Edge Debate, April 2005

Joe Short

Joe.short@dymamicDemand.co.uk

www.dynamicDemand.co.uk

Agenda

- The technology
  - *'Intelligent' appliances that could help smooth out fluctuations in electricity demand*
- The benefits
  - *Less back-up generation*
  - *less CO_2*
  - *better for renewables*
- The challenge
  - *Why hasn't it happened? What needs to be done?*

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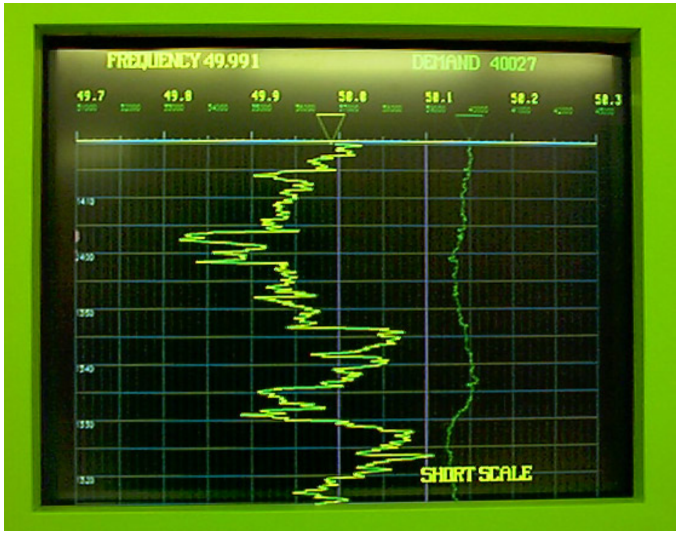
Background

- Frequency is **system-wide indicator** of power imbalance
- When there’s too much demand, generators **slow down**
- Can be measured from **any power outlet** in the country
- Early warning system

“50 Hz”



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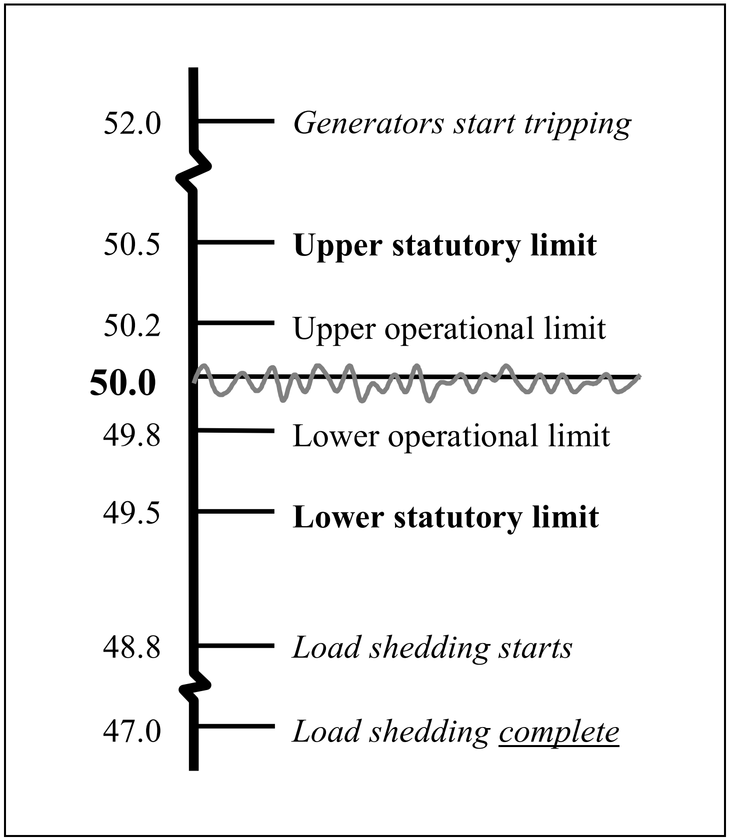
Frequency limits (UK)



Frequency control is essential.
How is it done?…

Source: National Grid Transco

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How is frequency controlled?

- Mainly done by **generators**
- Frequency-response (governor action)
  - Halts frequency-fall (primary)
  - Restores frequency (secondary)
- Involves **part-loaded** plant
- CO_2 emissions associated with response are around **2.1 million tonnes** per year

What is dynamic demand control?

