The Cost of Wind Energy

SAS Clan Gathering - Stirling, November 24th 2013

Dr Mike Hall

Friends of Eden, Lakeland & Lunesdale Scenery

Conservative Party Conference
3rd October 2011

'….We're not going to save the planet by putting our country out of business'.

George Osborne, Chancellor of the Exchequer


BASE LOAD & PEAKING POWER:
What Role Can Wind Play?

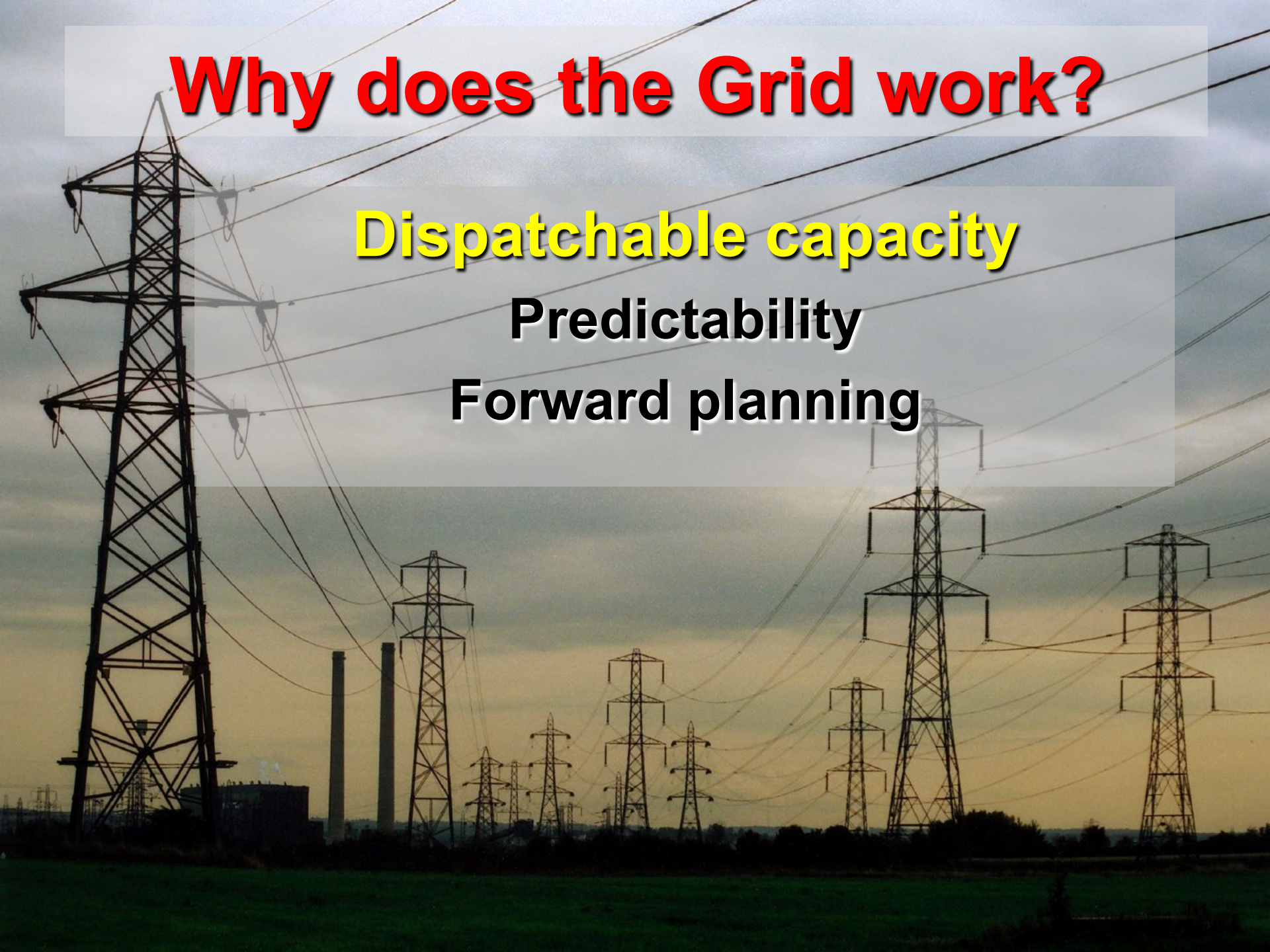
Outline

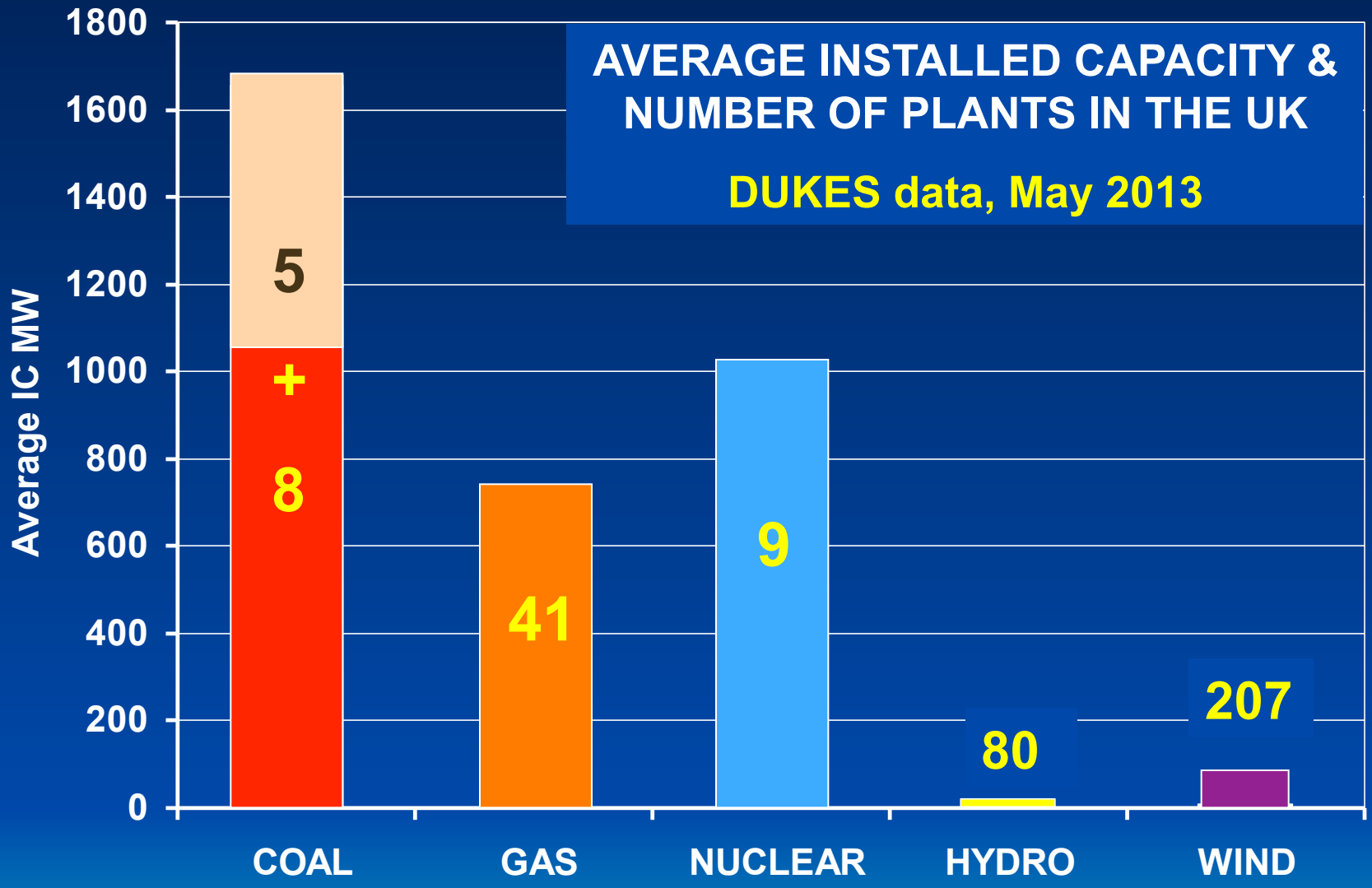
1. Why does the National Grid work?
2. The performance of the wind carpet
3. Can wind contribute to base load or peaking power?

Power generation in the UK

1980s	2013
Central planning by CEGB	No central planning
Government funded	Equity & debt funded
Public sector monopoly	Fragmented industry
Prices & incomes policy	Asset sweating industry
Fuel self-sufficiency	UK import-dependent
Climate change not an issue	Climate change central

The Electricity Act (1989) led to privatisation, the break-up of the CEGB and the creation of Powergen, National Power & National Grid.


Why does the Grid work?
Dispatchable capacity
Predictability
Forward planning



CHP, imported electricity & other burned excluded

Nuclear - 2011 to 2012

steady

19% & 19%

Generating capacity Heysham 1 is 1,150 MW and Heysham 2 1250 MW

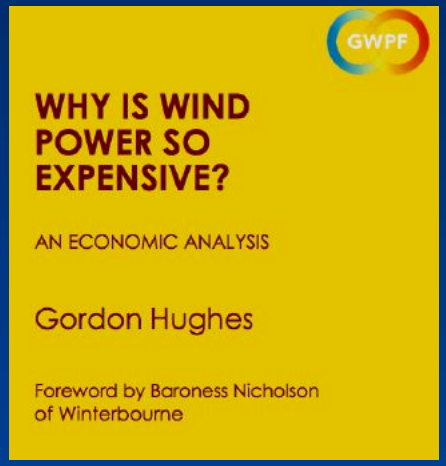
TOTAL = 2,400 MW

Coal - 2011 to 2012

Drax generating capacity is 6 turbines of 660 MW = 3,960 MW

CCGT Generation - 2011 to 2012

Down 40% to 28%



Cost £1 billion = £500,000 per MW

You would need 2,500 x 2.5MW onshore wind turbines to generate the same amount of electricity.

Onshore COST = £3.5 billion

COAL ↑ 30 to 39%

GAS ↓ 40 to 28%

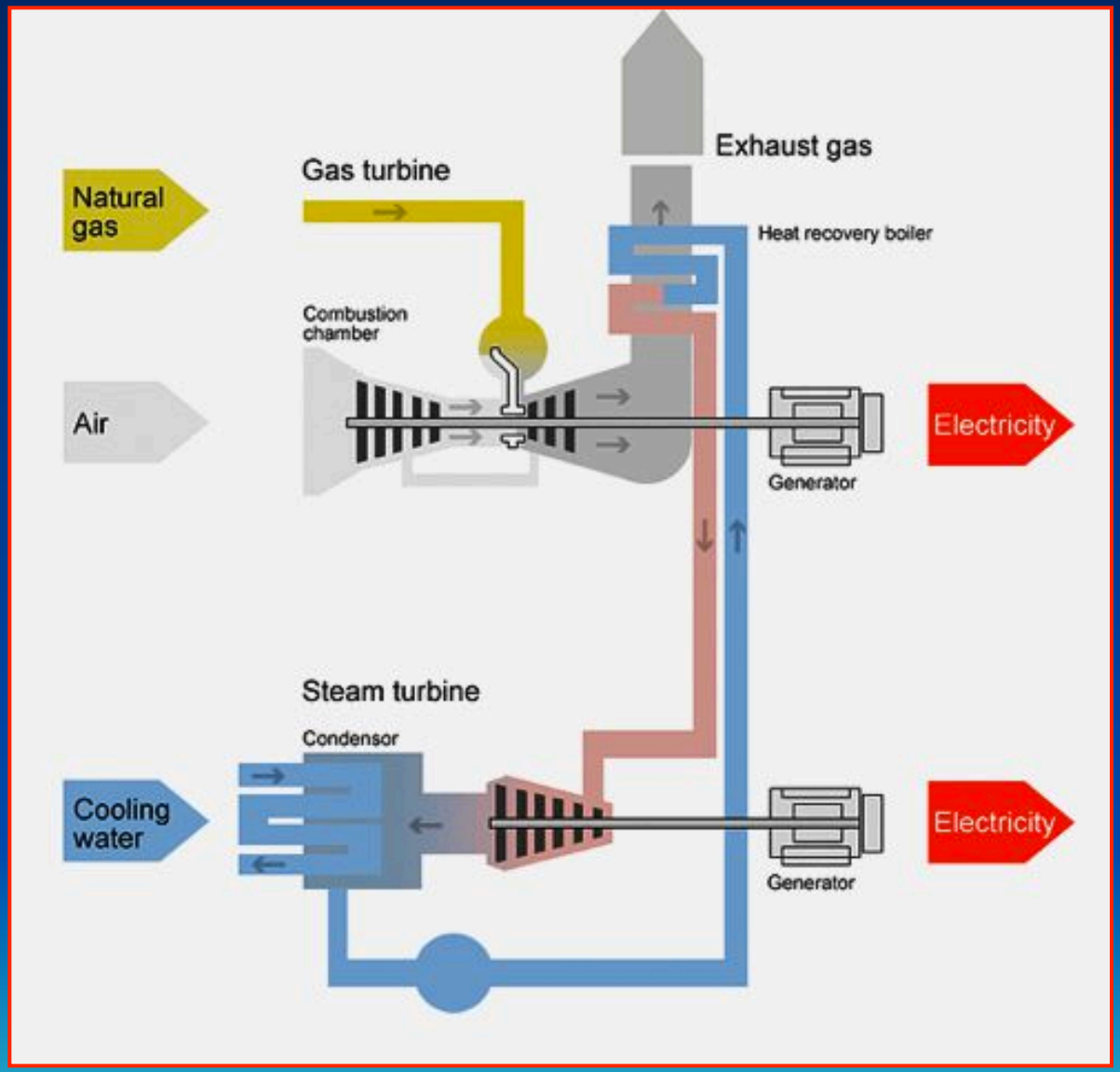
WHY?

