



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.

Carbon Reduction by Smarter Appliances-

Presentation to I Chem E– November 14th 2007

David Slater

Electricity Systems are Part of the Problem?

“Climate change presents a unique challenge for economics: it is the greatest and widest-ranging market failure ever seen.”

Nicholas Stern. The Stern Report 30 October 2006

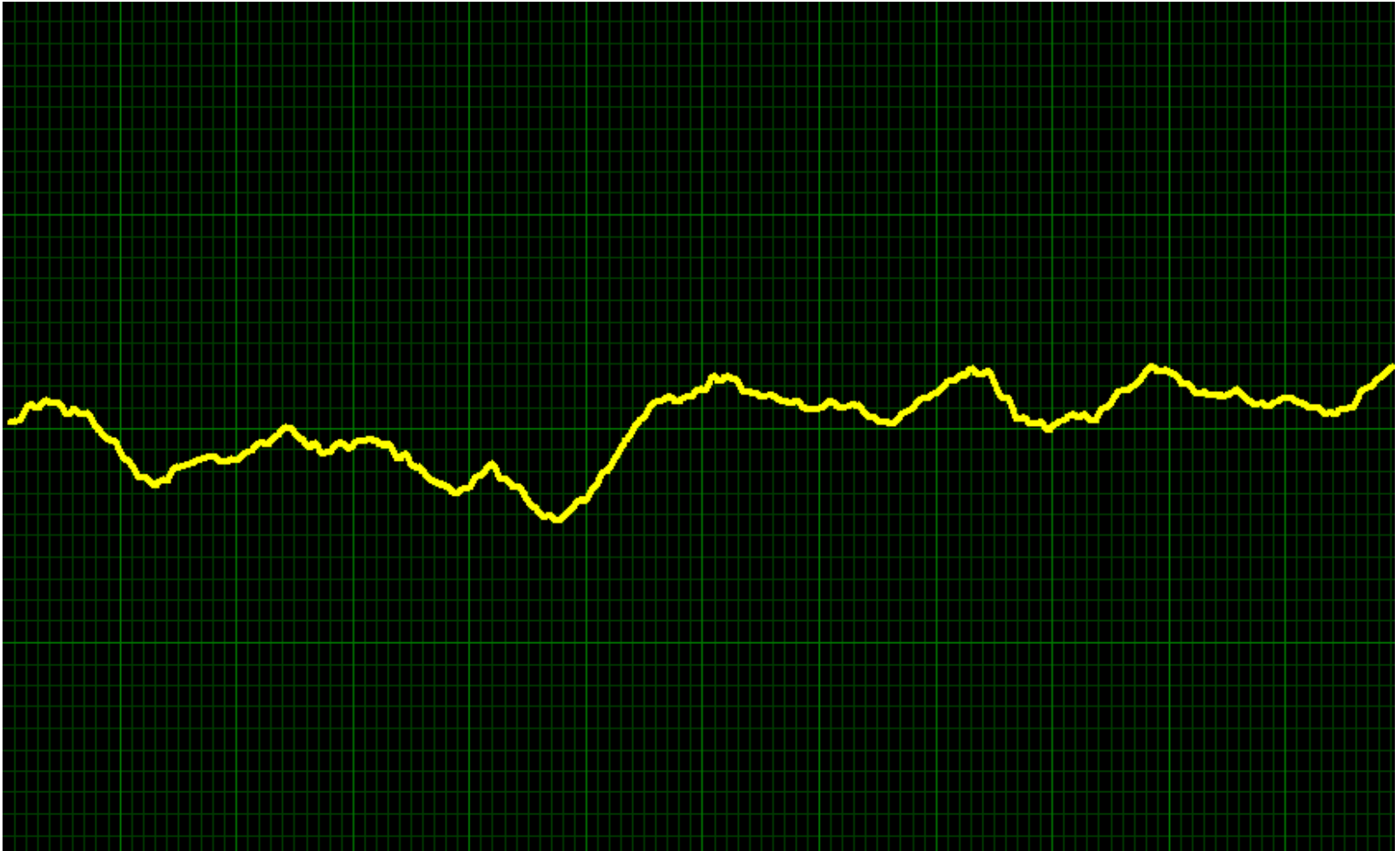
35% of global CO₂ emissions are from Power Stations

40 year old coal plants are being reconditioned!