- Appliances fitted with a frequency-sensitive control system
- Together act as a vast frequency-dependent load

- Like a rapid and efficient electricity storage
- Delivers a service equivalent to response
- Beginning to be promoted

  - “grid friendly” (PNNL, US)
  - “demand response” (New England, US, spot prices)
  - “responsive load” (UK)
  - “dynamic demand control” (UK)
  - “frequency control by demand management” (UK)

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Candidates for Dynamic Demand Control

- Time-flexible appliances

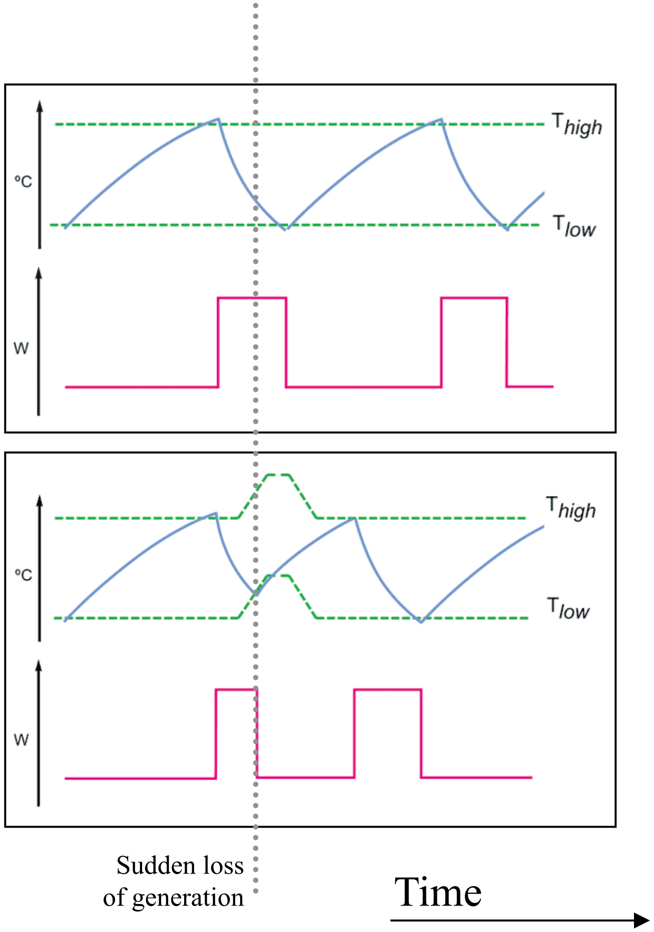
  (Anything that needs electricity but is to some extent flexible as to when that energy is delivered)

  – Refrigeration (commercial, industrial, domestic)