Coal generation = 9.16 Euros/MWh profit

Gas generation = 19.31 Euros/MWh loss

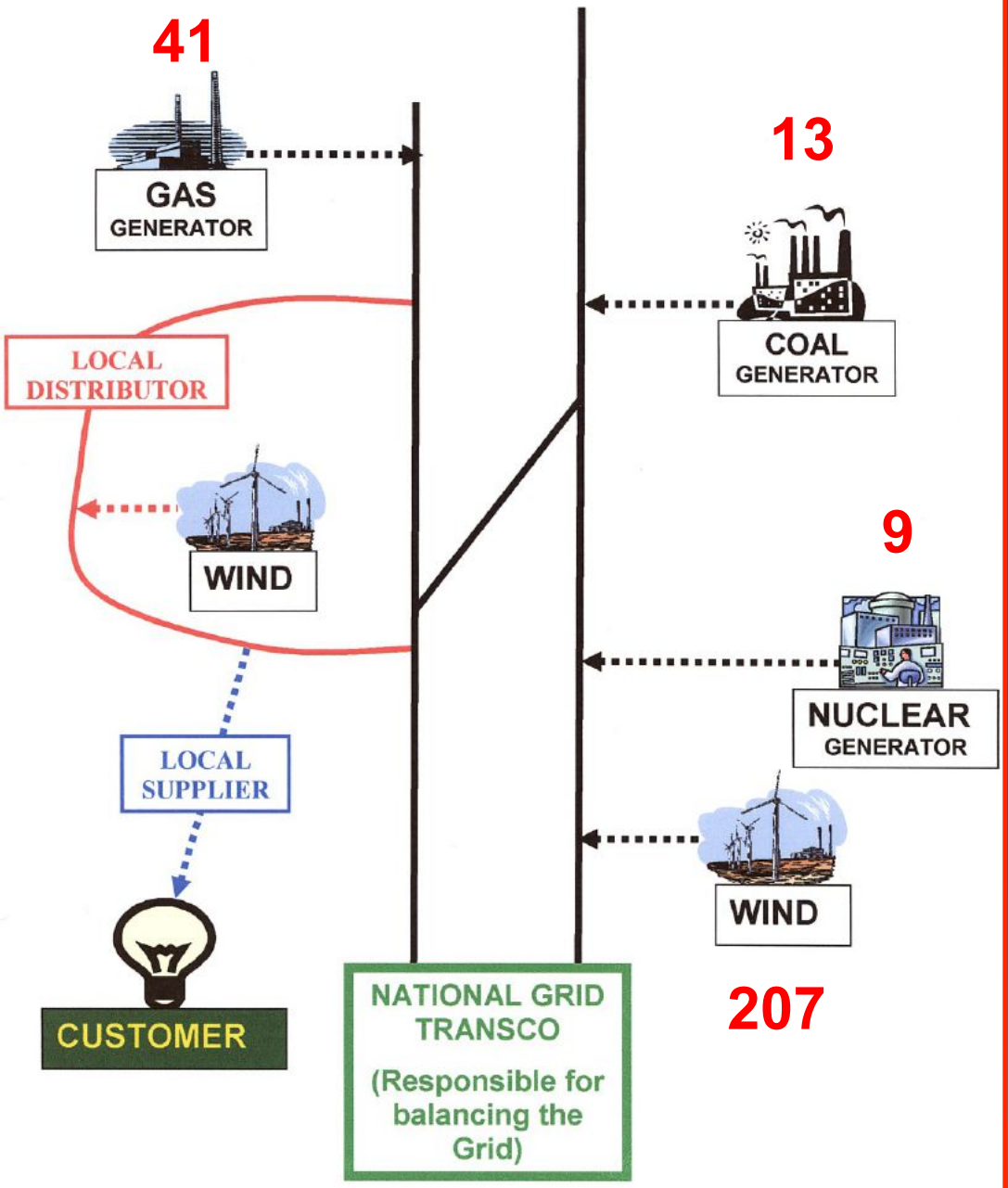
Bloomberg 15th Nov 2013

CCGT – getting two bites at the cherry!



Not readily ramped up and down

Produce 0.3t/MWh CO_2 cf Coal about 0.9t/MWh

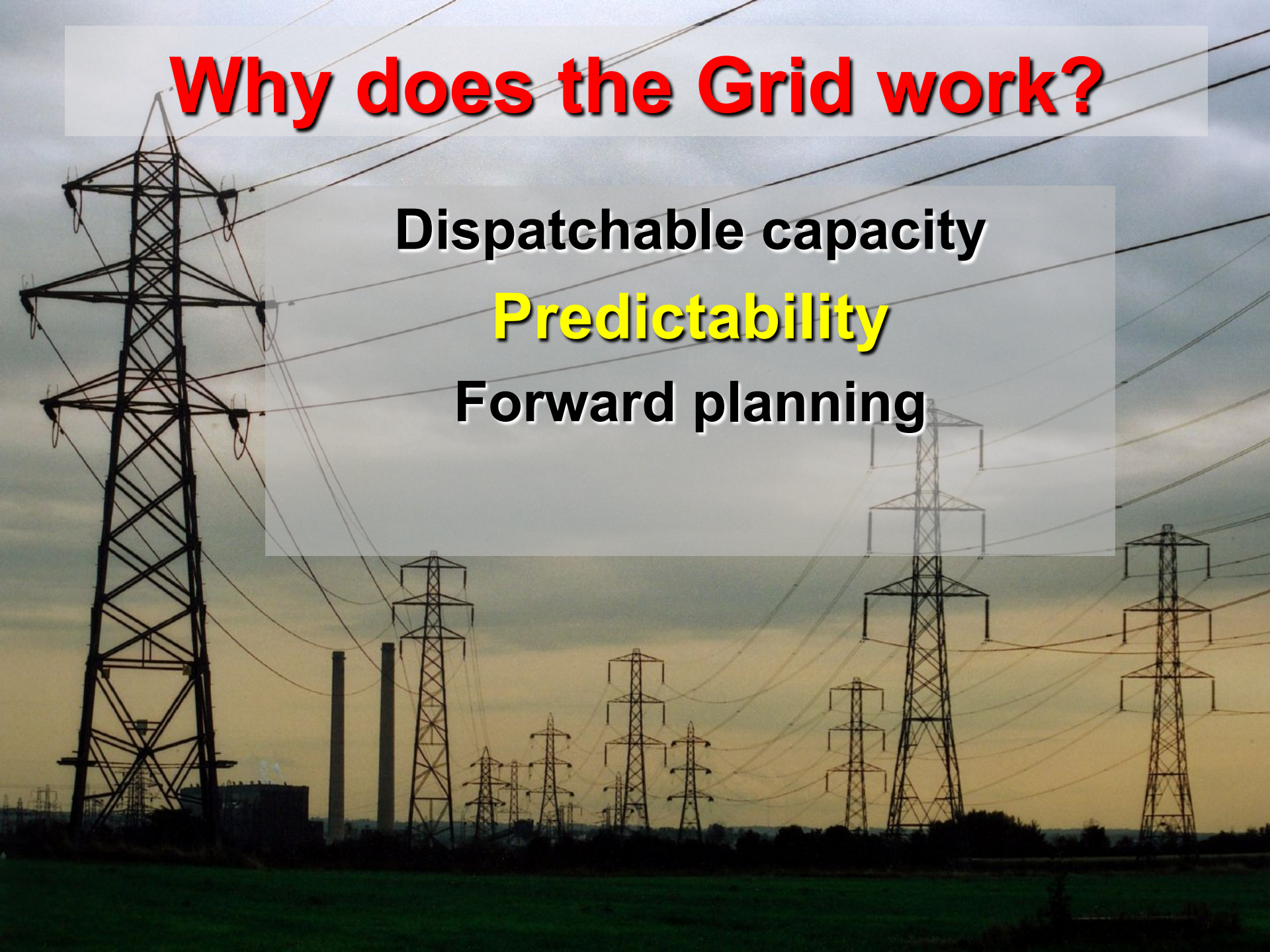


Supply

=

Demand

at all times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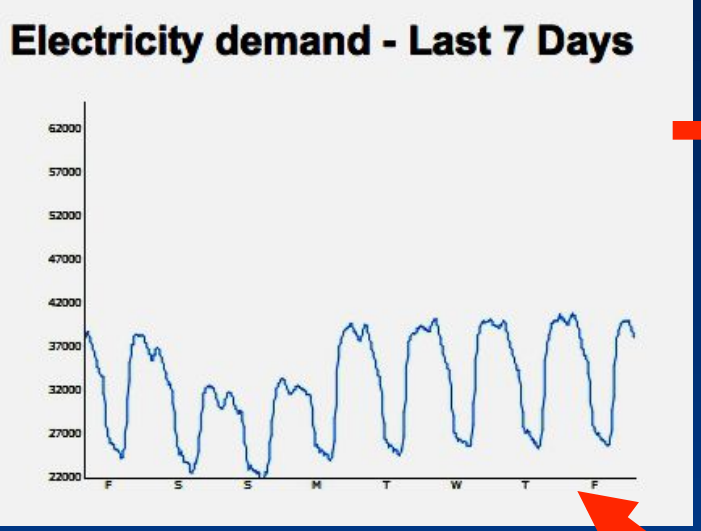
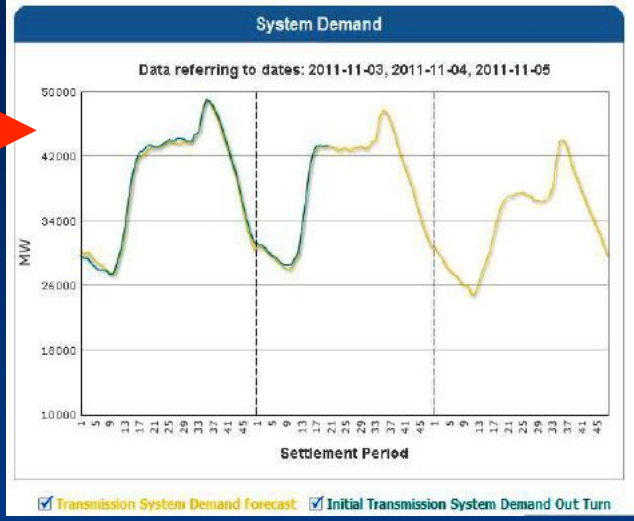


LOAD CURVES



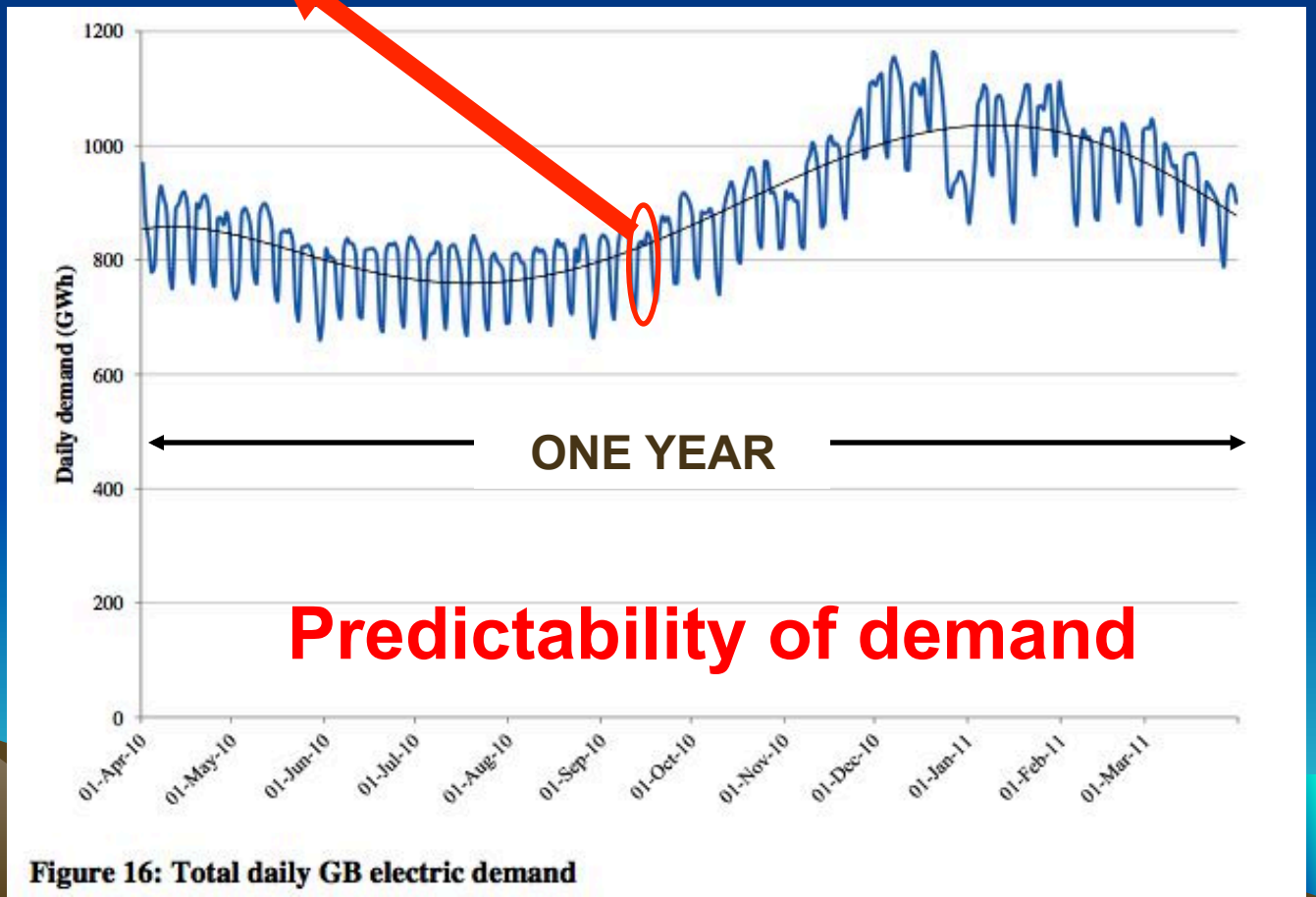


Figure 16: Total daily GB electric demand

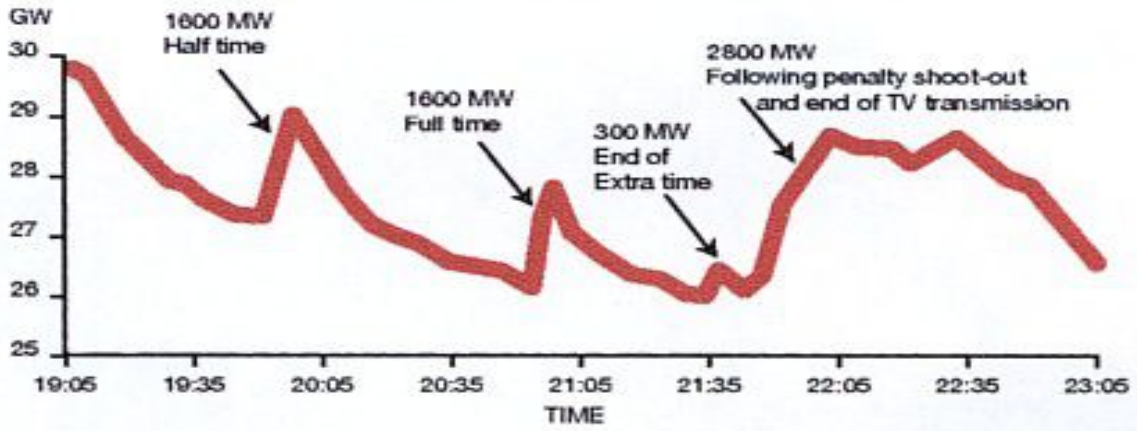
What about abnormal surges in demand?

