



Our Mission

We are a dynamic, visionary and ambitious company committed to improving the way electricity is supplied and consumed. reducing greenhouse gas emissions and reducing the overall cost of electricity supply.

Electricity Innovations for Sustainable Development

For Smart Grids and Stand Alone Electricity Systems.
At 15th Congress of UN Commission for Sustainable Development

David Hirst, Chief Technologist
New York, 4th May 2007 v0.1

Outline Agenda

- The Magic of Electricity
- The Complexity of Electricity
- Electricity is “costing the earth”
- Some better ways – touching on **RLtec** technologies
- Menu of deeper explorations
 - Fridges and the Energy Balancing Controller
 - Hot water, heating and Grid Capacity Enhancement
 - Blackout-free Grids
 - Connected & isolated mini-grids – Neighbourhood Trading
 - Economic optimisations
 - Market Failures
 - In Praise of Markets
 - Some ESI background

The Magic of Electricity

- “Western civilisation” depends upon it
 - Embedded in all aspects of our lives
 - Central to Industry & Commerce
 - No “IT” without it: No TV, no PCs, no Internet
- Huge enabler of human well-being
 - Lighting: efficient and free of (indoor) emissions
 - Information & Entertainment
 - Medicine & Food Preservation by **cooling**
 - Cooking & Hot Drinks
 - Hot water & Laundry
 - Water pumping
- Development Freedoms
 - Irrigation

The Complexity of Electricity

- US Grid is “most complex machine ever built by man”
- Deep, wide (and interconnected) infrastructure
 - Large scale generation units – once economies of scale
 - Very long lasting – much 50 years old (and ageing)
 - Strange structural mismatch: centralized supply : decentralised demand
 - Technocracy – engineering specialisms and “priesthood” culture
- Regulatory “nightmare”
 - Where is the “natural” market?
 - What markets can be designed?

***Technical, Cultural, Regulatory, and Investment
obstacles to rapid Innovation & Change***

Electricity has Deep Issues



Electricity is Costing the Earth

- Some 30% of GHG emissions from Electricity production – Historically & Now
- High carbon coal is predominant fuel, now & future
- Renewables growing slowly
 - “Ambient” generation is uncontrolled
 - Demand is said to be inflexible
 - System obstacles to rollout
- Markets sometimes failing

We have to find and implement better ways - fast

Some Great Ideas for Now

- Grid Capacity Enhancement
 - Reduce Peak Demand by shifting thermal storage
- Automatic Balancing Services
 - From Fridges Fitted with the Energy Balancing Controller (EBC)

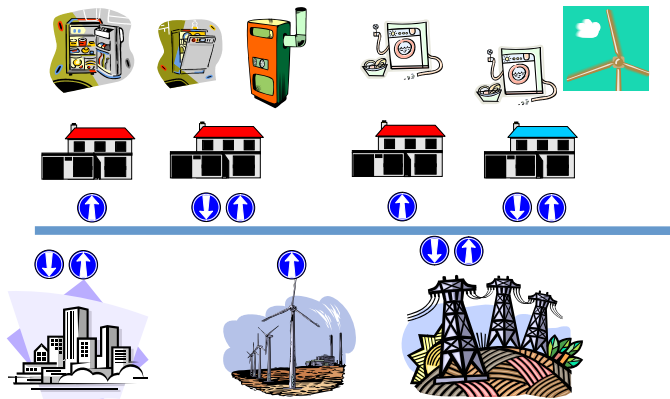


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Some Great Ideas for Soon (1)

- Neighbourhood minigrid Electricity Trading

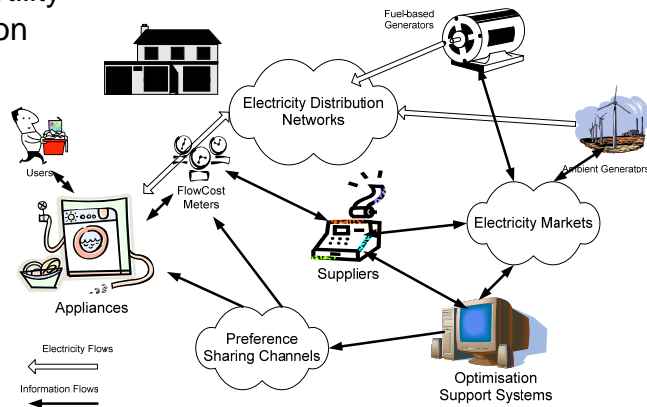


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Some Great Ideas for Soon (2)

■ Dynamic Utility Optimisation

- Idealised Real Time Market Pricing
- Reward well timed consumption



Ambient Generation

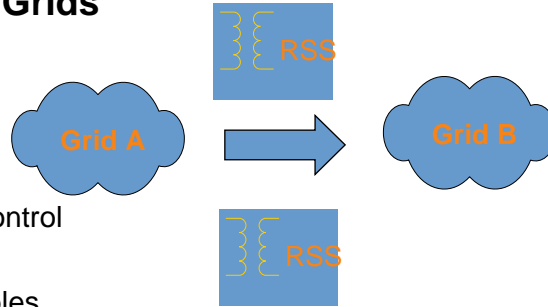
- When Wind (or sun) is forecast, then suppliers will decrease prices
- When prices decrease, then more appliances will run