  – Air conditioning

  – Water heating

  – Heat pumps

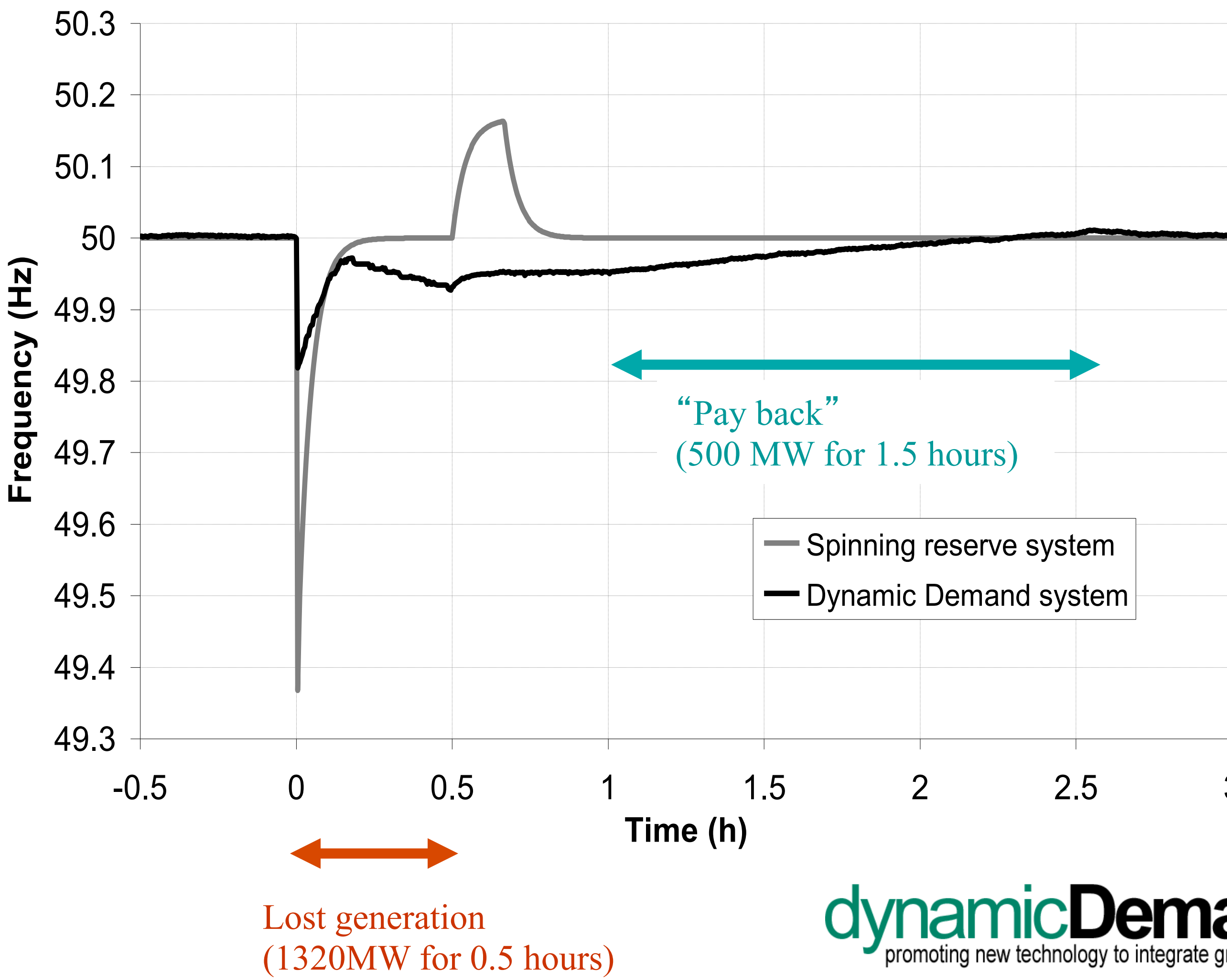


What happens when many act together…

Simulation of a sudden loss of generation

1320MW lost at T=0 hours which is restored during the ten minutes following T=0.5 hours and a "paying back" of this energy starting at T=1 hour.

- 1320MW of dynamic demand control
- Cf: 1320 MW of spinning reserve



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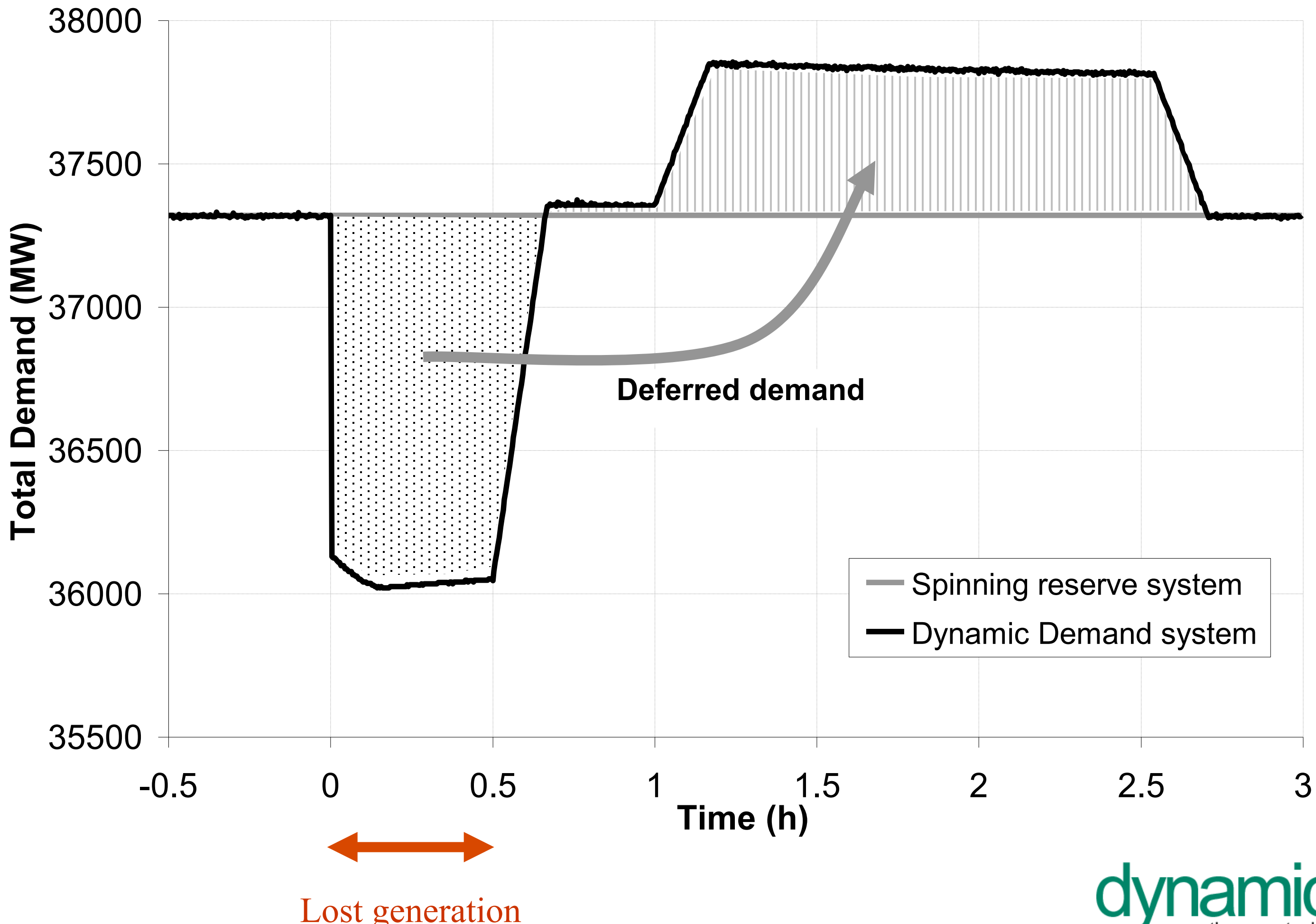
Total demand for the same simulation