The top three surges in demand

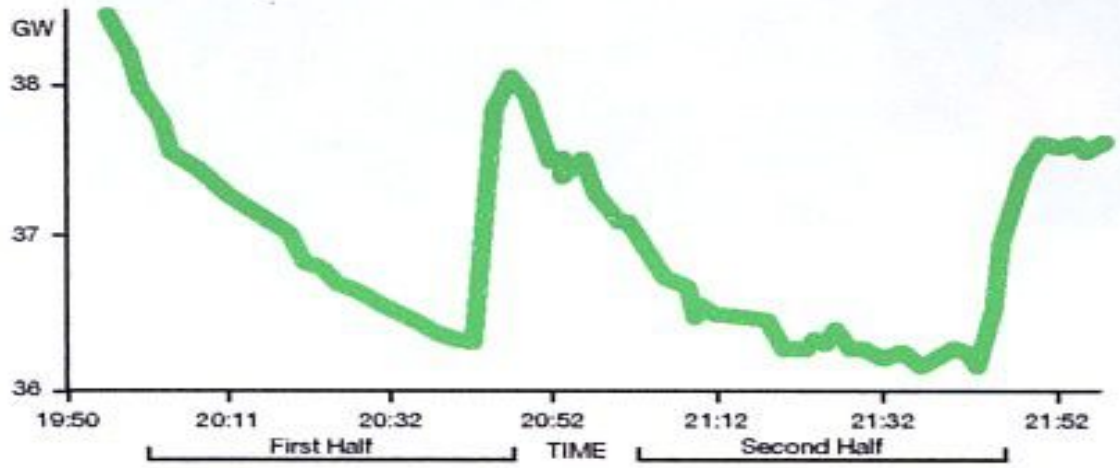
- Semi-final England vs Germany, 1990 2,800MW
- Quarter final, England vs Brazil, 2002 2,570MW
- Wedding of Kate & William, 2012 2,400MW

2,400MW = about 1 million kettles being boiled at once

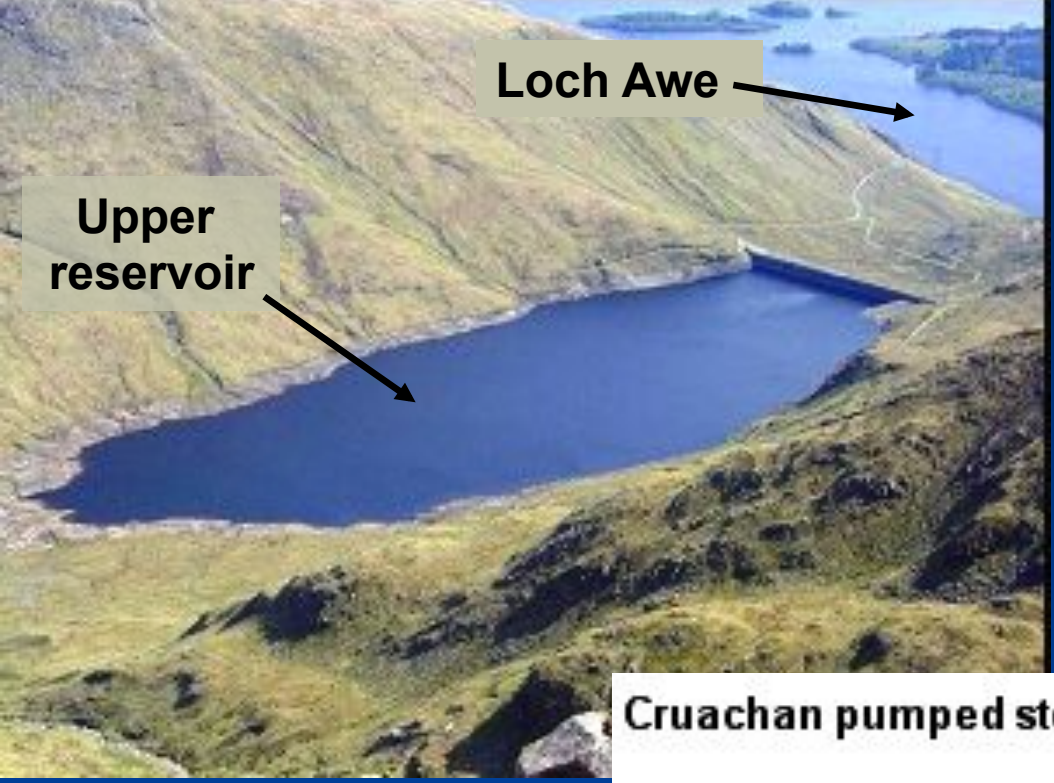
England Vs Germany 1990, World Cup Semi-Final, Kick Off 19:00



