

***Making networks fit for  
renewables ...***

**Managing intermittency**

**Goran Strbac  
Imperial College**

**23 October 2008**



# Acknowledgements



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- Challenges in integrating renewable generation
- Looking ahead.....
  - Short term: networks
    - Access and network pricing, review of network operation and planning principles
  - Medium term: system balancing
    - Capacity margin, plant utilisation, reserves, plant flexibility, role of demand side, storage and interconnections
  - Long term: decarbonised electricity system
    - Role of flexibility

# Challenges of integrating renewable generation



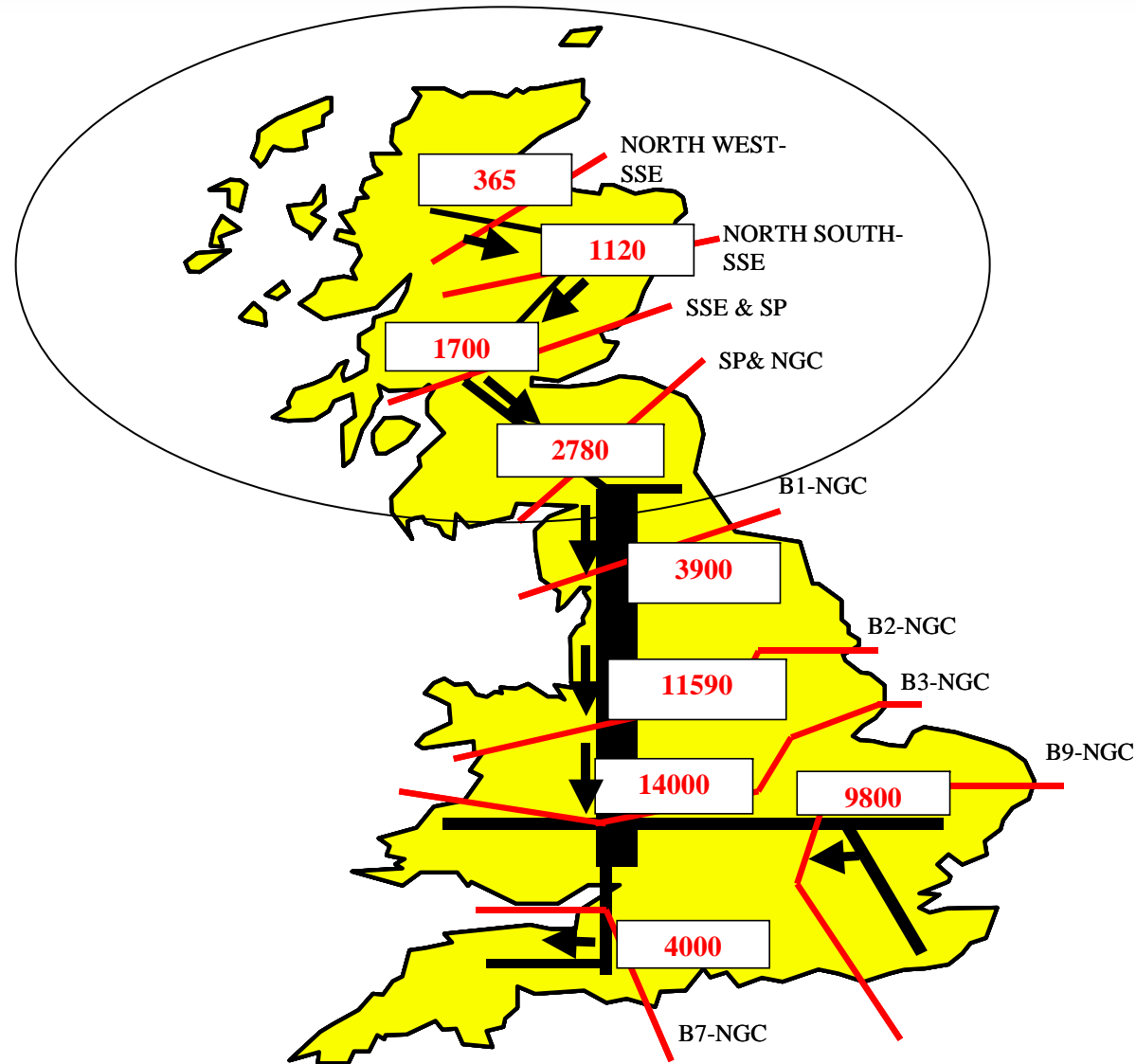
- Generation capacity adequacy
  - How “reliable” is renewable generation as a source?
- Real time system balancing
  - What are the needs for flexibility and reserve?
- Networks requirements
  - How much network capacity is required to efficiently transport renewable power?
- System stability
  - What is the stability performance of the new system?
- Technical, commercial and regulatory framework
  - Does the transmission access facilitate sharing of capacity? Does the market reward flexibility and security adequately?