Do your Laundry When the Wind is Blowing

Great Ideas for Soon (3)

▪ Blackout-free Grids

- Secure
- Decentralised
- Autonomous Control
- 100% Renewables

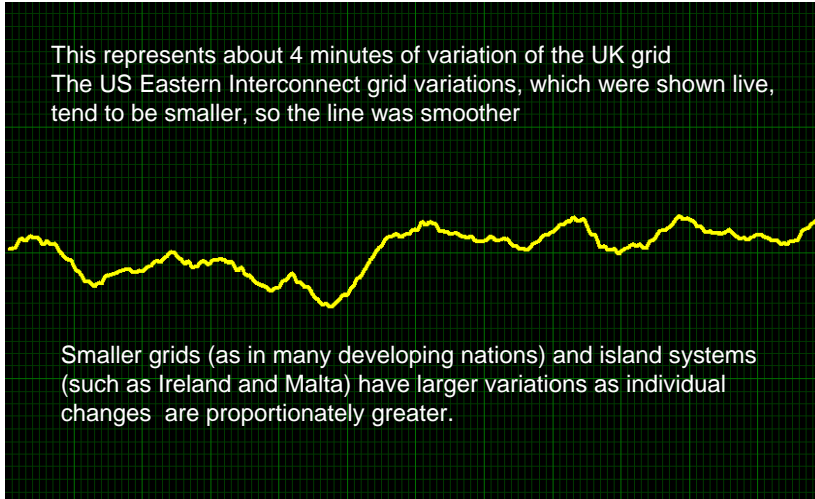


Topic Slides

- The slides that follow were used during the presentation, or help put those slides in context

System Frequency (UK example)

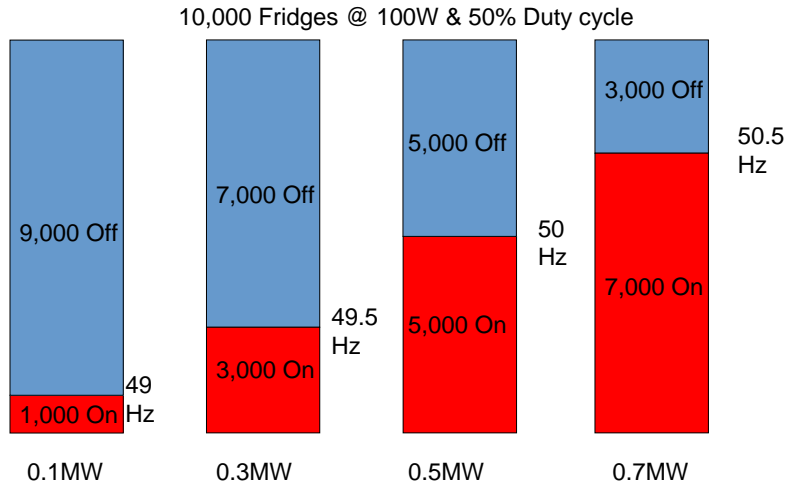
This represents about 4 minutes of variation of the UK grid
The US Eastern Interconnect grid variations, which were shown live,
tend to be smaller, so the line was smoother



Smaller grids (as in many developing nations) and island systems
(such as Ireland and Malta) have larger variations as individual
changes are proportionately greater.



Fridge Population Behaviour



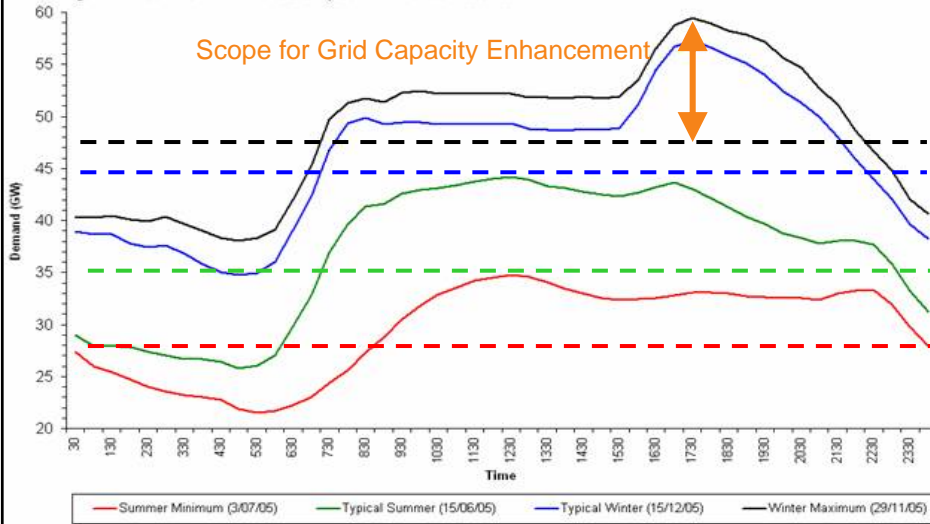
Geysers Listen

- If frequency is Low, tend to switch Off
- When frequency is High, tend to switch On
- So Low frequency reduces demand
- Arises naturally at high load