England Vs Sweden 2006, World Cup 2006 First Round, Kick Off 20:00



nationalgrid



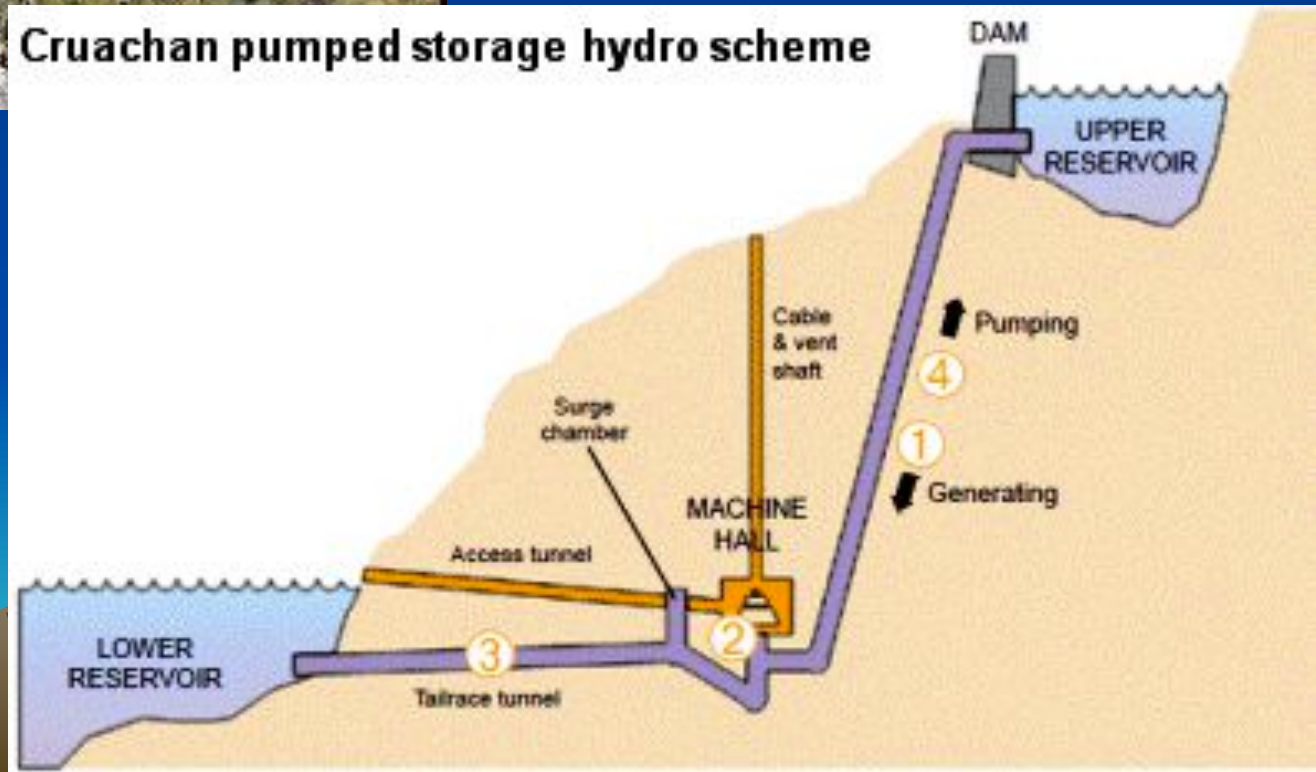
Ben Cruachan

Used in periods of peak demand

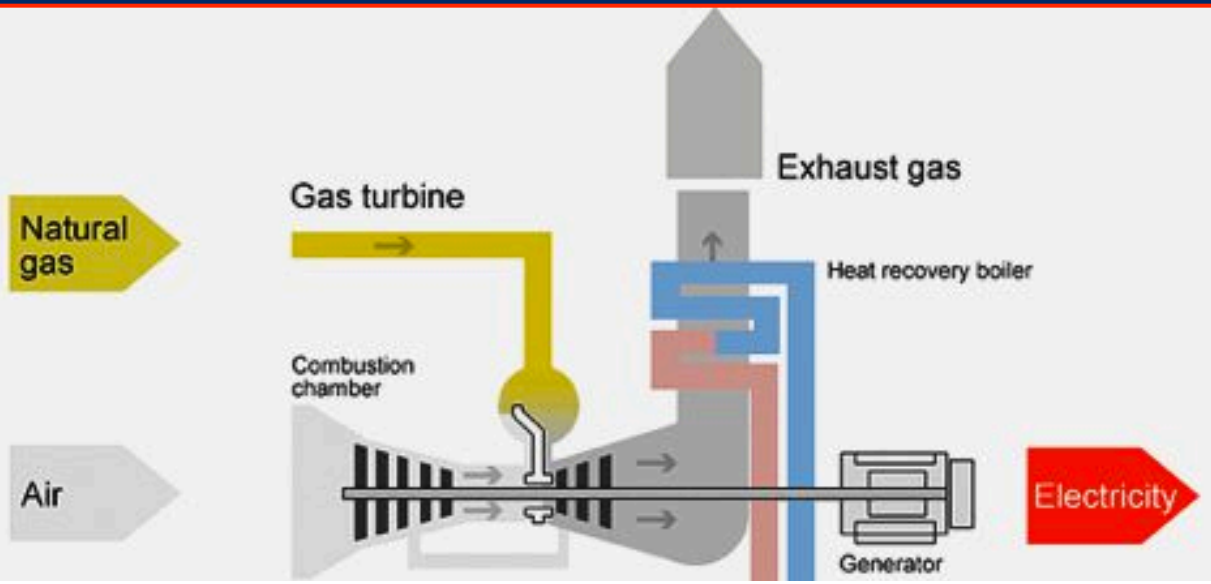
440MW

If in spinning reserve mode it can reach full power in 30 seconds,

otherwise 2 minutes



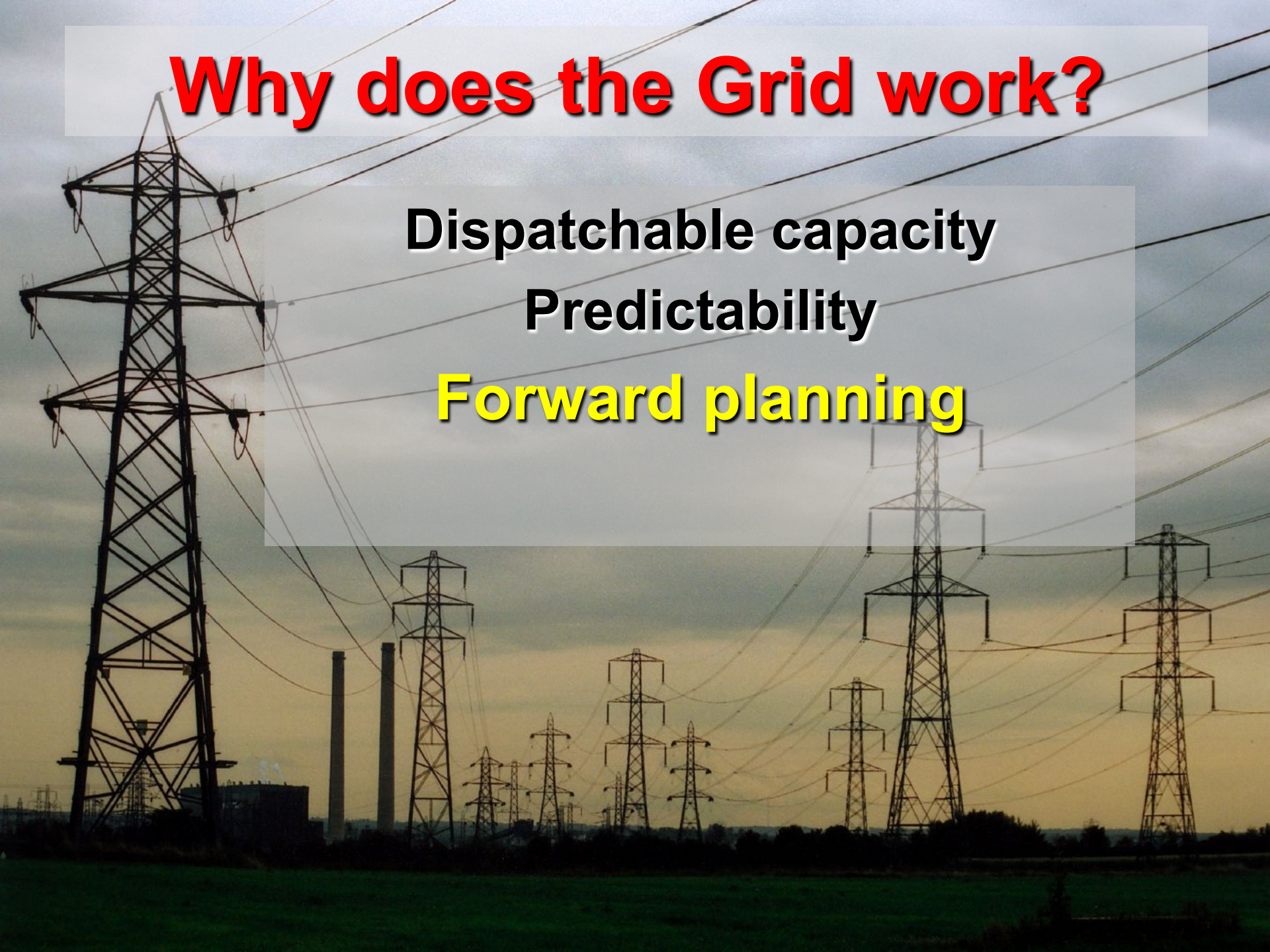
OCGT – Open Cycle Gas Turbine



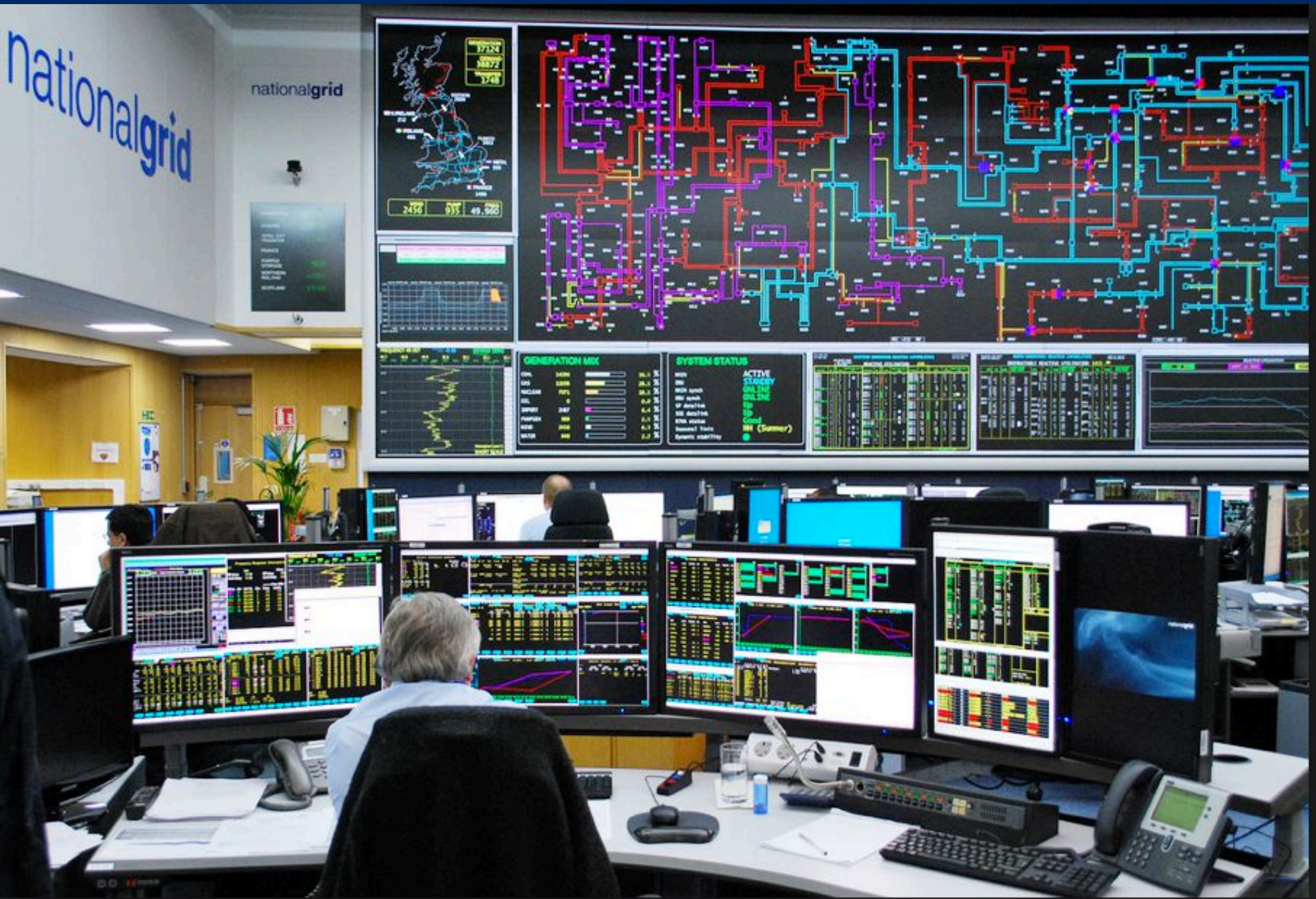
Reserve plant for periods of peak demand or when the wind drops

Can reach full output in 2-30 minutes depending on readiness

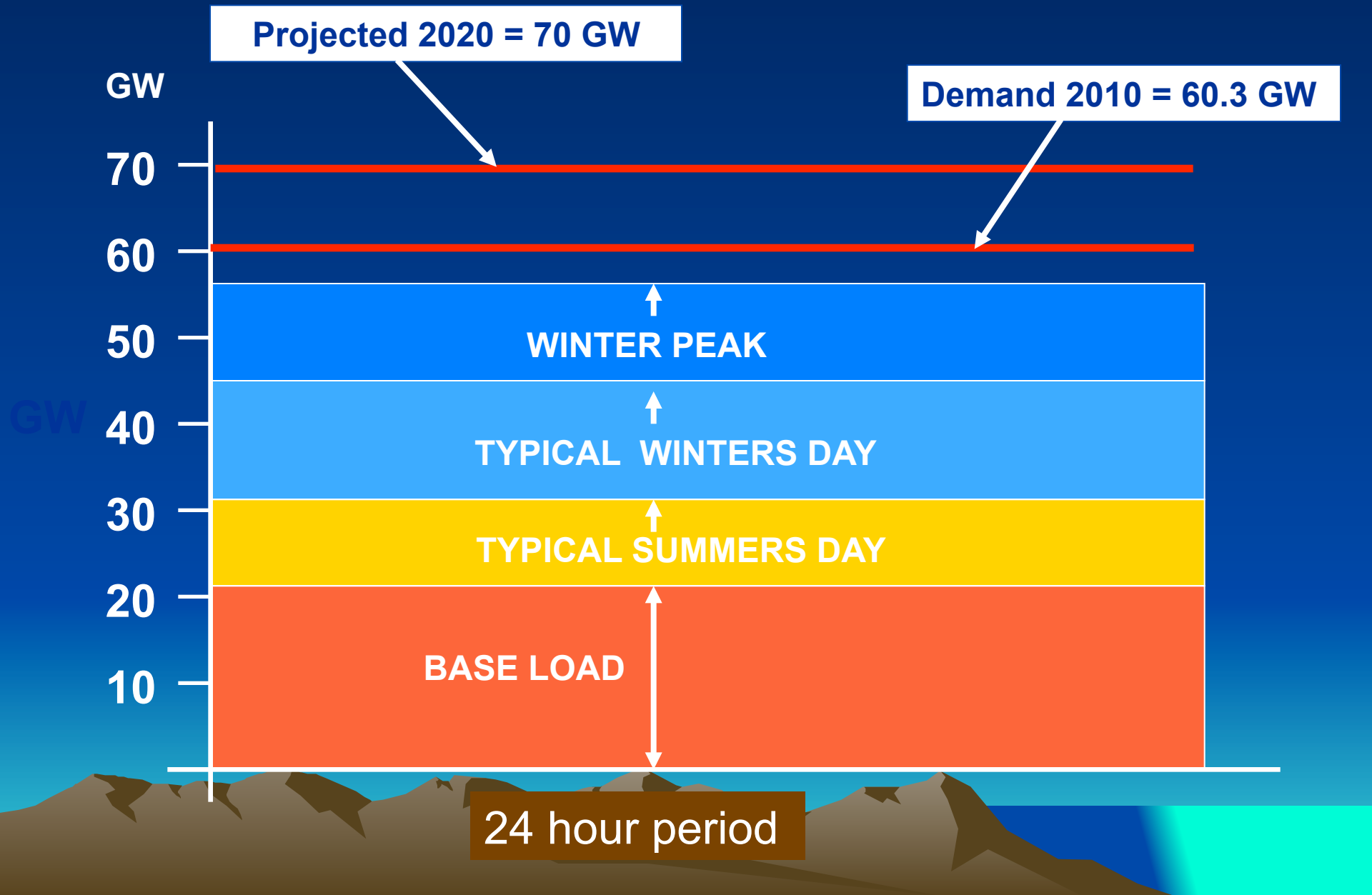
Uses 2x the gas per unit of electricity


Why does the Grid work?
Dispatchable capacity
Predictability
Forward planning

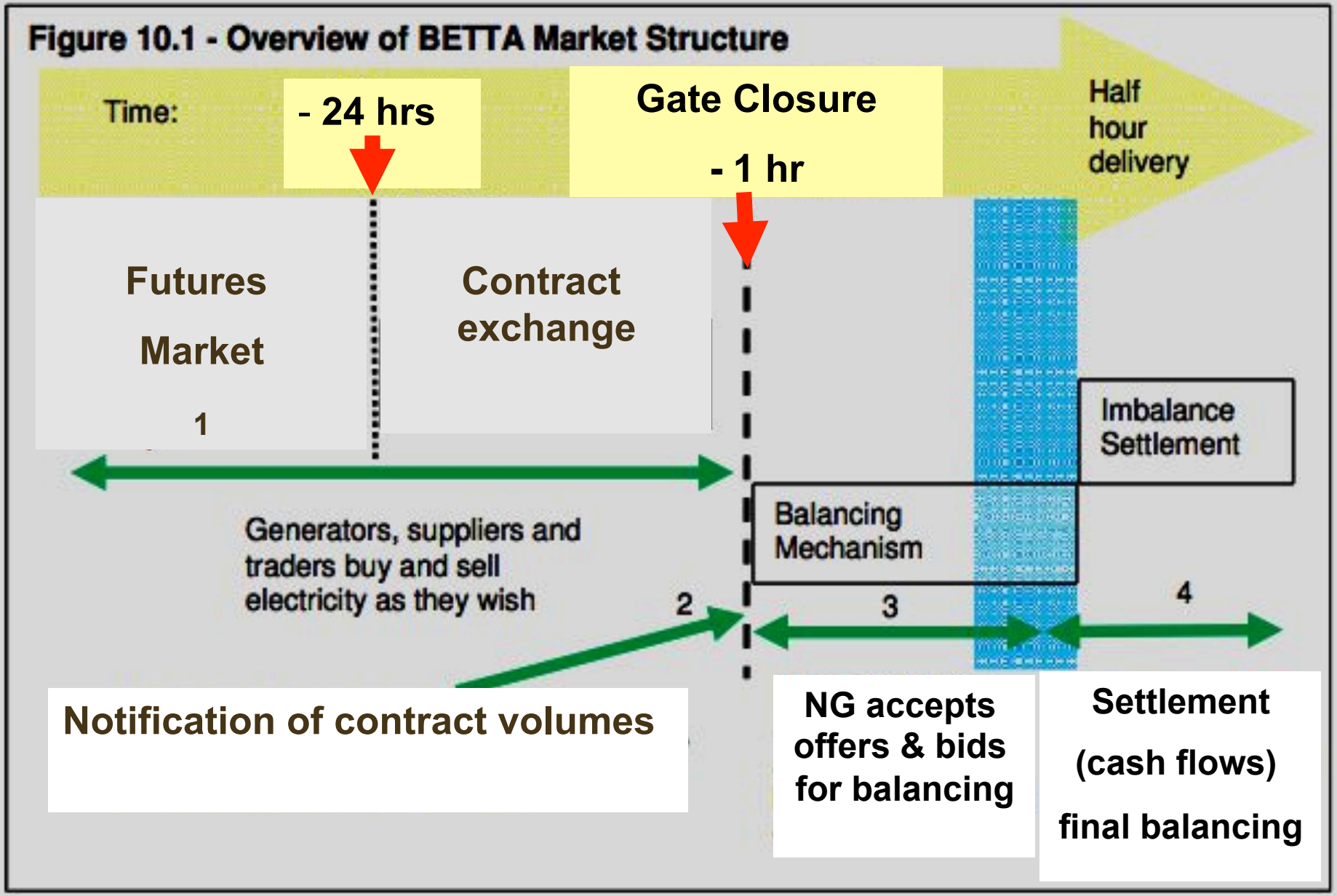
National Grid Central Control Room – Wokingham, Berkshire



HOW MUCH ELECTRICITY DO WE NEED?