The Drivers of Electricity Efficiency

- Load Factor
 - The more use from the plant, the lower the costs/unit
 - The “flatter” the demand curve, the less need for peaking plant.
- Fuel Efficiency
 - For coal and gas, the more constant the output, the greater the efficiency and less the wear
 - Part load also generally reduces efficiency
- Some types of renewable generation are weather dependent and will make generation / demand matching harder

System Frequency (example)



Frequency Response

- Crises happen – lost plant, lost lines leading to system split etc.
- Response utilised continuously for smaller demand / generation mismatches, as well as to be available for larger event

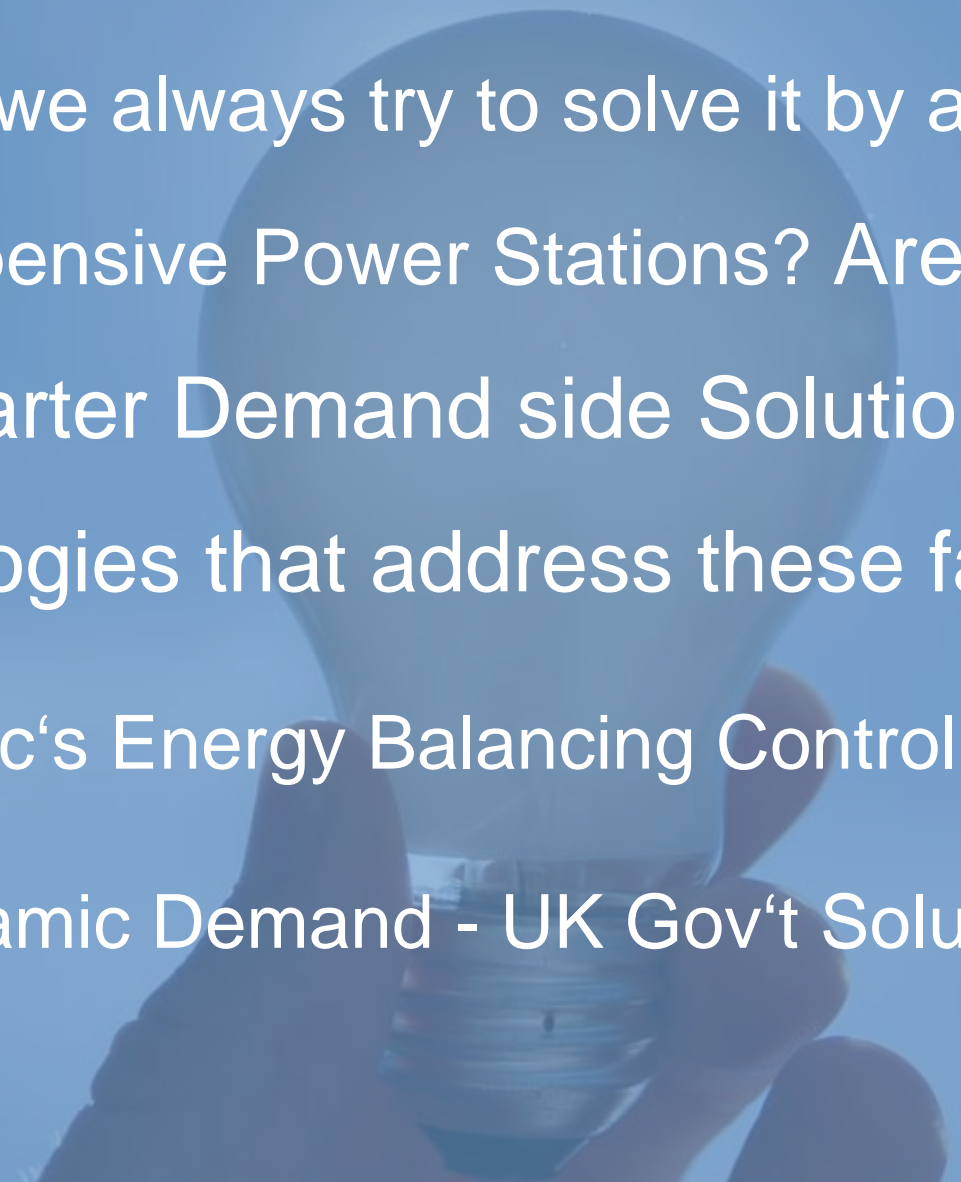


Costs of Frequency Response

- ~ £100m p.a. in the UK
- Part loaded plant
 - Capacity to increase (& reduce) output
 - Non optimal efficiency
- More flexible plant tends to be older
 - And so less efficient
 - Or very expensive (e.g. Dinorwig)
 - And coal fired
- Big plant is easier to instruct



Recipe for High Carbon?



Why do we always try to solve it by adding more expensive Power Stations? Are there any Smarter Demand side Solutions/ Technologies that address these failings?

- RLtec's Energy Balancing Controller (EBC)
- Dynamic Demand - UK Gov't Solution?

The Product

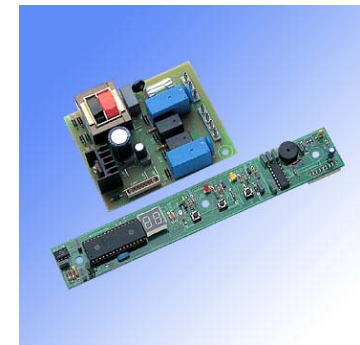
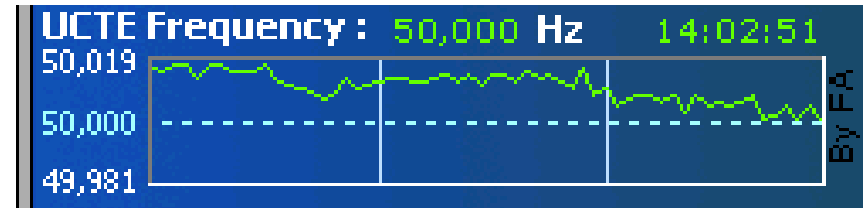
- **RLtec have developed a series of patented algorithms that provide FR**
- **Can be applied to a number of appliances**
 - Refrigeration compressor motors
 - Air conditioning
 - Water heating
 - Pumping
 - Battery chargers (fork lifts, hybrid vehicles etc)
- **Automatic so not centrally dispatched**
- **Obviates the need to balance by using generation**
 - **i.e. non-carbon emitting**

Fridges Do It Better



How does it work?