# Access to networks



- Distribution networks
  - Update of network security standards to include distributed generation
  - Update of network pricing regime
  - Non-network solutions to network problems
- Transmission networks
  - Transmission access review
  - Fundamental review of GB Security and Quality of Supply Standards (SQSS)
  - Access arrangements, standards and grid codes for offshore transmission networks

# Transmission

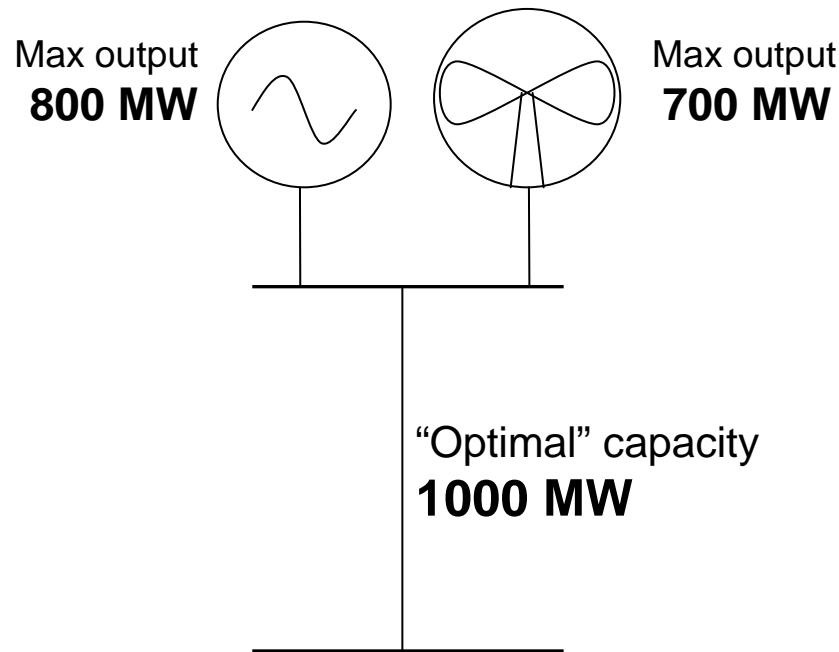


# Sharing of network capacity



- Sharing of network capacity between conventional and wind generation
  - Wind generation contribution to security of supply is limited; system will be characterised by large capacity margins
    - Example: Peak demand 60GW, installed capacity of generation 100GW (70GW conventional and 30GW of wind)
    - How much transmission is required?
  - Network capacity should be shared: e.g. on windy days, wind will tend to occupy transmission capacity, on non-windy days conventional generation takes over

# Illustrative example



1000MW of transmission can deliver about 85% load factor for 800MW of flexible conventional plant and full energy output of 700MW of wind generation operating at 35% load factor

# Comparison



From	To	Economics	GB SQSS
NW-SHETL	N-SHETL	2437	2561
N-SHETL	S-SHETL	3571	4439
S-SHETL	N-SPTL	4110	4904
N-SPTL	S-SPTL	3564	5438
S-SPTL	UN-E&W	5357	7667
UN-E&W	N-E&W	4935	7514
NW-E&W	N-E&W	1942	2424
NE-E&W	N-E&W	2218	4895
N-E&W	M-E&W	7870	10674
MW-E&W	M-E&W	4798	6848
ME-E&W	M-E&W	4459	4869
M-E&W	S-E&W	8434	9206
SW-E&W	S-E&W	2781	4360
SE-E&W	S-E&W	1438	4766

The total installed capacity of generation (conventional plus wind) in Scotland, in the study, is 19.5GW and local load of 6.5GW.