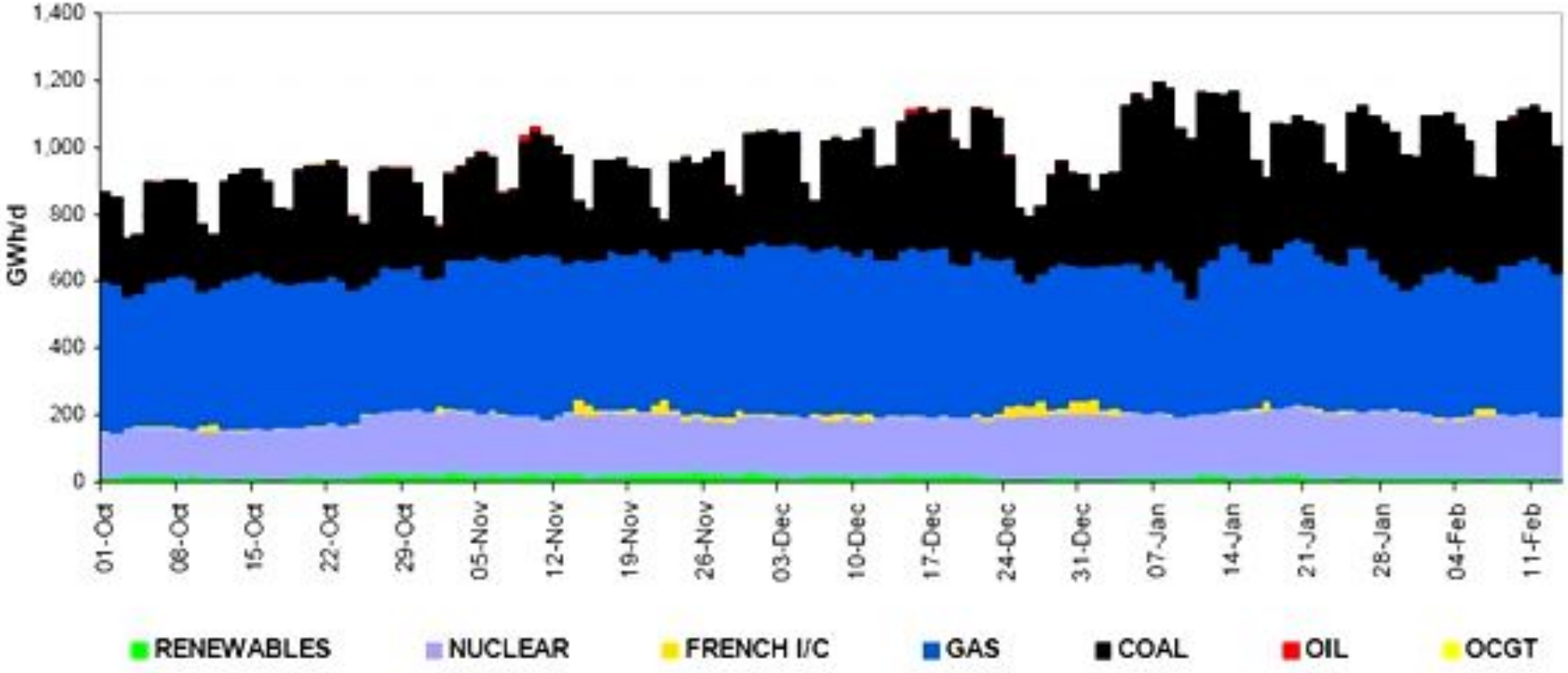


Gate Closure and the balancing mechanism



Generation Mix

Electricity contribution by fuel type

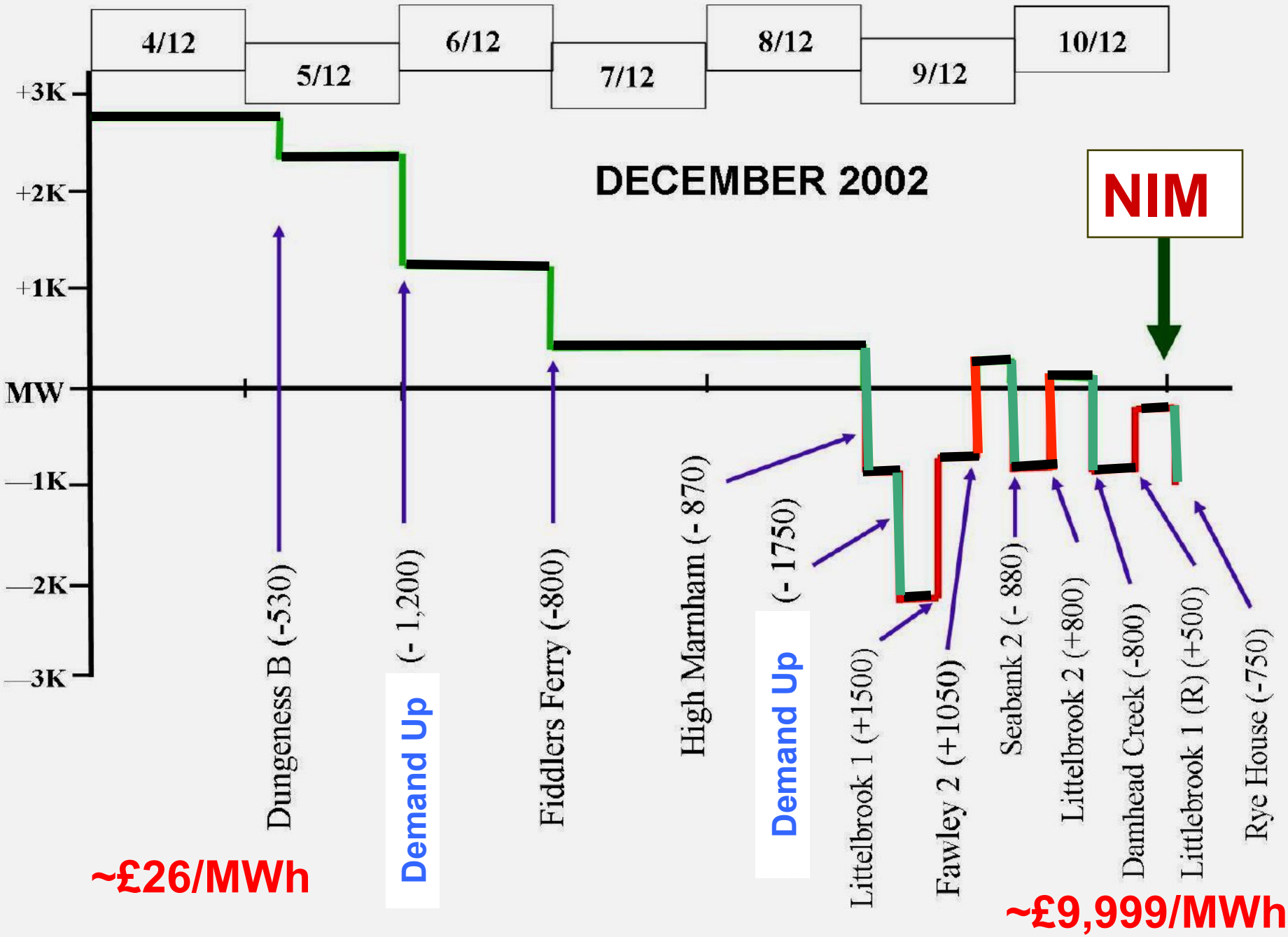


National Grid data

What if the unexpected happens?

A real-life example

(December 2002)


4/12
5/12
6/12
7/12
8/12
9/12
10/12
+3K
+2K
+1K
MW
—1K
—2K
—3K
DECEMBER 2002
NIM
Dungeness B (-530)
(- 1,200)
Fiddlers Ferry (-800)
High Marnham (- 870)
(- 1750)
Littelbrook 1 (+1500)
Fawley 2 (+1050)
Seabank 2 (- 880)
Littelbrook 2 (+800)
Damhead Creek (-800)
Littlebrook 1 (R) (+500)
Rye House (-750)
Demand Up
Demand Up
~£26/MWh
~£9,999/MWh

Stages in forward planning

- Gate closure
- spinning reserve and standby
- Phased call-in of additional generators
- Notice of Insufficient Margins (NIM)
- Termination of supply to industrial customers

The last NIM was issued on Friday 19th October 2007

STOR = Short Term Operating Reserve

‘Hidden’ diesel back-up

In 2011/12 = 496MW

- at 12 times the wholesale price

0.79 t/MWh CO_2

‘Diesel won’t be used as renewables back-up’ – Carbon Brief 5 Aug 2013

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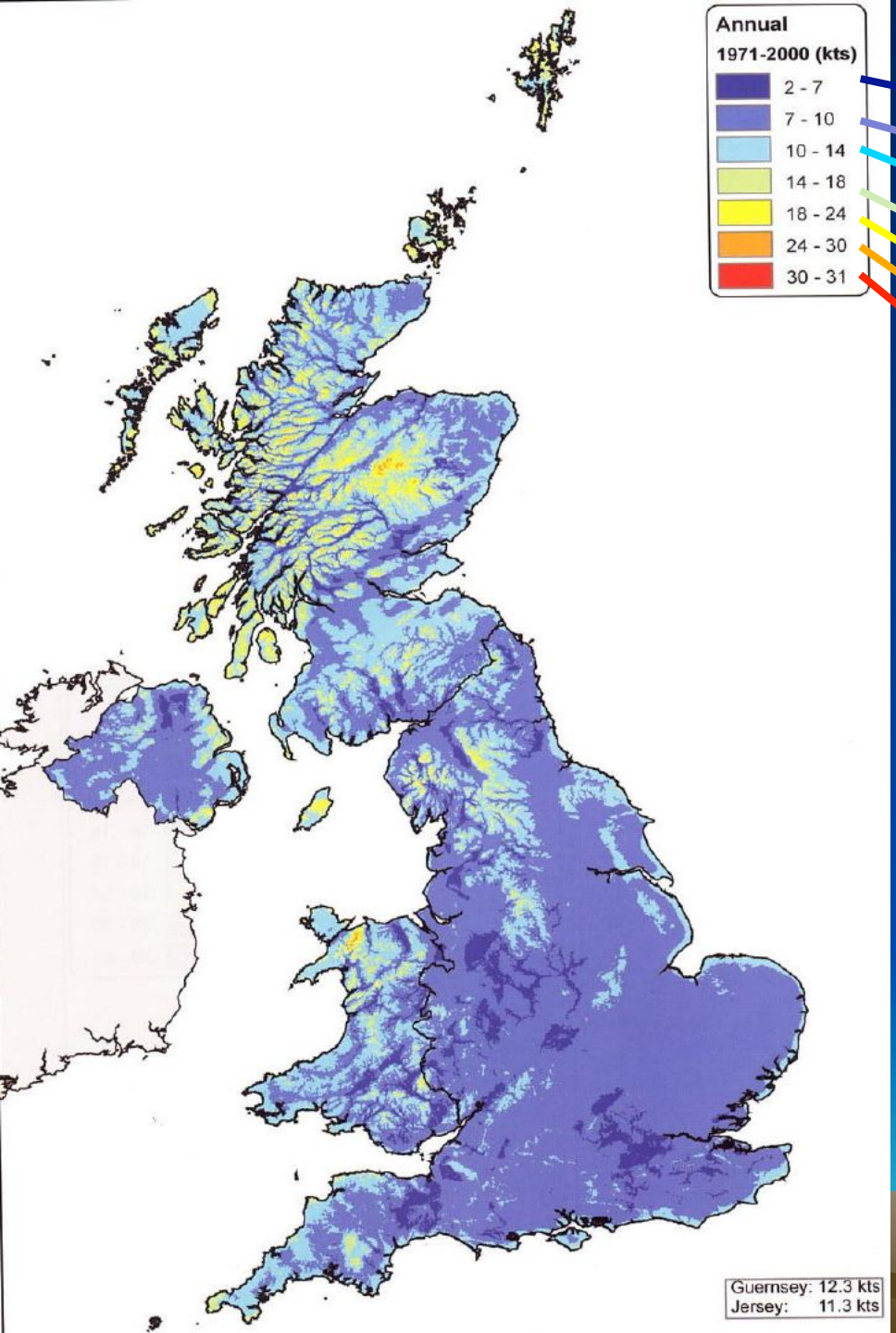
2. **The performance of the wind carpet**
3. Can wind contribute to base load or peaking power?



UK Annual Wind Speeds

2.3 to 8.0

8.0 to 11.5

11.5 to 16.1

16.1 to 20.7

20.7 to 27.6

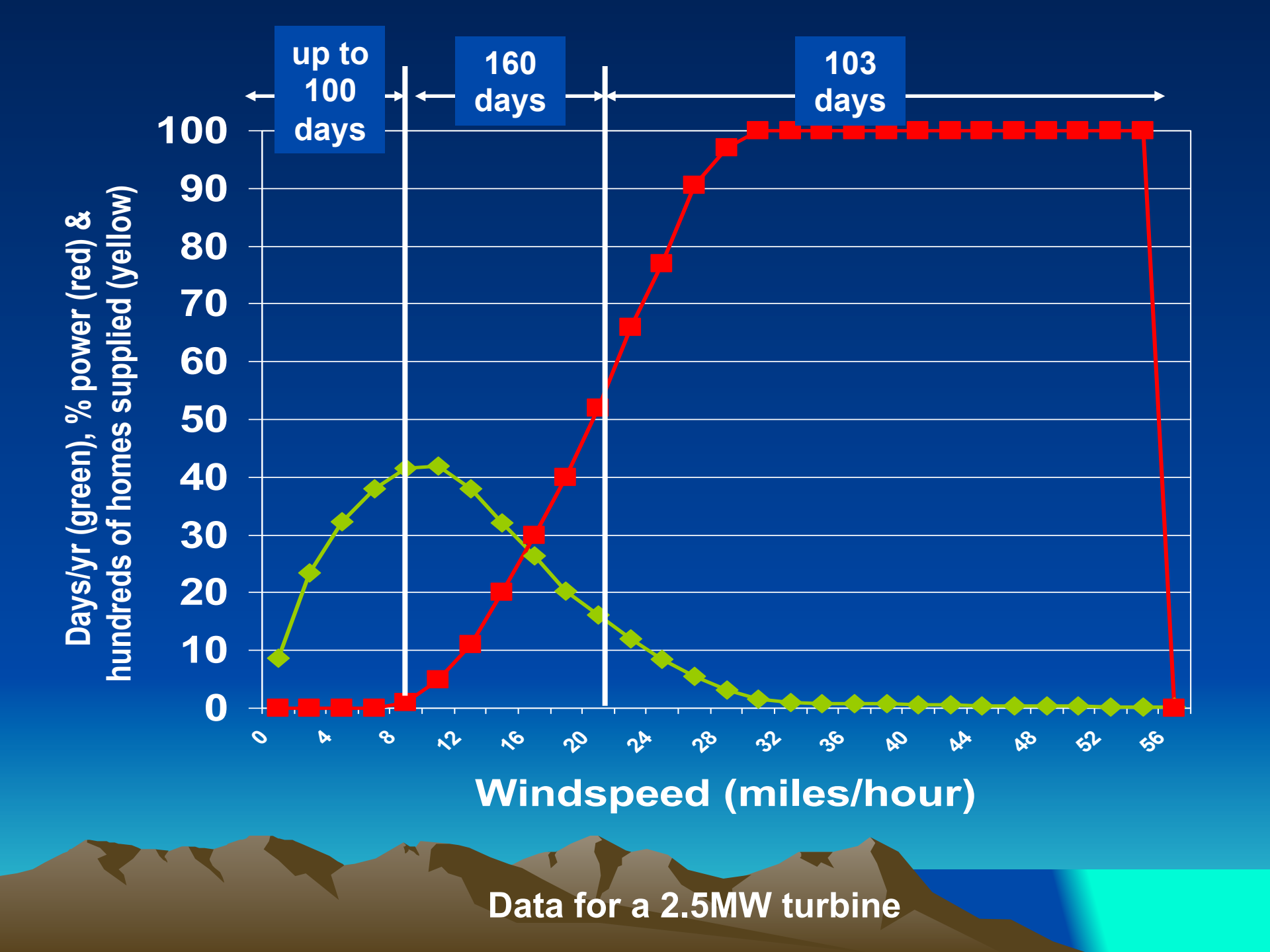
27.6 to 34.5

34.5 to 36.0

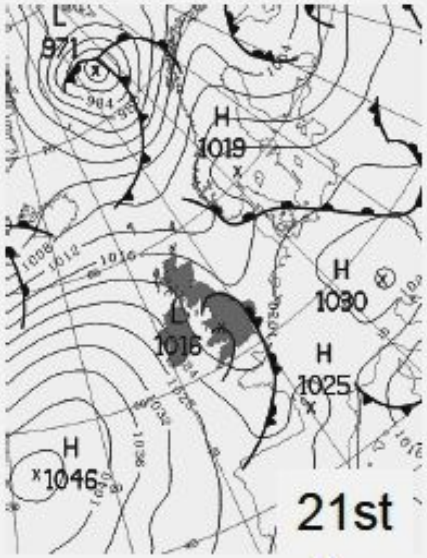
Mph equivalent

'The climate of the UK and recent trends'.