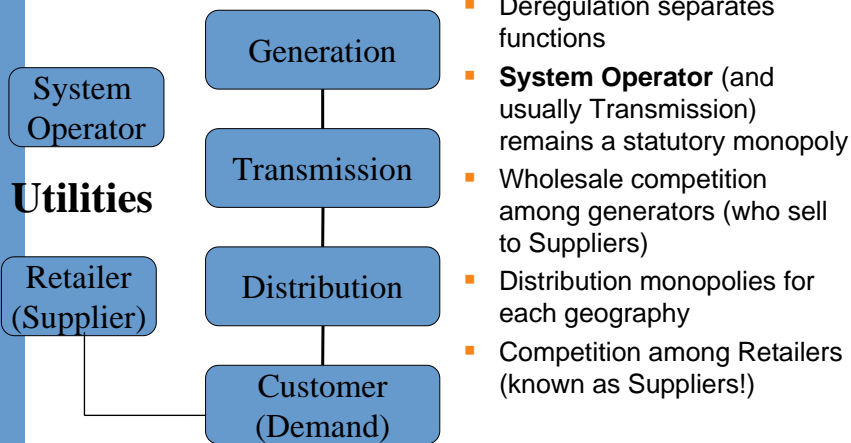


Peaks are Reduced So Less Capacity Needed

Figure 2.2 - Summer and Winter GB Daily Demand Profiles in 2005/06

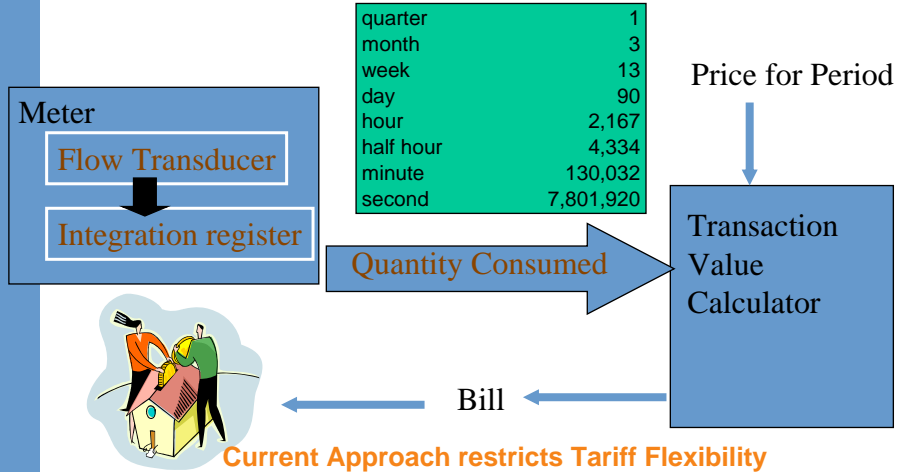


Electricity Supply Industry (ESI)

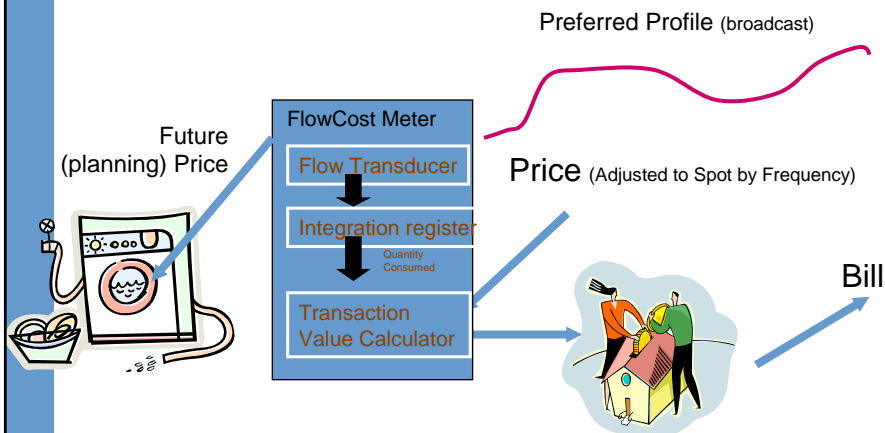


- Deregulation separates functions
- **System Operator** (and usually Transmission) remains a statutory monopoly
- Wholesale competition among generators (who sell to Suppliers)
- Distribution monopolies for each geography
- Competition among Retailers (known as Suppliers!)

Meter Data Flows & Processes



Tariff Broadcasting



Planning by Appliances & Machinery

- Many appliances and machines (like System Operators) can plan
 - Minimise cost of consumption; and
 - Meet the demanded deadline
 - So long as they know the costs (ie the Tariff)
- So Tariff should:
 - Be continuously variable (without discontinuities)
 - Vickrey On Road Pricing
 - Have visibility into the future } balance
 - Respond to circumstances
 - Reward exports (e.g. solar) fairly



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