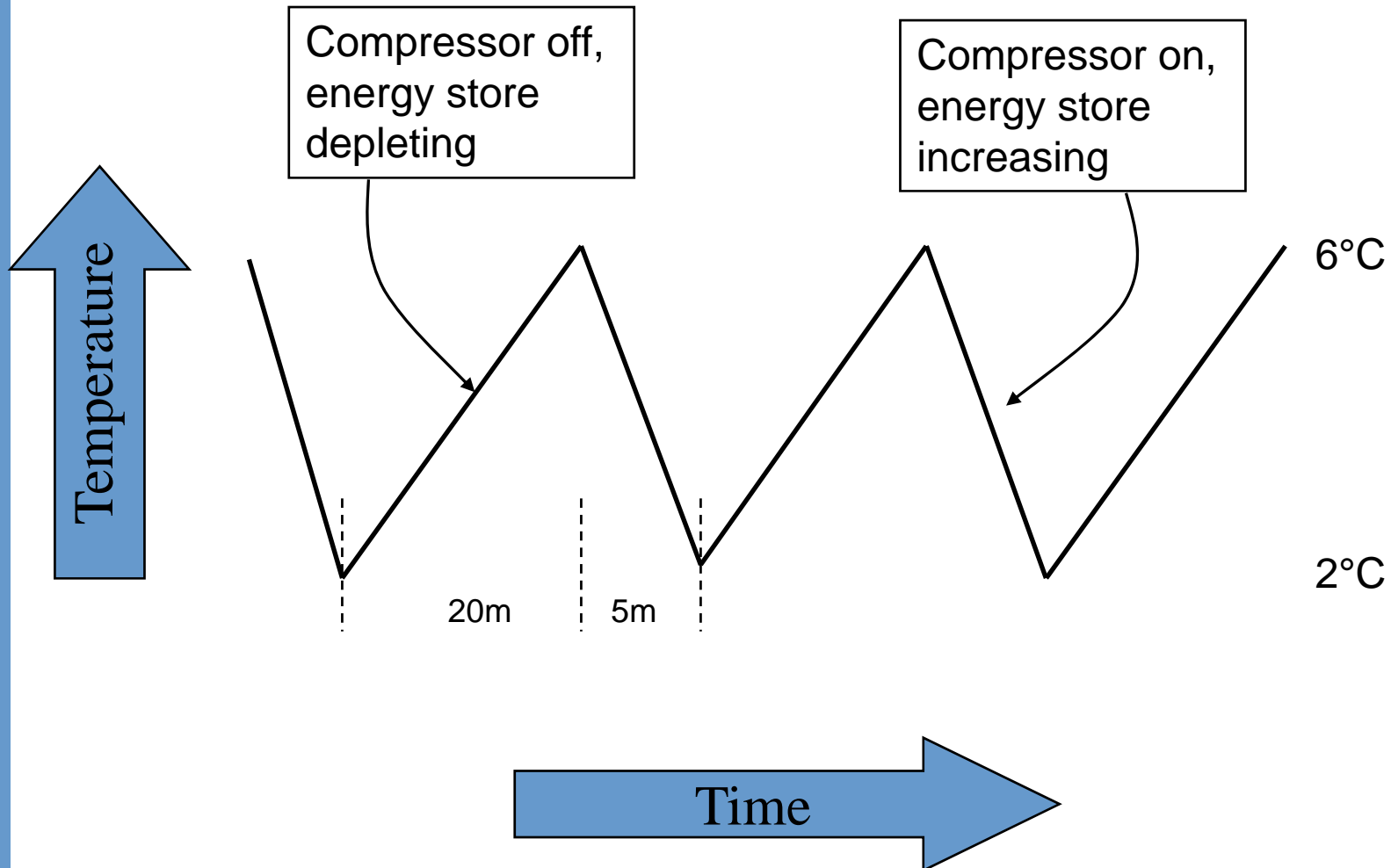
- Monitors grid condition
 - Frequency measurement
- Controls compressor motor
 - Temperature measurement & grid condition
- No functional impairment
 - No reduction in food preservation performance
 - No material increase energy consumption
 - No decrease product lifetime
- Implementation
 - Software within “electronic controller”
 - Intelligent thermostat / motor