# Will TAR facilitate efficient integration of renewables?



- Concept:
  - Departure from central planning to a market based approach to transmission investment; choice in access
  - Energy Price (single) + Access Price (location specific) => Energy prices will vary in time and with location
    - On windy days prices of electricity in Scotland will be lower than prices in England
- Will it deliver?
  - Regimes for TNUoS, firm long term access, and real time access, non-firm access, are disconnected (users choice under the proposed regime may lead to inefficient operation and investment)
  - Is BETTA design (energy only market) appropriate for signaling investment in transmission? (may lead to overinvestment)
  - Demand excluded, single sided market (significant opportunity missed)
  - Time scale for short term access: 48h (much shorter time scales will be required if the access is to be helpful for wind)

# Regime for offshore grid



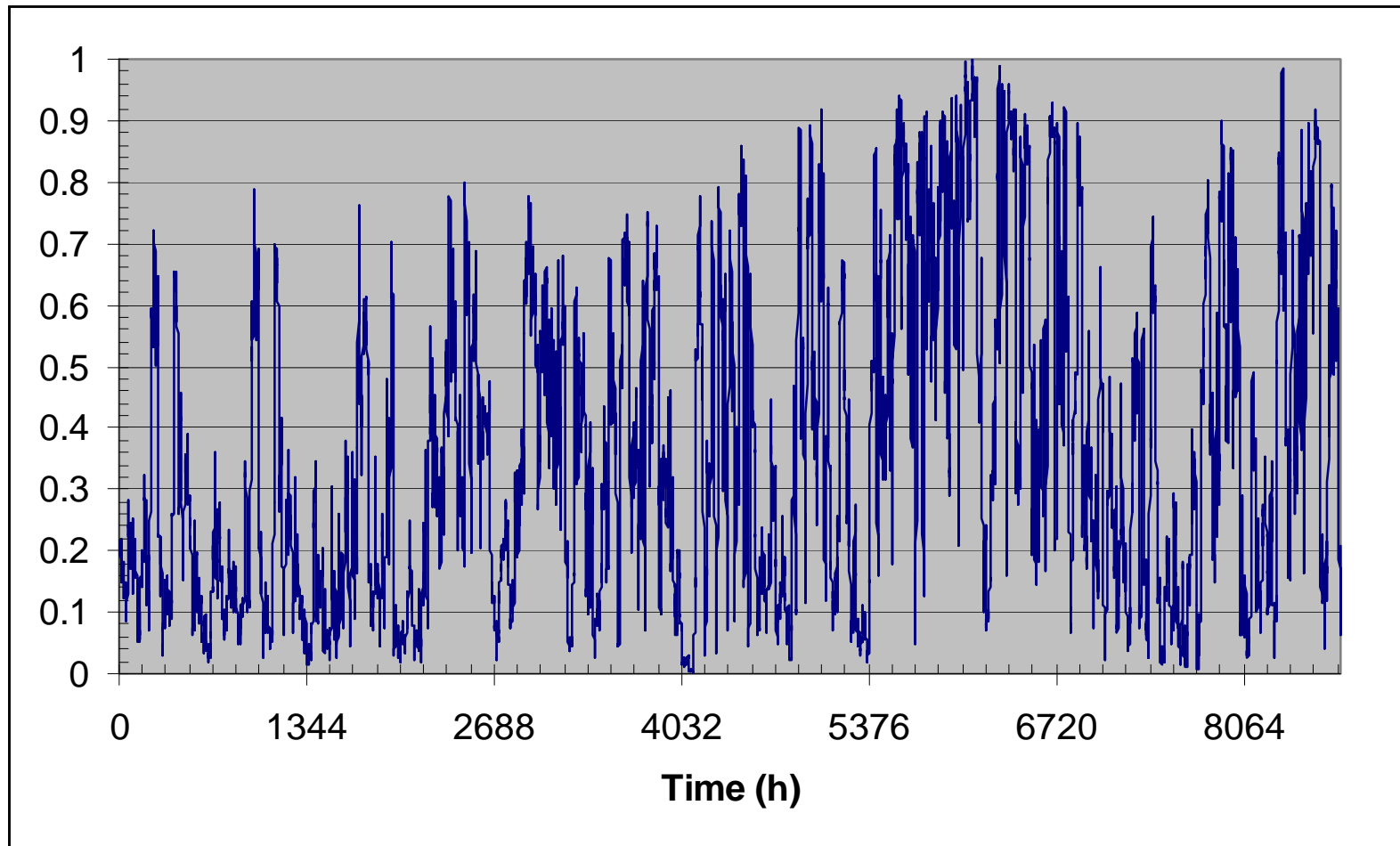
- Compensation regime onshore and offshore different
  - Generators that are connected to onshore networks and pay for network access are compensated in case that transmission network is unavailable, while
  - Generators connected to offshore networks are not compensated
- Does it support networks for renewables?
  - Regime is unduly discriminatory and inefficient
  - Will increase the cost of offshore development to the UK consumers