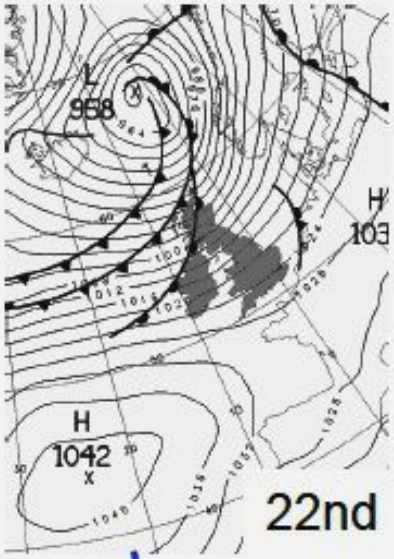
Published by the UK Climate Impacts Programme and the Meteorological Office, 2007


up to 100 days
160 days
103 days
Days/yr (green), % power (red) & hundreds of homes supplied (yellow)
100
90
80
70
60
50
40
30
20
10
0
0
4
8
12
16
20
24
28
32
36
40
44
48
52
56
Windspeed (miles/hour)
Data for a 2.5MW turbine

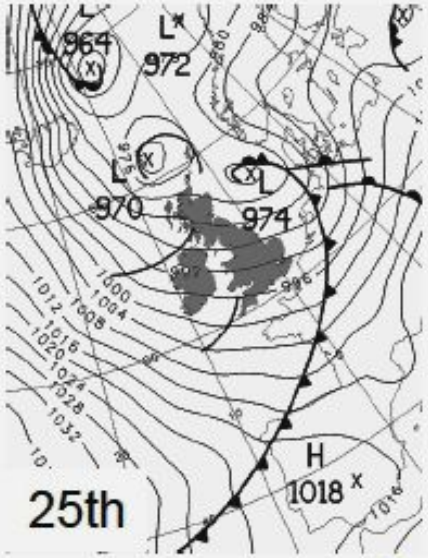
Meteorological pressure charts explain it



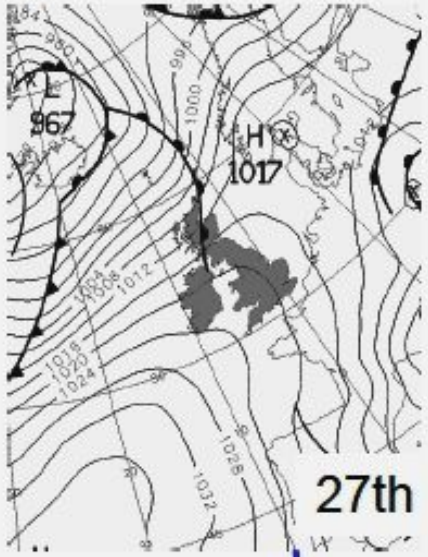
21st



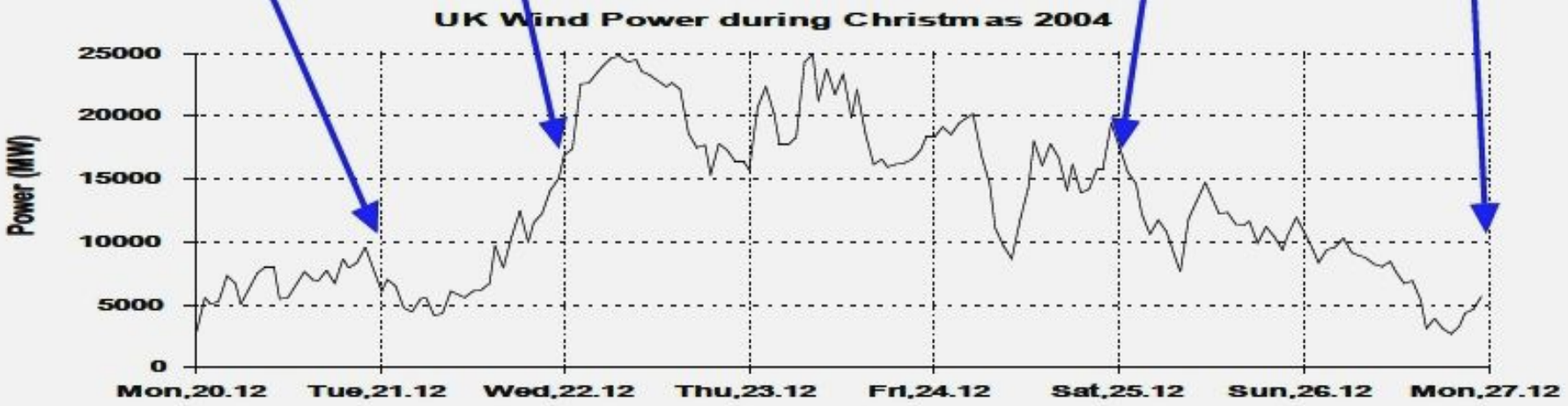
22nd



25th



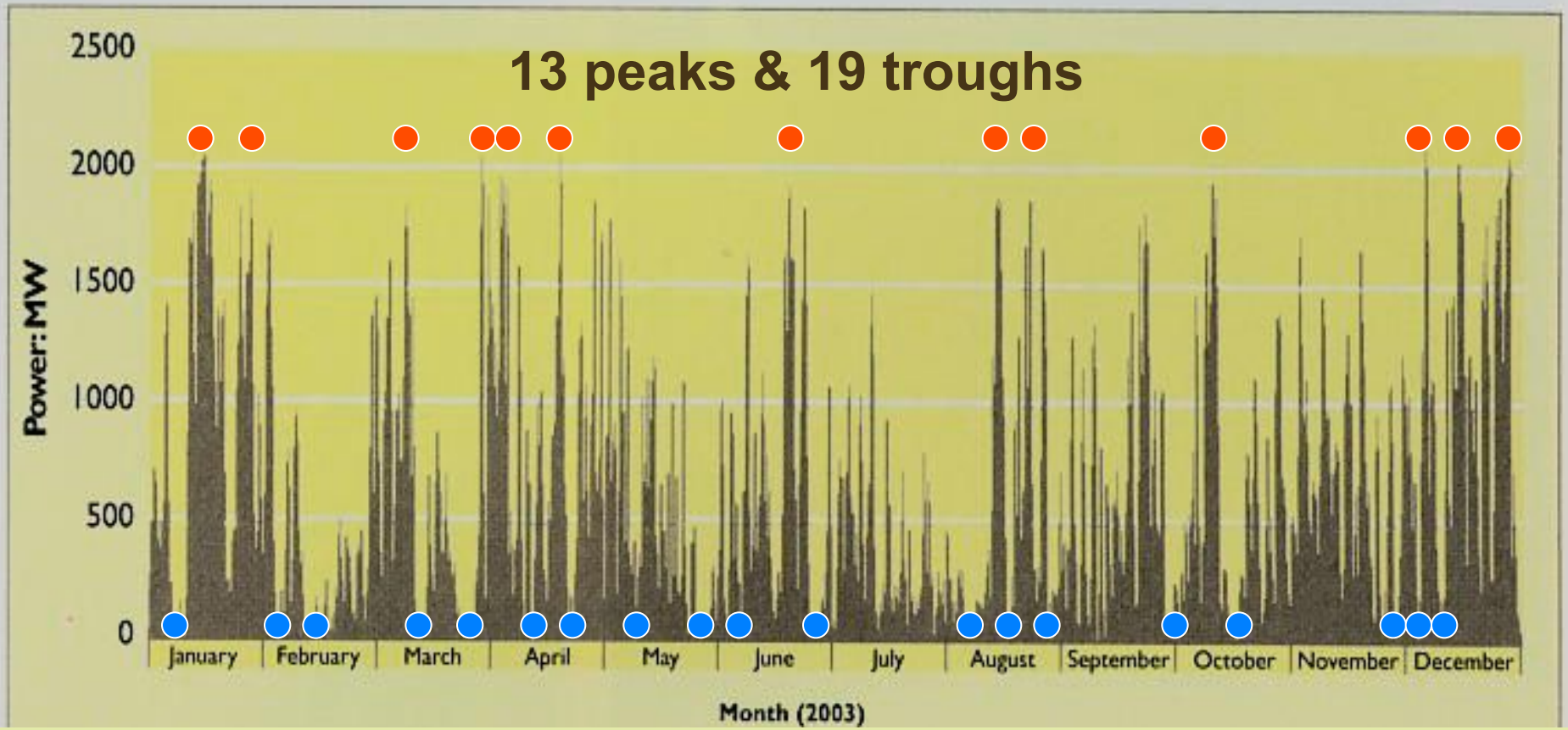
27th



- The closer the isobars the stronger the winds
- Weather systems are bigger than countries

Oswald Consultancy Ltd

The reality of Denmark's wind carpet

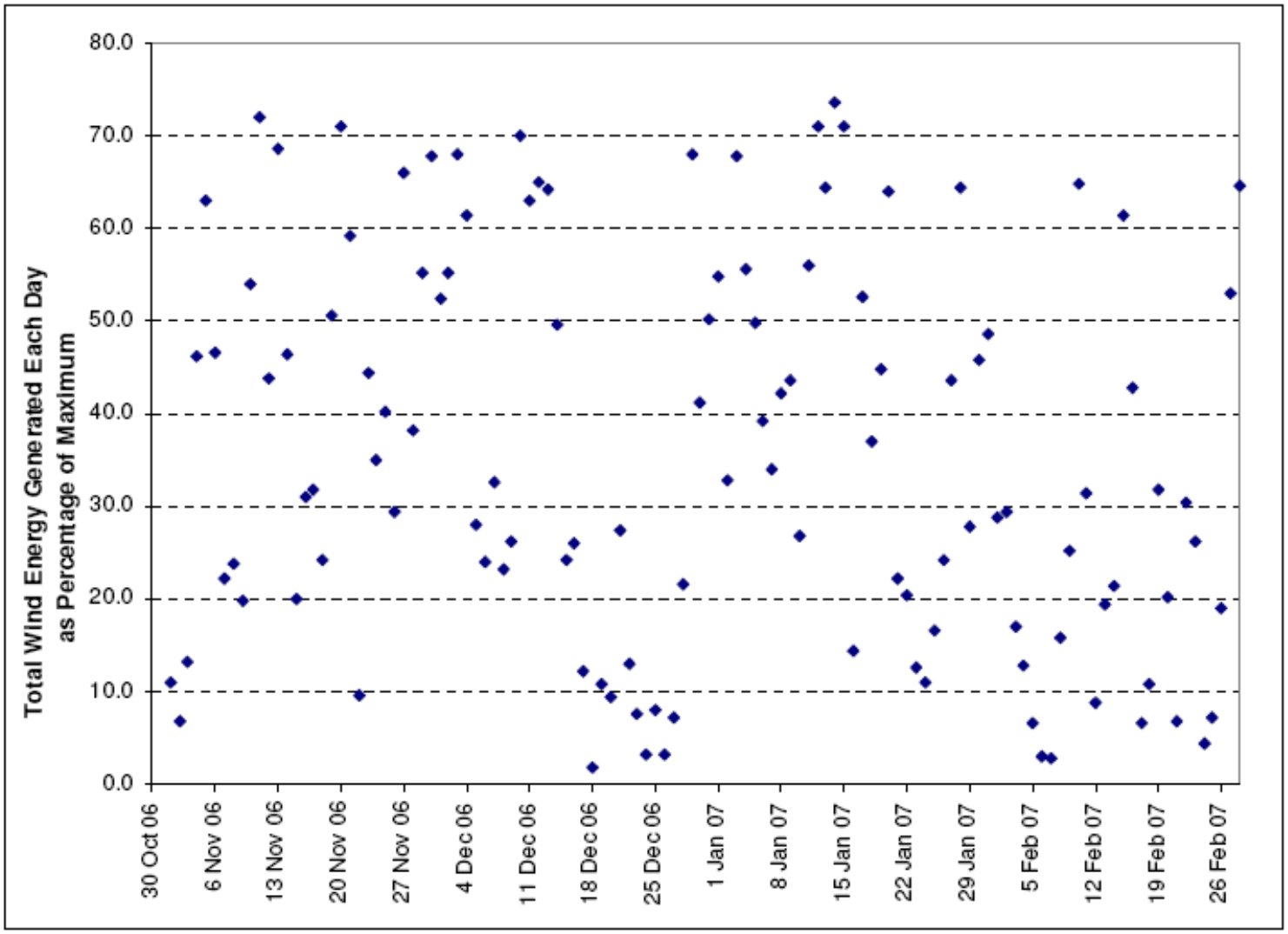


Wind power output exceeded 2,000 MW many times each year but falls below 100 MW even more often

The output is random and unpredictable

Total daily wind input over 4 months

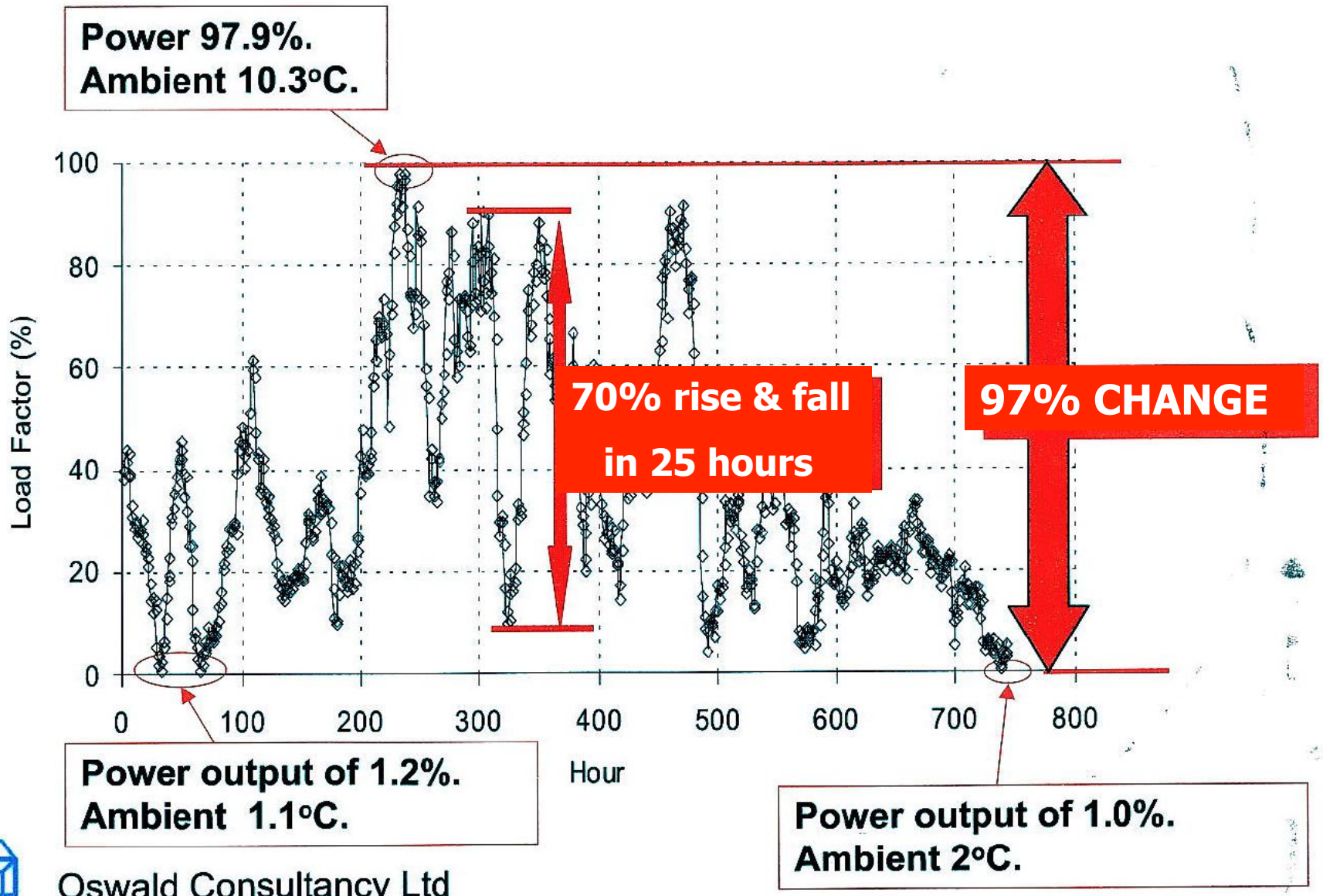
Figure 27 – Wind Output, daily output as % of maximum