Using energy stored in fridges and freezers

- Domestic fridges cycle on and off to maintain a temperature range generally between 2C and 6C
- There is discretion of when to switch the compressor on and off within this temperature range
- Altering compressor switch on or off timings, based on system frequency, defers or advances load, thereby providing frequency response
- Freezers have a similar, but colder, cycle to fridges.
- In this presentation example fridge data has been used

Domestic Refrigerator Operation



Typical Fridge Characteristic

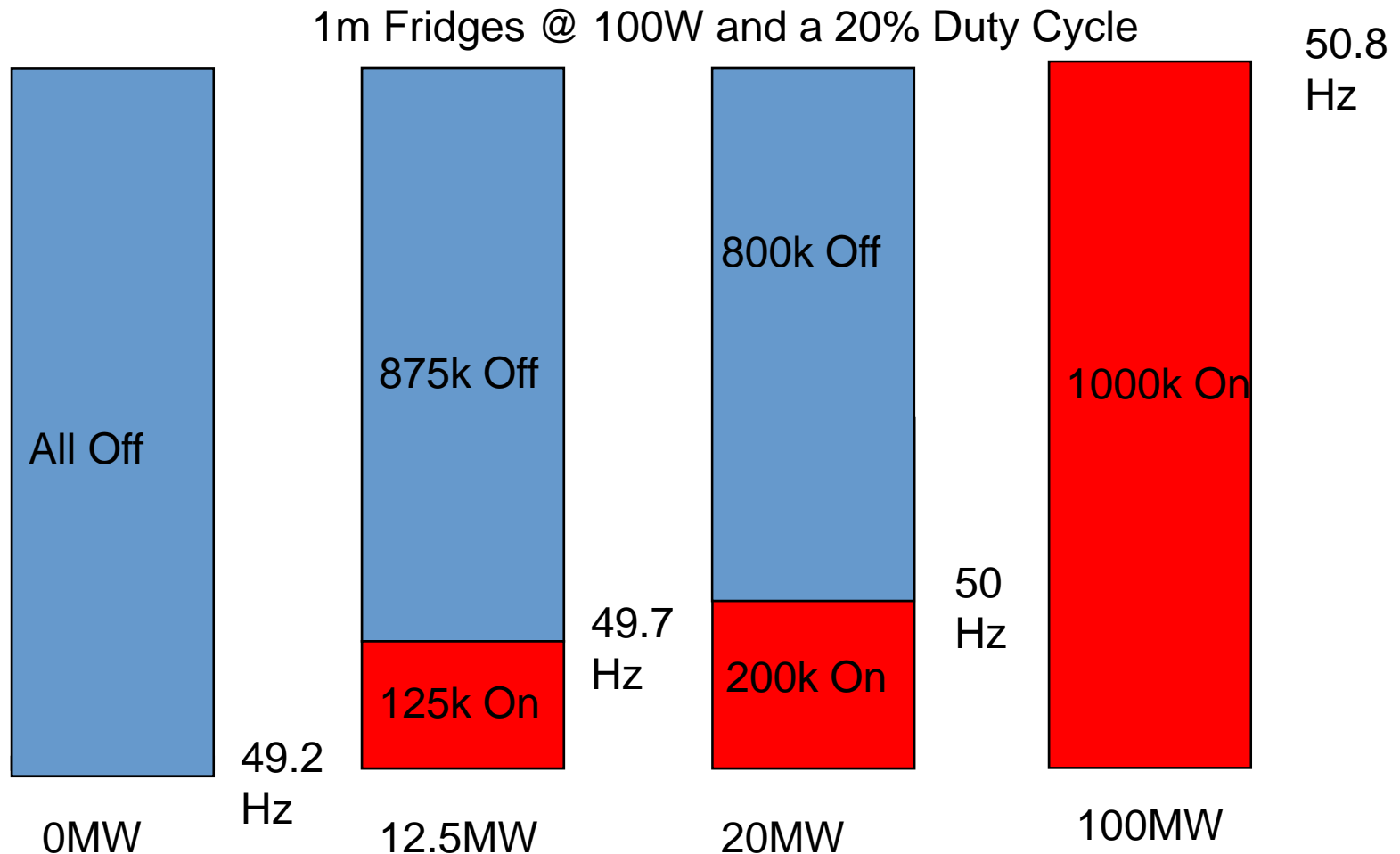
- A domestic fridge may have a 100W compressor with an 80 minute cycle comprising 60 minutes off and 20 minutes on. Other time cycles exist but the above will be used for this presentation
- The mean demand of this fridge is therefore 25W
- A “non synchronised” large population of fridges will therefore have a continuous total demand of 25W per fridge, with 25% on and 75% off
- Frequency response is provided by modifying the Electronic Control Unit built in to fridges - there is no ability for the customer to modify the frequency response behaviour