# Fundamental review of GB SQSS



- Is the philosophy of the present GB SQSS appropriate i.e. does it provide an appropriate framework for establishing efficient and secure network operation and development?
- Is GB SQSS barrier to entry and does it prevent competition in generation and supply (leading to unnecessary electricity price increases)?
- Is GB SQSS barrier for connecting renewable generation (and hence barrier for implementing Government Policy)
- Does GB SQSS provide a transparent framework for network users to make appropriate choice for their access arrangements (between short and long term)?

# System operation with wind power: *Capacity and Balancing*



# “Backup” options



- Conventional generation capacity –
  - 20 GW of conventional generation operating at less than 10% load factor
- Interconnections: increasing diversity
  - Sharing of reserve between different geographical areas, “Firming” up wind by connecting wind farms in different areas
- Opportunities for Demand Side

# Balancing task



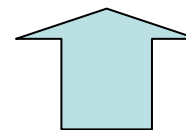
- Wind generation output is difficult to predict and is very variable
- Predictability:
  - Forecast error increases with prediction time horizon
  - Need for frequency regulation services and various forms of reserve will increase
  - Not all wind generation may be possible to accommodate
- Variability:
  - Increased need for flexible plant

# Estimates of wind forecast error and reserve requirements for 26GW of wind



Lead Time [Hours]	Standard Deviation [MW]	Likely maximum change [MW]	Extreme change [MW]
0.5	360	1,090 – 1,450	2,600
1	700	2,100 – 2,800	3,950
2	1,350	4,050 – 5,400	6,550
4	2,400	7,200 – 9,650	13,500