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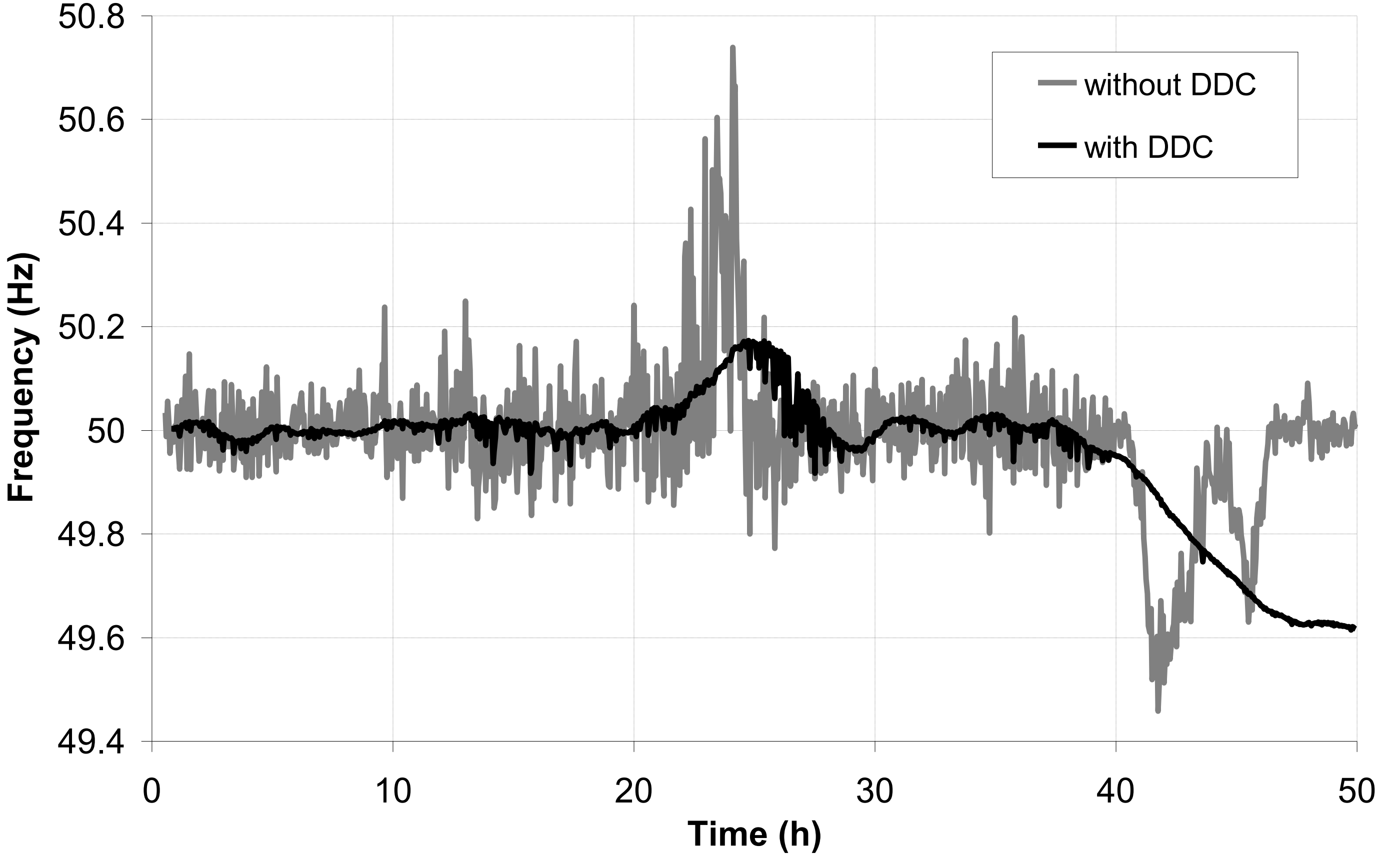
Help integrate renewable energy?