Modified Electronic Control Unit in fridges

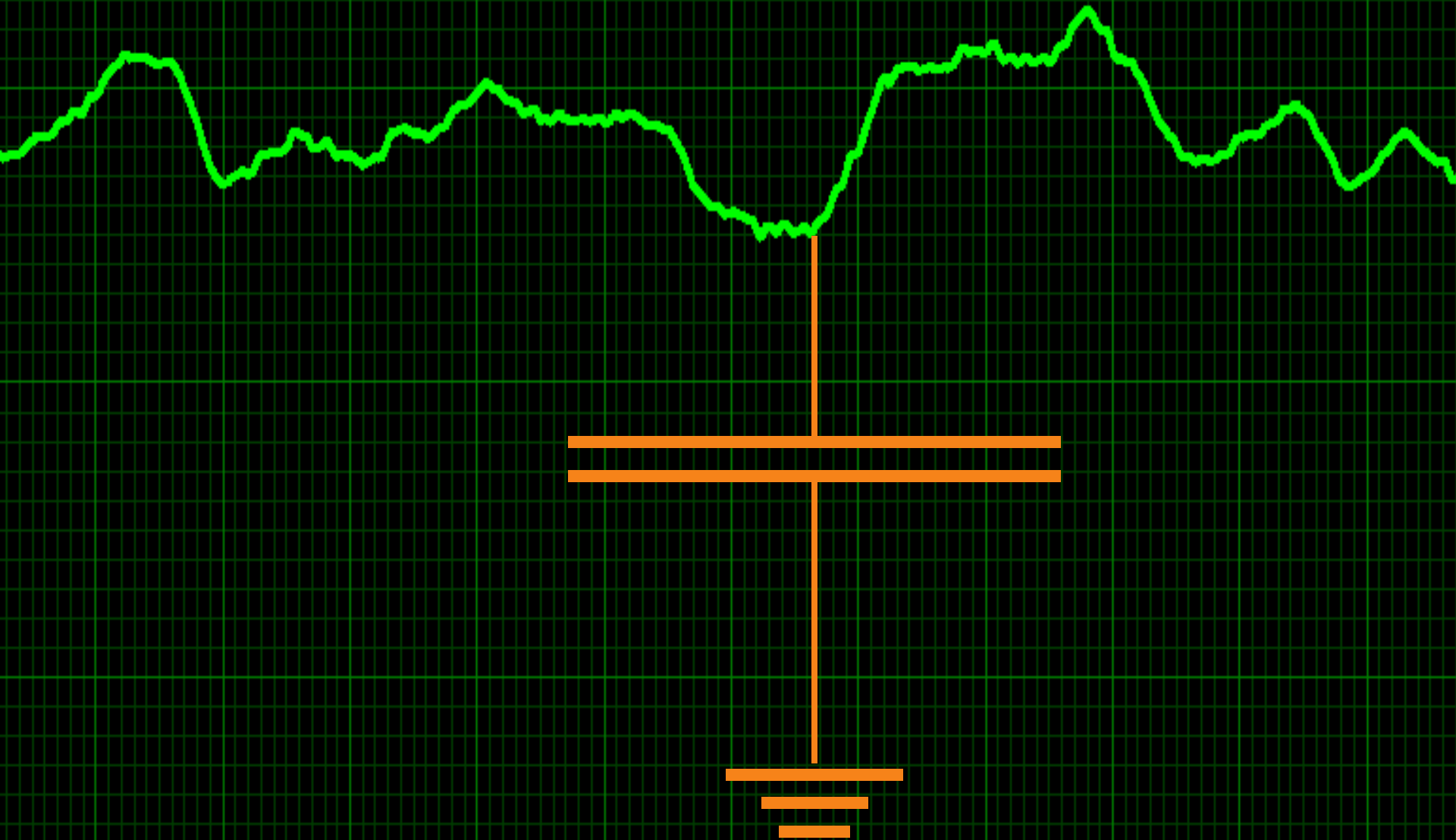
Control System:

- Reads the frequency, whilst stable around 50 Hz, normal thermostat/compressor operation
 - If frequency is low, some fridges in cooling cycle will be turned off
 - If frequency is high, some fridges in warming cycle will be turned on
-
- Diversity is critical and ‘engineered in’