4 hours may be required to schedule large CCGT



Likely additional reserve requirements

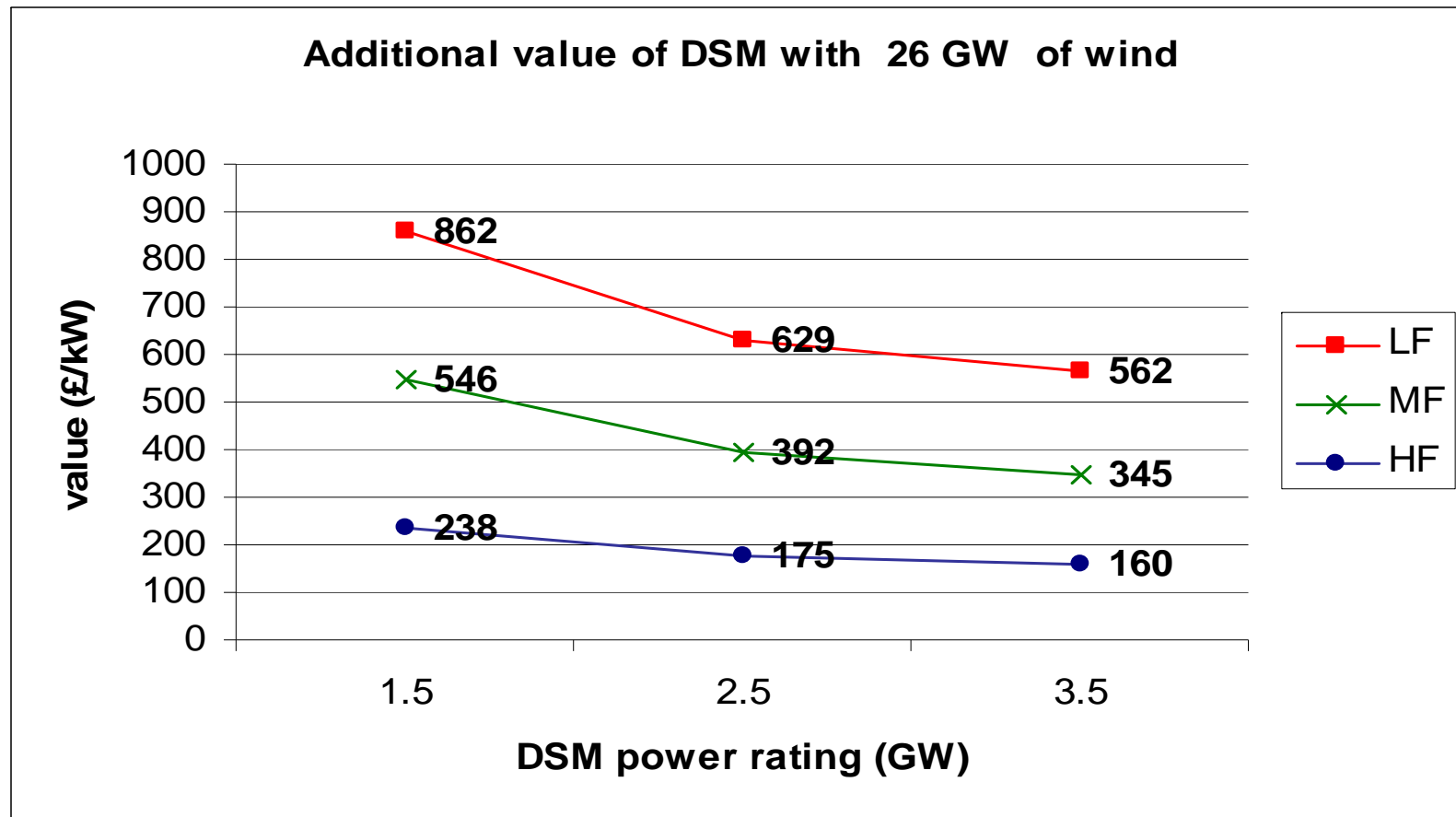
# Business as usual is not an option



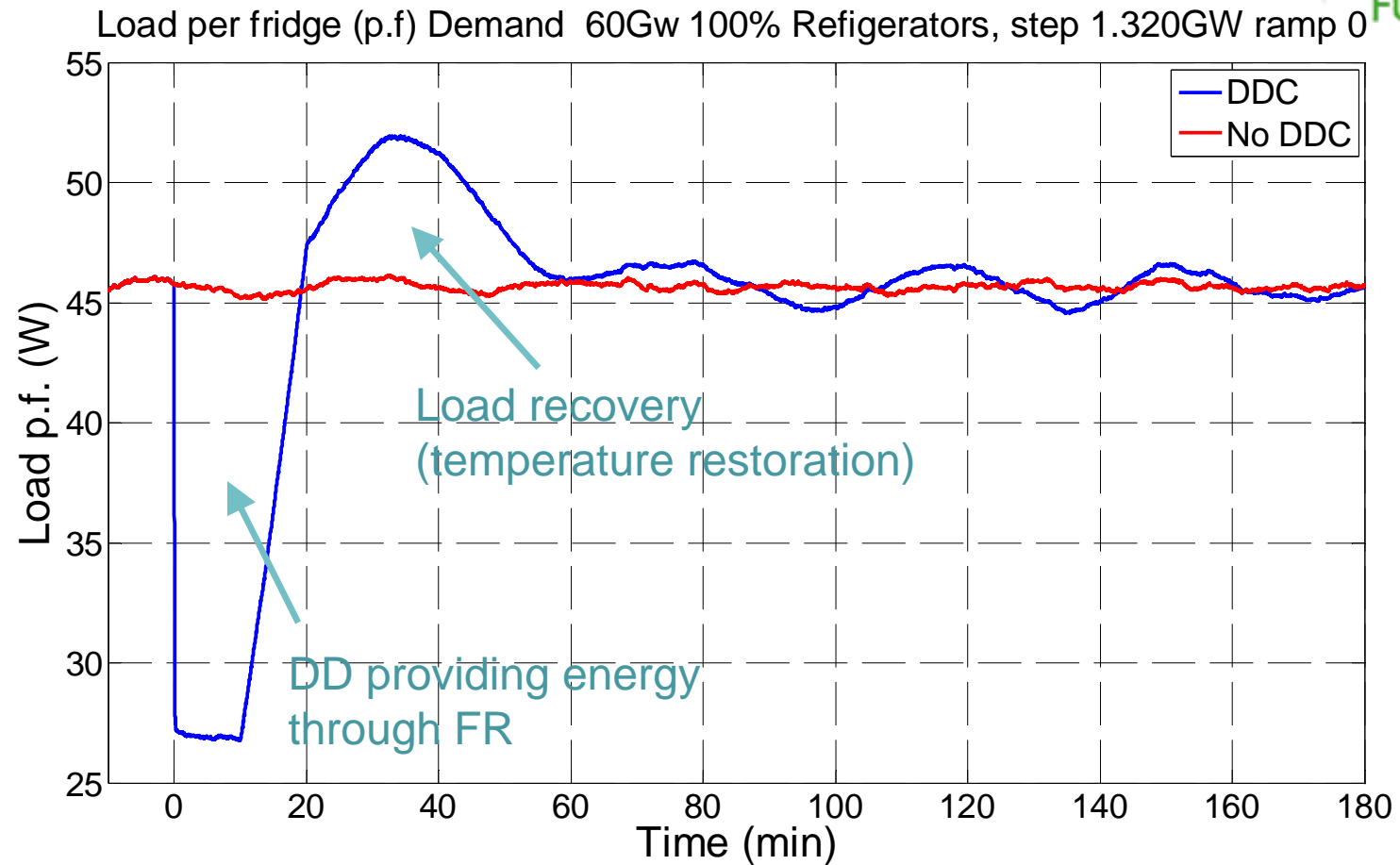
<b>Generation flexibility Reserve policy</b>	<b>High Flexibility</b>	<b>Medium Flexibility</b>	<b>Low Flexibility</b>
<b>Demand 70 GW</b>	<b>364</b>	<b>654</b>	<b>1322</b>
<b>Demand 56 GW</b>	<b>455</b>	<b>1187</b>	<b>2822</b>