Source: National Grid Winter Consultation Report

EIUG

Aggregated UK output, Jan 2006



Oswald Consultancy Ltd

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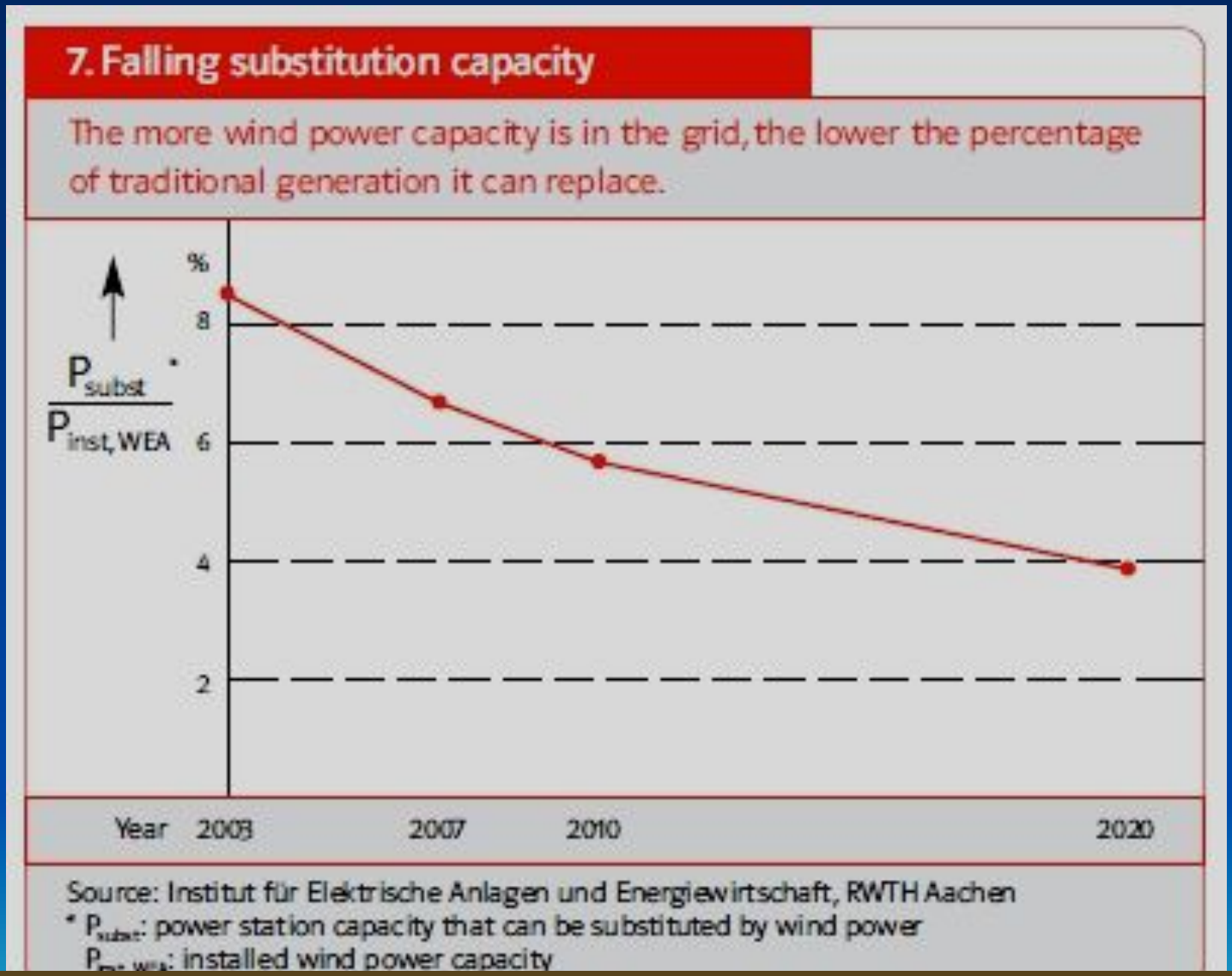
Fuel self-sufficiency	UK import-dependent
Climate change not an issue	Climate change central
Dispatchable supplies	**Non-dispatchable**
Adequate margins	**Inadequate margins**

So can wind provide base load?



Concept of capacity credit

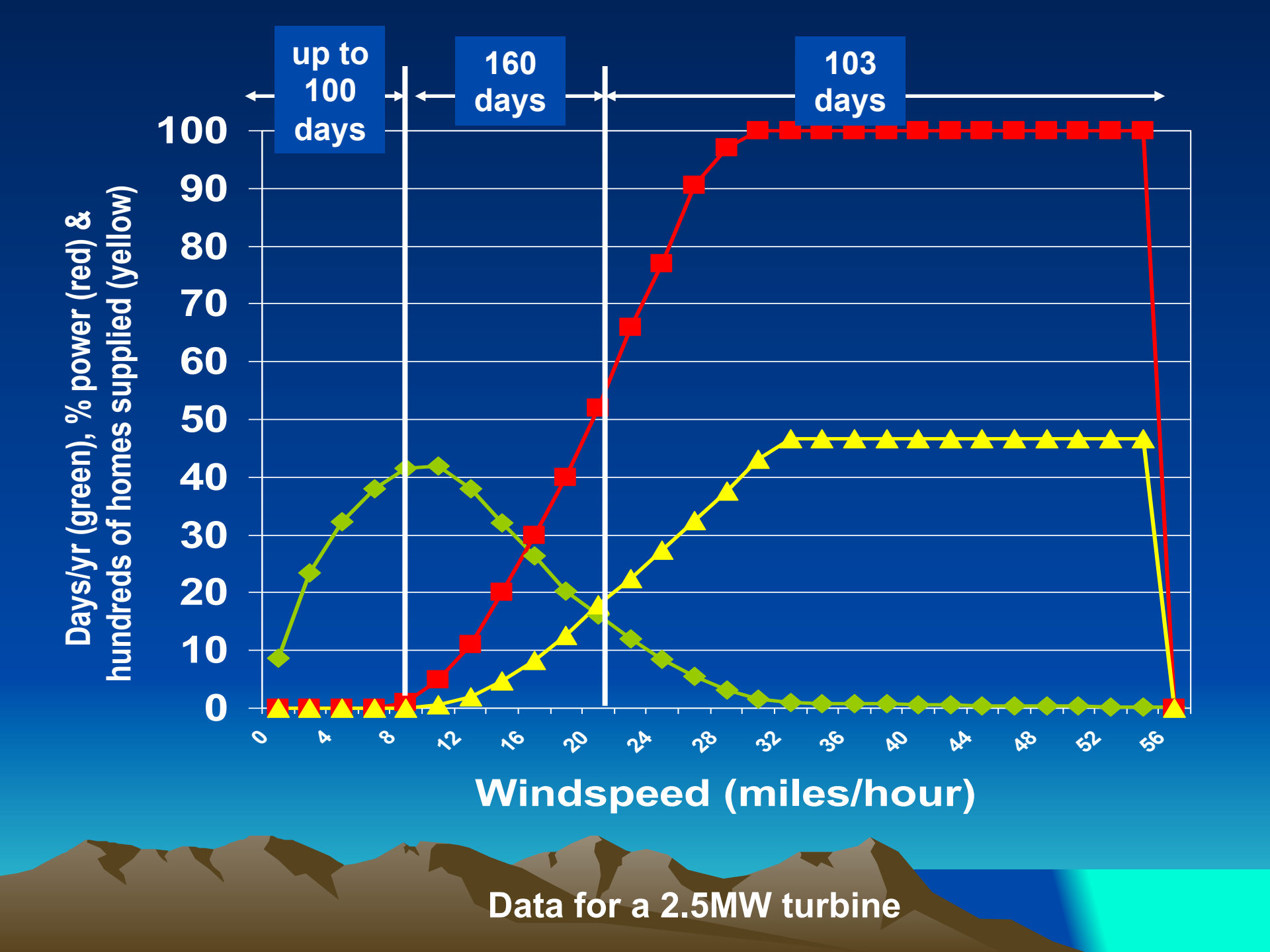
'The more wind capacity is in the grid, the lower the percentage of traditional generation it can replace'

Eon-Netz Wind Report 2005, page 9

What about load following and peaking power?

Wind is random and intermittent and disturbingly unpredictable.

- Any given wind farm will produce **no electricity at all** for 55 - 110 days a year.


up to 100 days
160 days
103 days
Days/yr (green), % power (red) & hundreds of homes supplied (yellow)
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30
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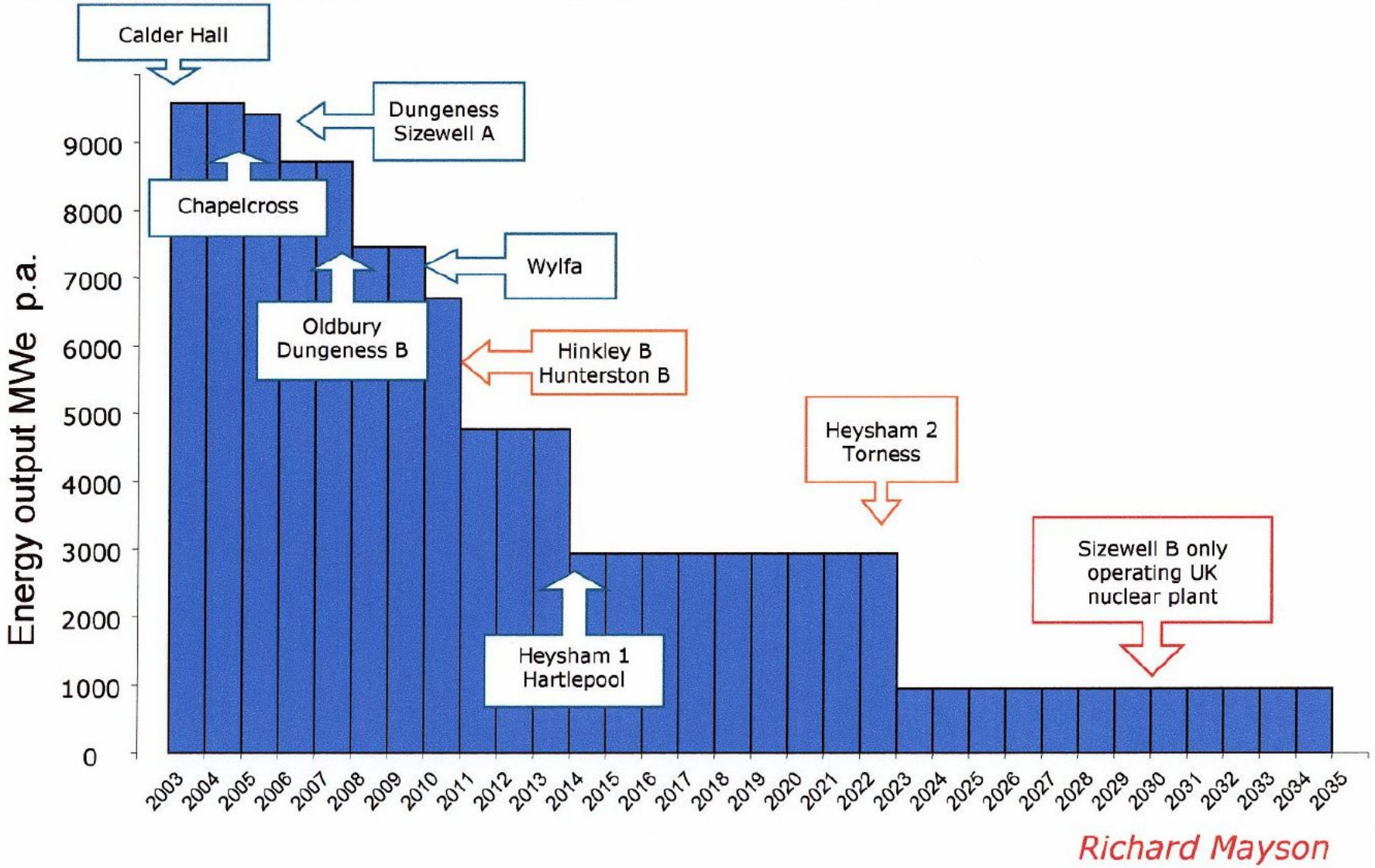
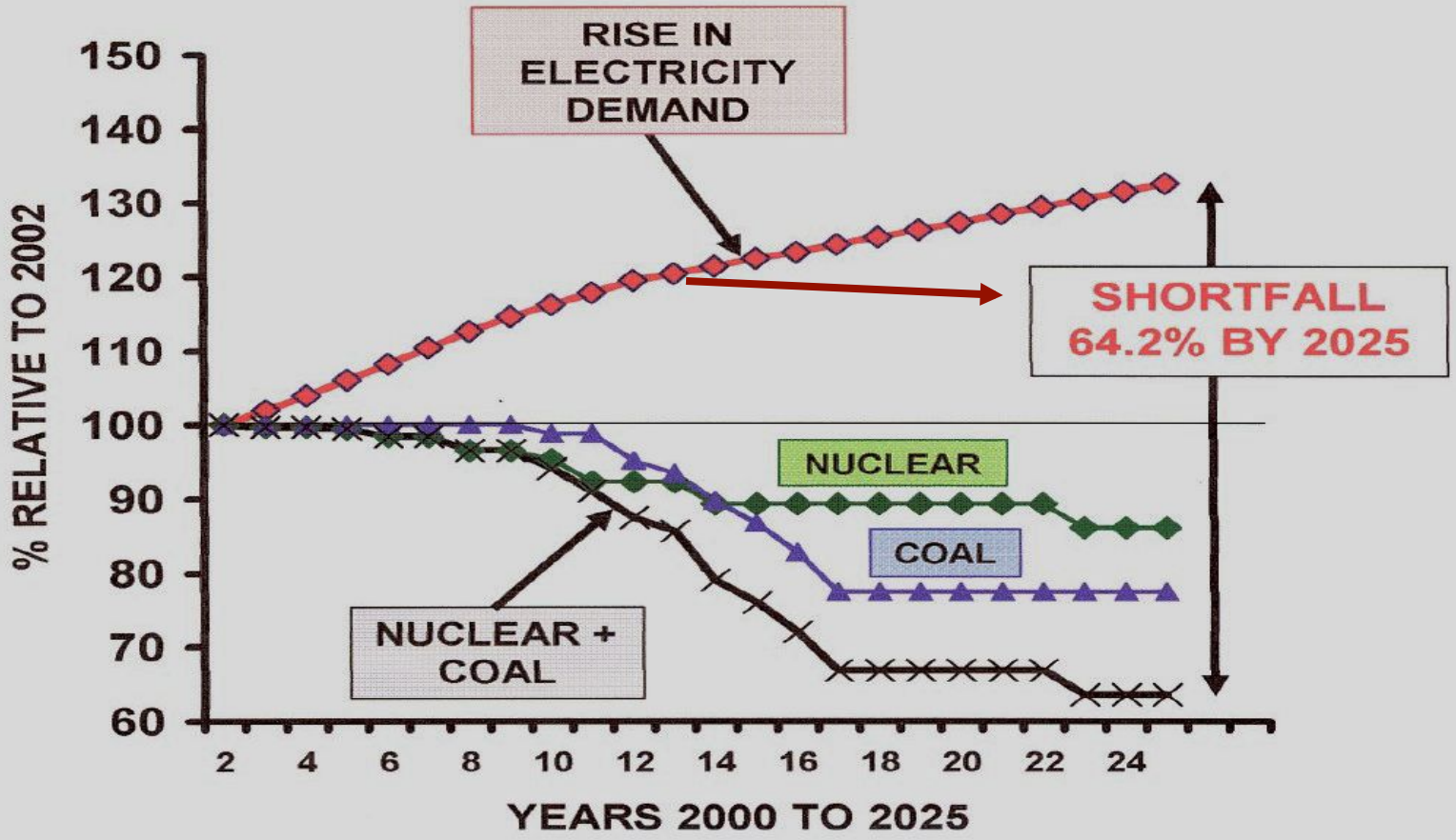
Windspeed (miles/hour)
Data for a 2.5MW turbine