Fridge Population Behaviour at possible settings

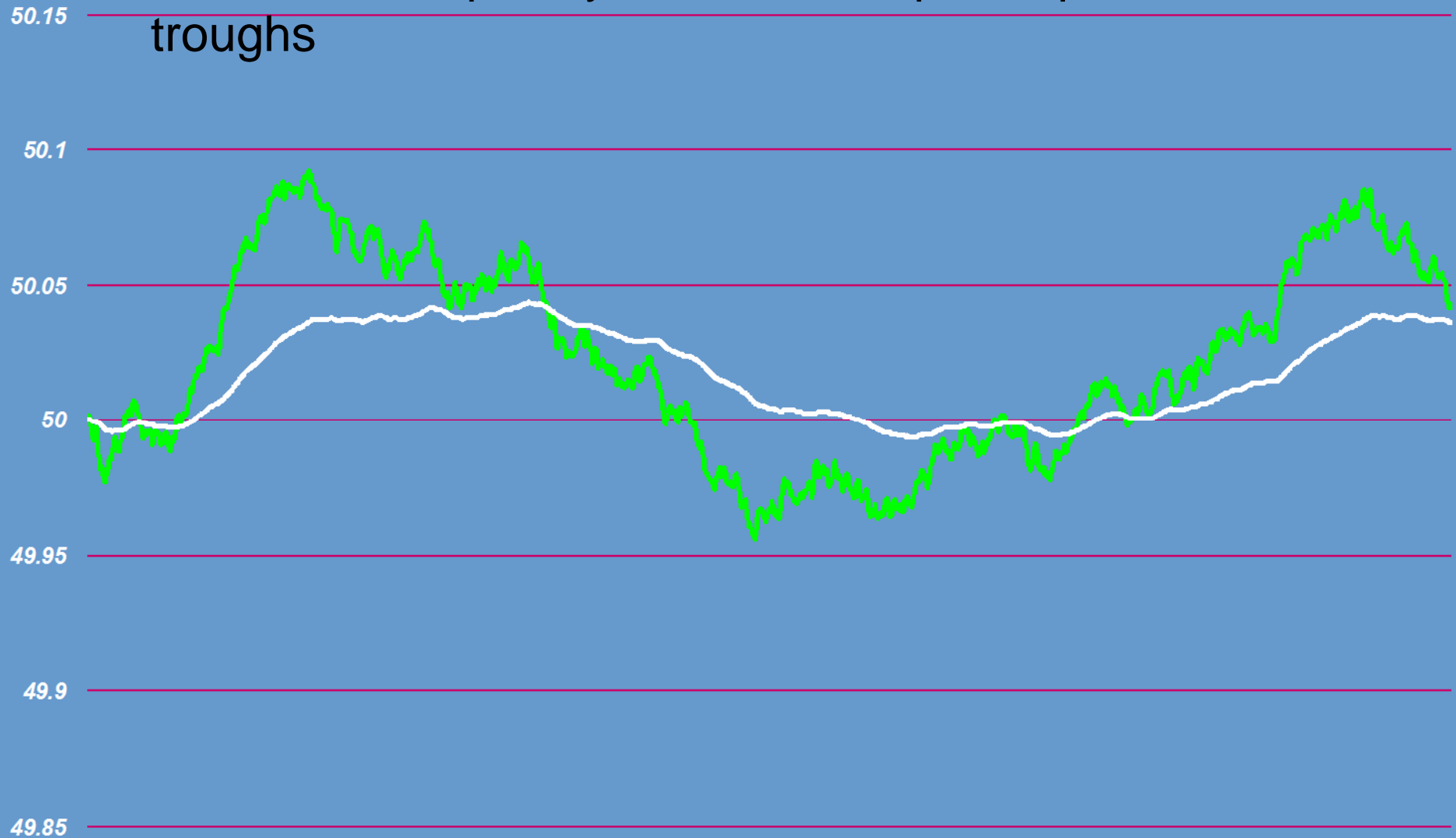


The Fridges' Energy store acts like a giant Capacitor



Damped Variation

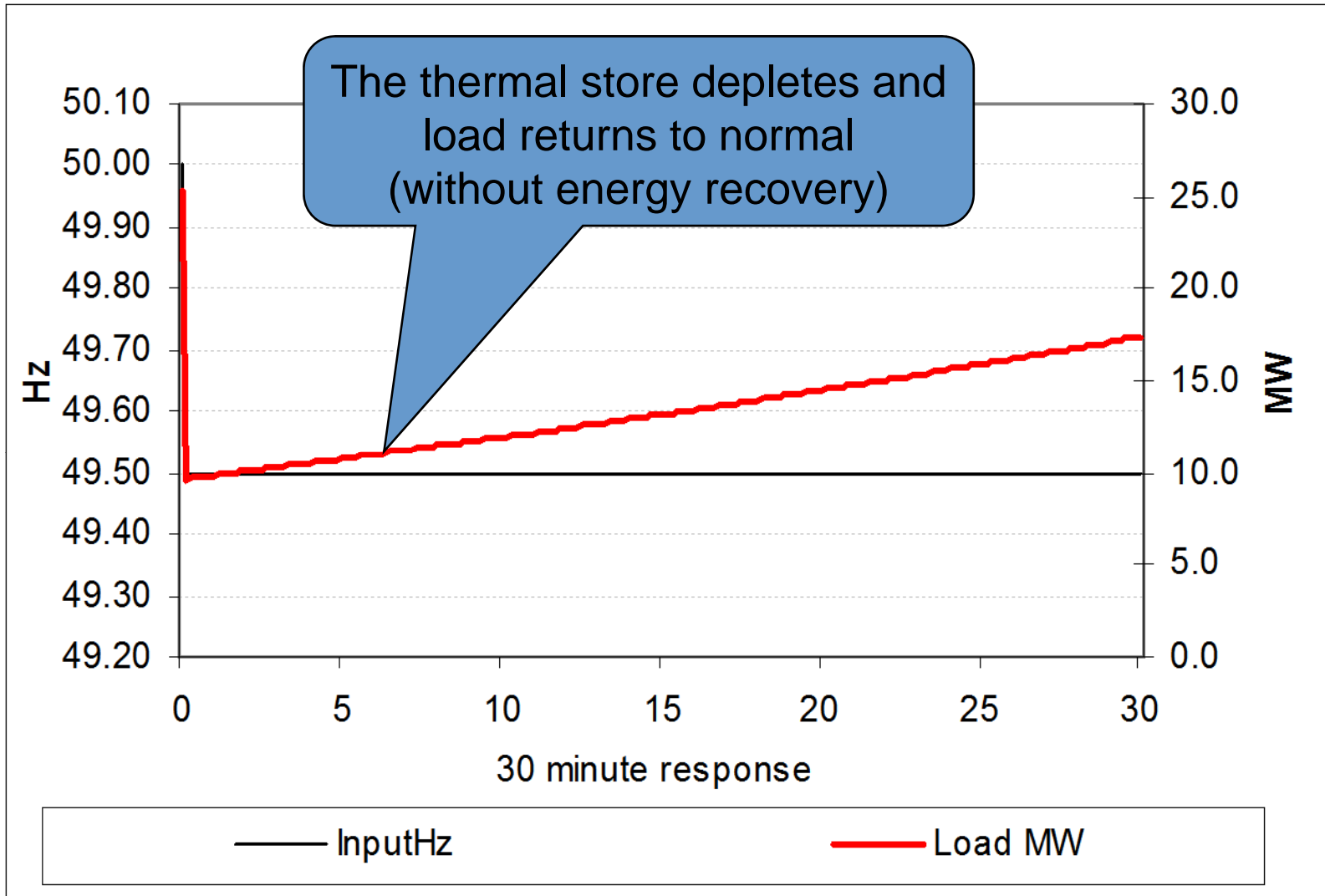
- Smoothed frequency means less spikes, peaks and troughs