(Wind power simulation)

- •14GW capacity (approaching 30% penetration)
- •23 sites
- •Period of high variability chosen
- •Real data scaled up
- •Trad: 3GW spinning reserve
- •DDC: 2GW of reserve + 1GW DDC



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Summary of benefits

- Provides equivalent service to traditional response
- Also provides longer-term load deferment
- Could replace all traditional response saving **2.1 million tonnes of CO_2** pa.
- This is **25%** of the saving from the UK's 10% renewable energy target
- Low-cost
- Could help integrate renewables
- Lucrative (Current cost > £80m pa)
- Realistic (No changes to the system)

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Why hasn’t it happened?

- Current regulatory (and institutional) climate not yet suited to long-term innovative project
  - Hard to guarantee an income for <u>future</u> provision of response.
  - E.g. regulations could change.
- Manufacturers unaware or unwilling to risk R&D with no signs of a market mechanism
- Needs political and wider support
- Dynamic Demand funded for next 18 months to increase awareness and encourage new regulations

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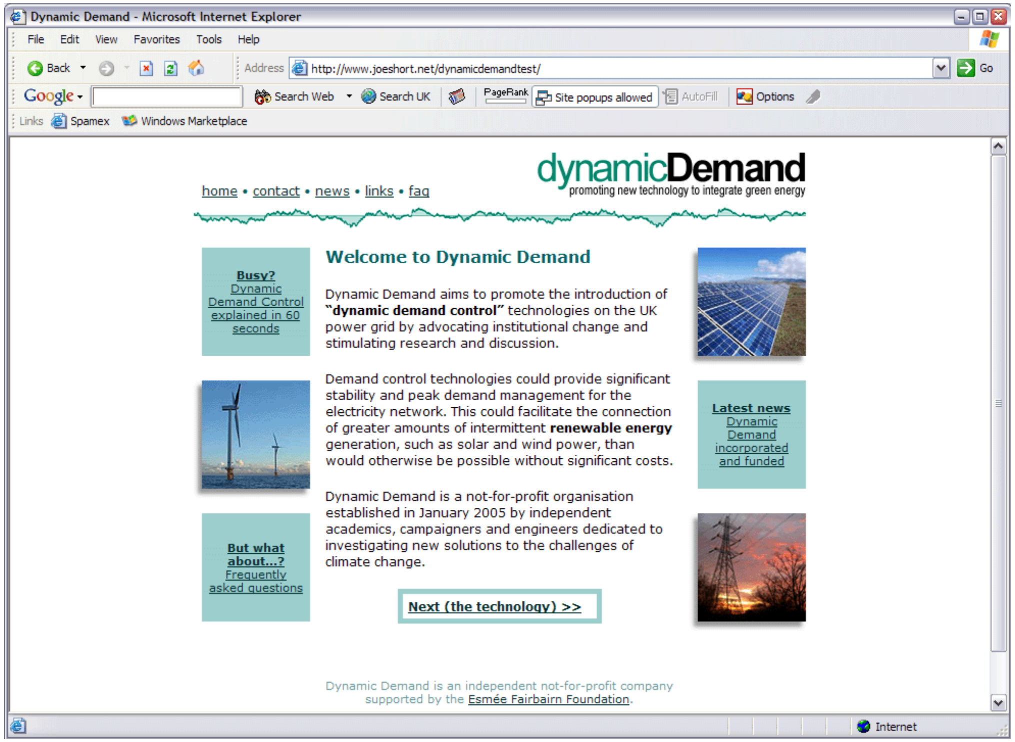

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