The failed face of strategic energy planning

Projected rundown of UK nuclear energy



Richard Mayson



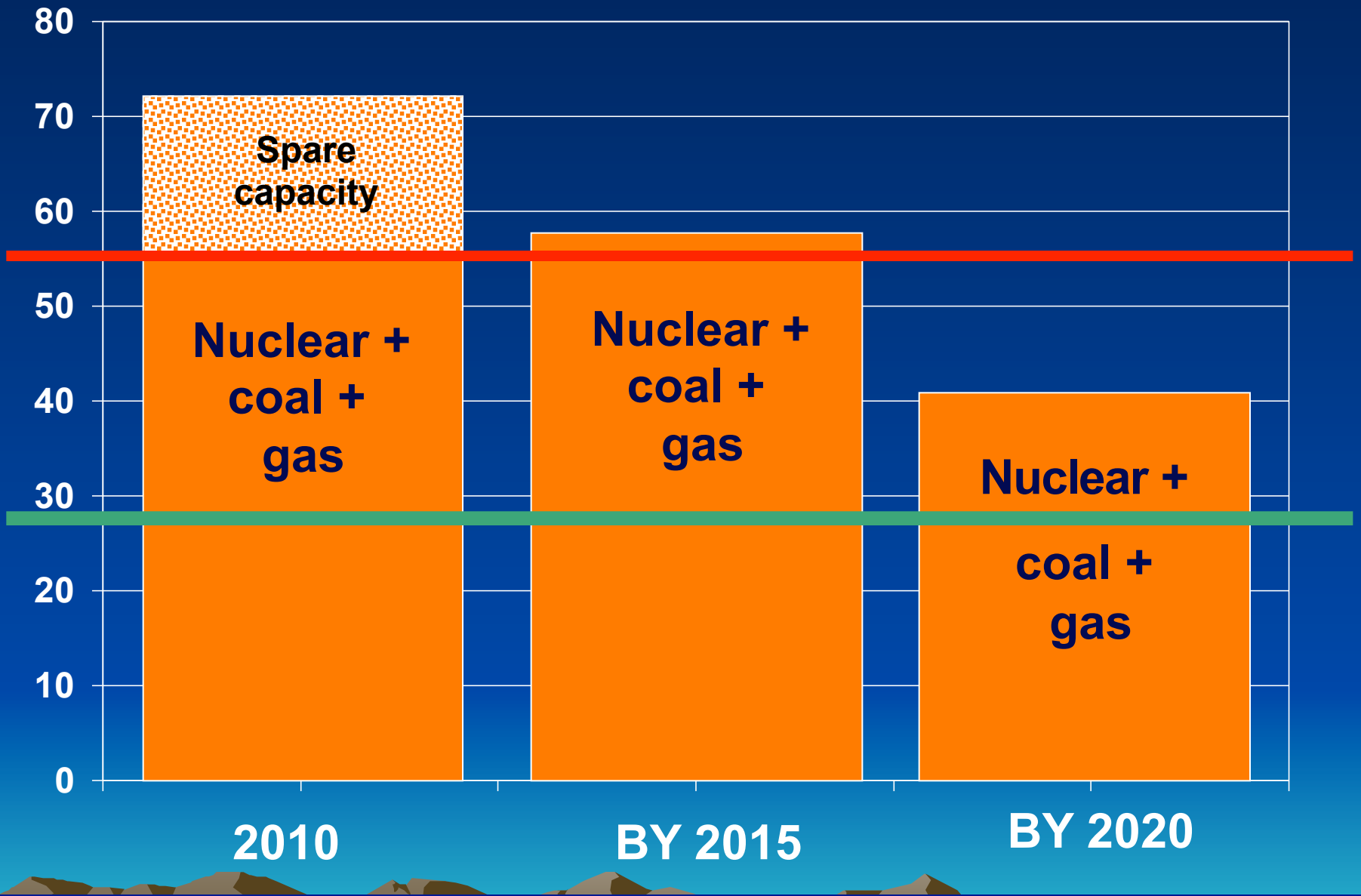
- Demand increase, 1.5% per year from 2000-2010 & 0.8% to 2025 [DTI figures]
- Timetable for nuclear closure [BNFL]
- Coal closures - Final Report for EA on LCPD scheme 1/7/2003 [Oxera]

UK plant closures threaten Grid stability

RWE	coal	Didcot Tilbury	3/2013 2015	3,131 MW
E-ON	coal	Ironbridge Kingsnorth	2015 3/2013	2,910 MW
SSE	coal	Ferrybridge	4/2014	1,995 MW
RWE	oil	Fawley	3/2013	1,000 MW
E-ON	oil	Is. Of Grain	12/2012	1,380 MW
			TOTAL	**10,416 MW**

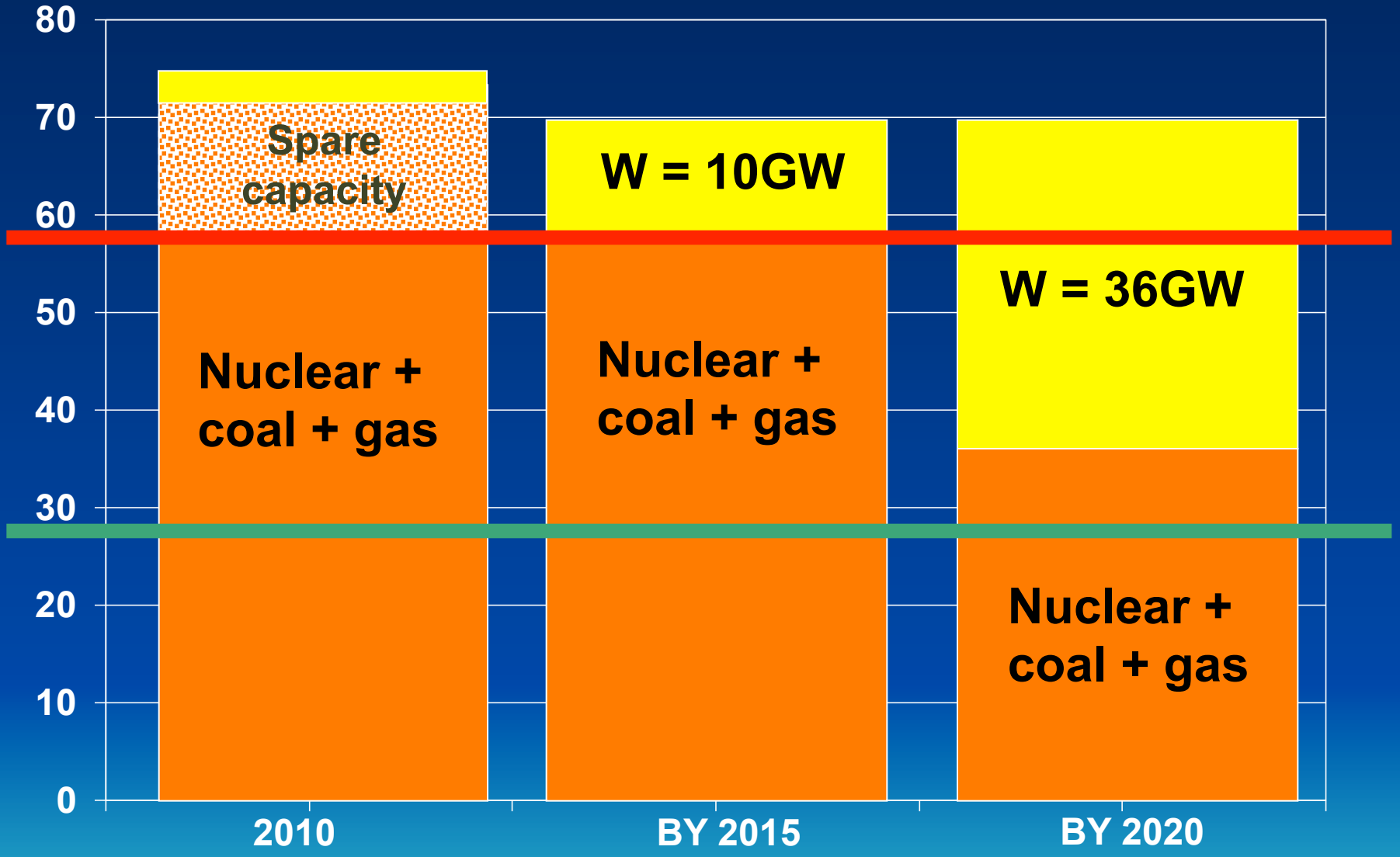
GERMANY building 10 new hard coal plants = 7,985MW IC

THE DECLINE OF DISPATCHABLE POWER PLANT



CONVENTIONAL (NUCLEAR, GAS, COAL) GENERATION;

THE ‘HIGH WIND’ PENETRATION SCENARIO



House of Commons Energy and Climate Change Committee report dated **12th December 2010** on **Emissions Performance Standards** said;

‘….for wind farms …. more capacity will need to be built in order to provide equivalent generating power. The UK’s total capacity is … forecast to increase significantly by **2020 to around 100-130 GW**.’

Paragraph 12, page 9

Paul Golby, CEO of Eon (UK) said;

- *'It would take 50 gigawatts of renewable energy to meet the EU target* [of 15%]. *But it would take 90% of this amount as back-up … to ensure supply when intermittent renewables were not available. That would push Britain's installed power base from the existing* ***76 gigawatts to 120 gigawatts.'***

The Guardian, June 4th 2008

Why UK wind power should not exceed 10 GW

by Hugh Sharman

‘…. the UK will find it impractical to manage much over 10 GW of unpredictable wind power without major new storage schemes or inter-connectors … while wind power should be exploited as fully as possible, it must not be at the expense of renewing existing firm generating capacity.’

Civil Engineering, 2005, V.158, pp161-9

Ian Welch – National Grid

Head of Research & Development

I don't think we have got the answers, but .[…]. the intermittency of future energy generation is one issue that keeps me up at night. What the country really needs is a large-scale energy storage system to deal with the reliability issues of technologies such as wind and solar.

The Engineer, April 2011

Energy regulator warns over blackouts

'..the closures leave the UK in a critical position. Ofgem predicted a 1-in-12 chance that a 'capacity crunch' in the UK would result in the lights going out.'

Daily Telegraph June 22nd 2013

'..reserve margins are forecast to drop from 9% last winter to 4.5% this winter…'

National Grid Winter Outlook 2013-2014

'…Capacity is so stretched that a cold spell, combined with routine problems could overwhelm the system and see blackouts in 2014/15'

Daily Mail, 17th October 2013

One final summing up quotation

"Wind energy is fundamentally insecure. It is delusional to the point of recklessness to assume it will ever meet 30 per cent of UK electricity consumption with an acceptable level of reliability. As events in winter show… [….] …nearly all of its generating capacity needs to be backed up by fossil fuelled power stations. The more wind we have on the system the greater the problem will be. For the wind lobby (and our politicians) to fail to acknowledge this is intellectually dishonest.“

Jeremy Nicholson of the EIUG
E&T Magazine 2009


WINDFARM
What do you mean, there's no electricity on the site?!!!


JIM'S AUTOS
That? Oh, that's the Salmond Green Economy' four-door sedan! It only drives when the sun shines and the wind blows.
So, you need to tow a back-up fossil fuel car behind it!
BACK-UP CAR
Steve Hunter

THE ANSWER

With our present technology base, wind has only a marginal role in base load, no role in load-following, poses major problems for the GRID, and all at crippling costs for the country.

Look after your own forward planning - Thank you