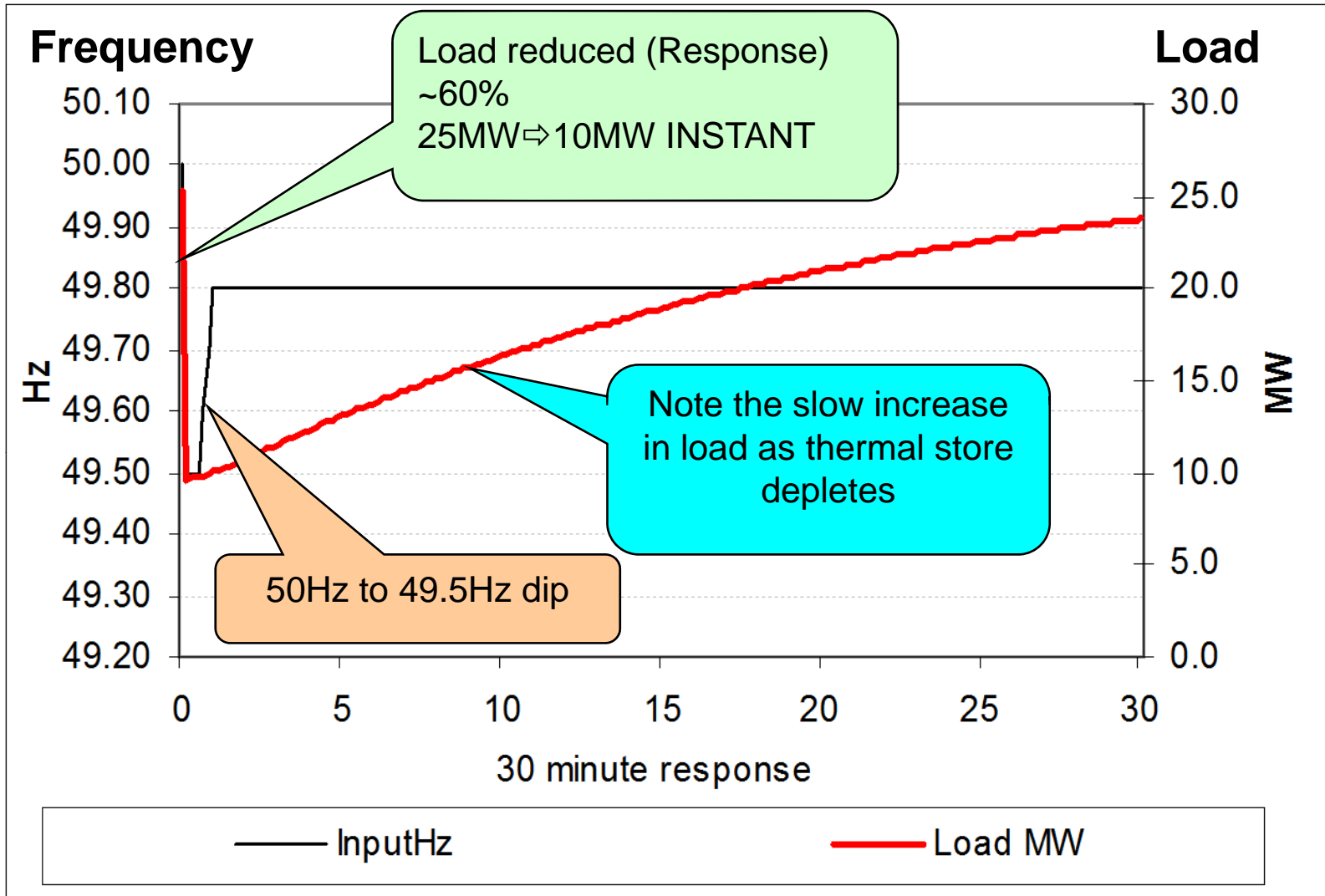
Service Provided

- 1m new fridges fitted with the device provides about 25MW “response”
- Eventual potential up to 100 MW
- The service provided is equivalent to:
 - Primary response plus
 - Secondary / tertiary response with time / quantity limit
