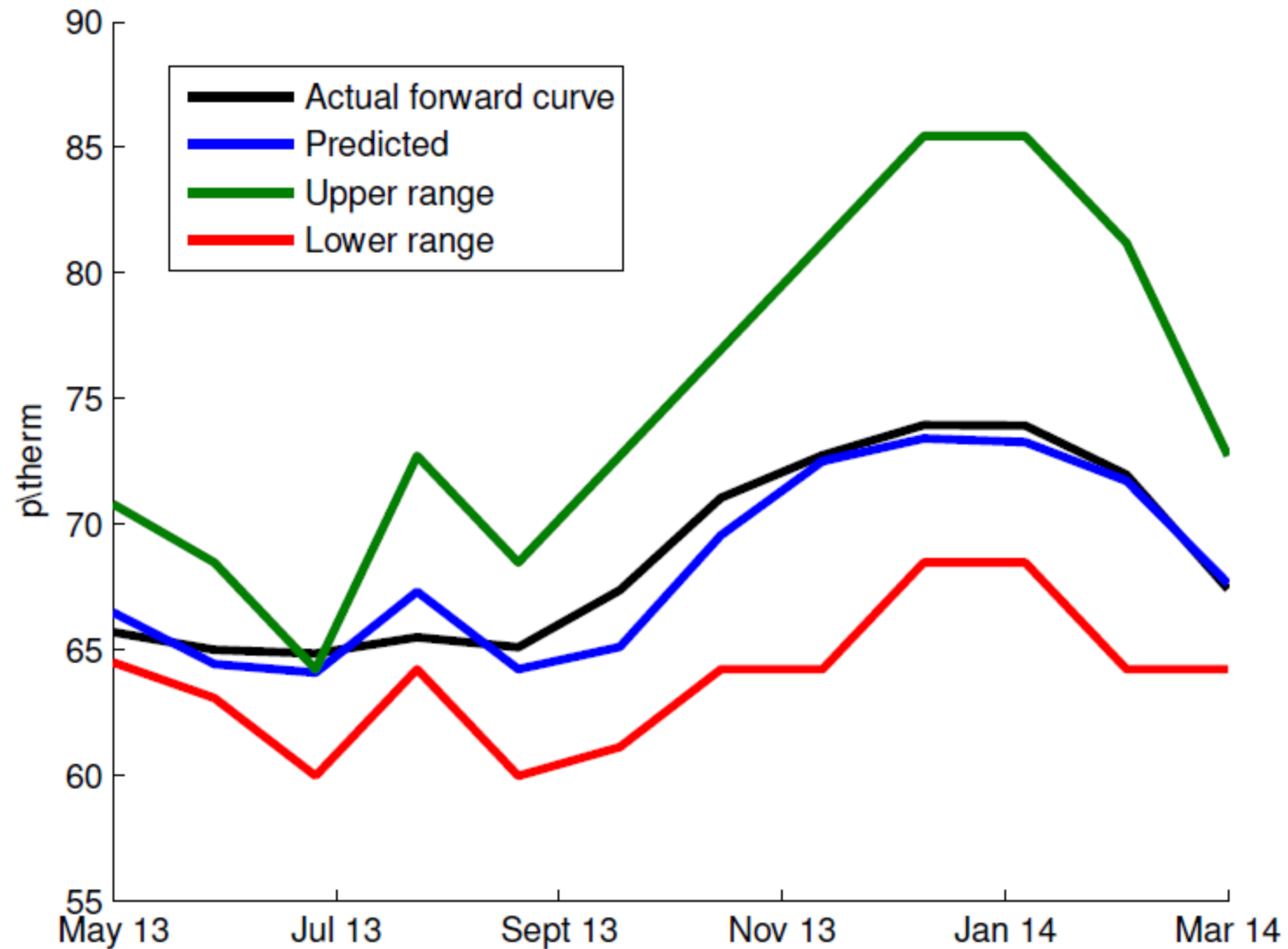


Results: Simulated amount of Long Range Storage



Results: Simulated amount of Medium Range Storage





- Developed a model of the UK natural gas market incorporating the uncertain nature of demand.
 - The flows of gas obtained from this model replicate actual historic flows.
- The model can be used to examine various 'stress-tests', e.g., an extremely cold winter or a sudden loss in Norwegian supply.
- Following an eight week consultancy project, Bord Gáis Energy now use the model as a risk analysis tool.