Number of hours of surplus electricity

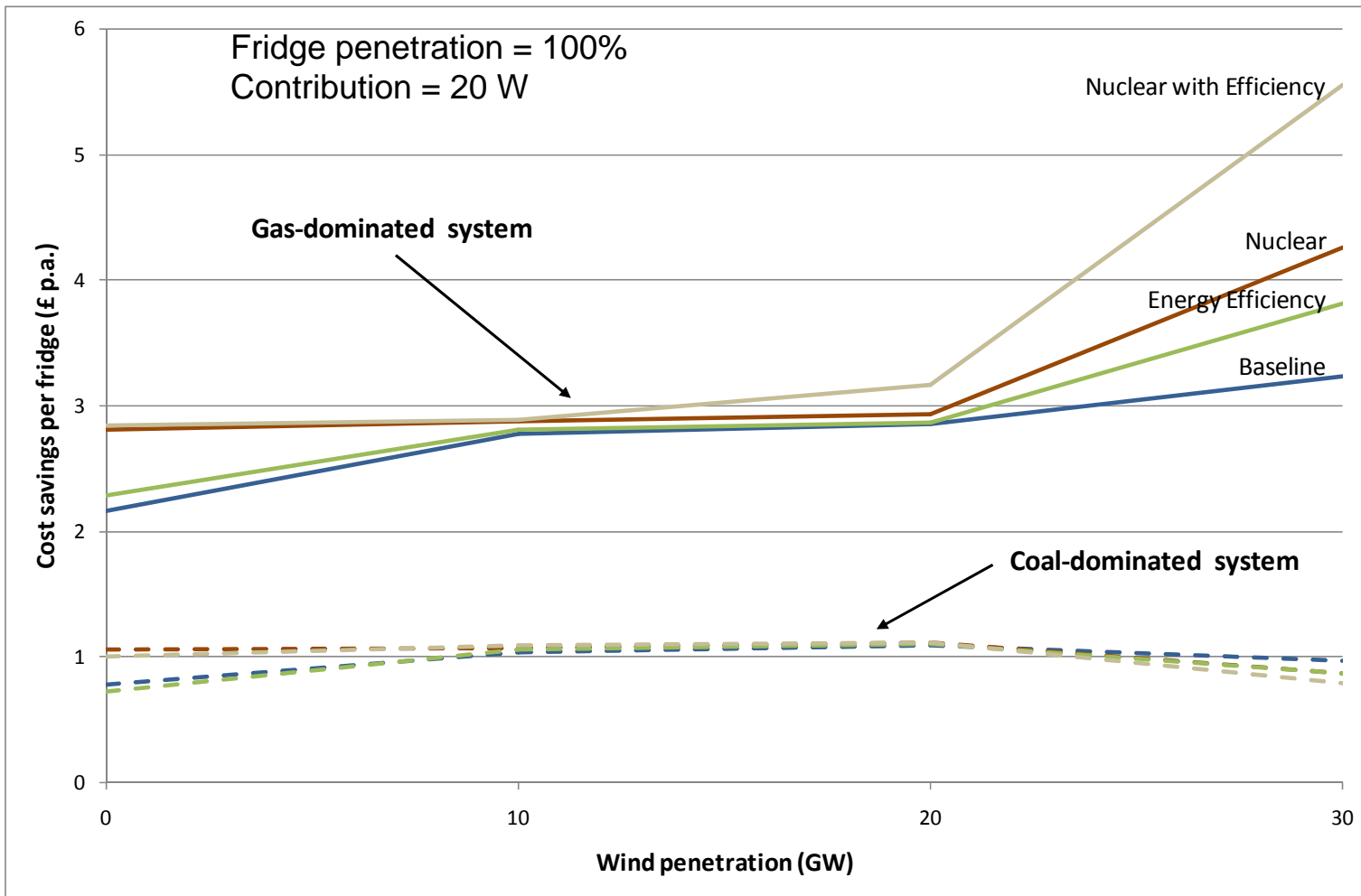
# Potential for DSM



# Potential for dynamic demand in frequency regulation?



# Annual Cost Savings per Refrigerator for Different Wind Penetrations



# Decarbonised Electricity System



- Key challenge: cost effectiveness, potentially very low utilisation of generating plant and networks;
- Fundamental change in providing system operation philosophy
  - Flexibility: reallocate control functions from generation to other sectors, demand and networks;
  - Enhance system control capability to release latent generation and network capacity
    - More sophisticated control and decisions making prices using advances in metering, communication, information and infrastructure
    - Enabling technology: demand side, storage, FACTS
- Systems approach to informing technology strategy
- Design of new Commercial, Regulatory and Policy framework to facilitate efficient operation and system development

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