 - Enhanced high frequency response or symmetrical response with longer duration
- Some discretion over quantity / time characteristics
- Recovery of capability in about 30 minutes
- The following slides give examples of responses to frequency trajectories with specific parameters set

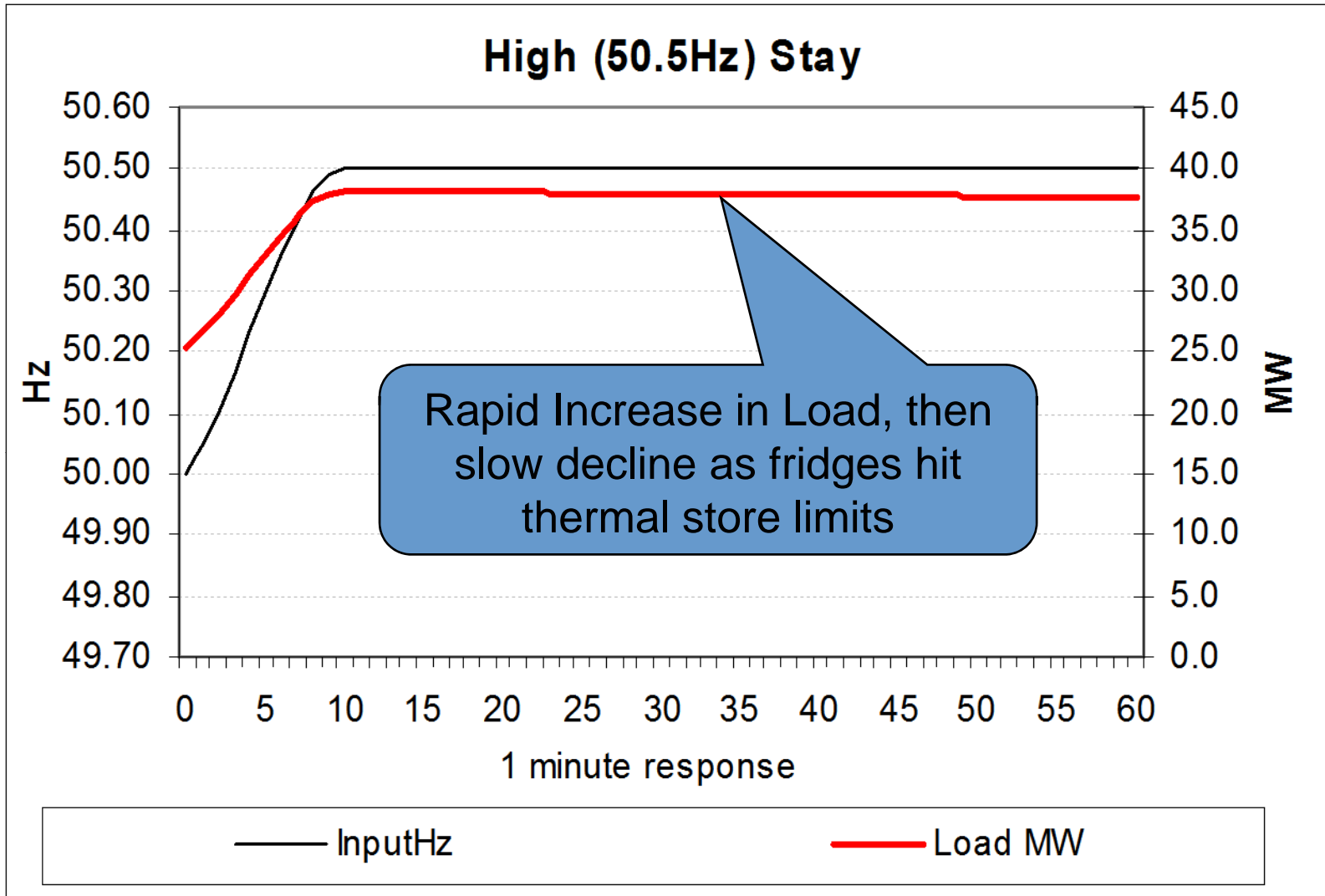
Drop to 49.5 no recovery
Range 0.8Hz



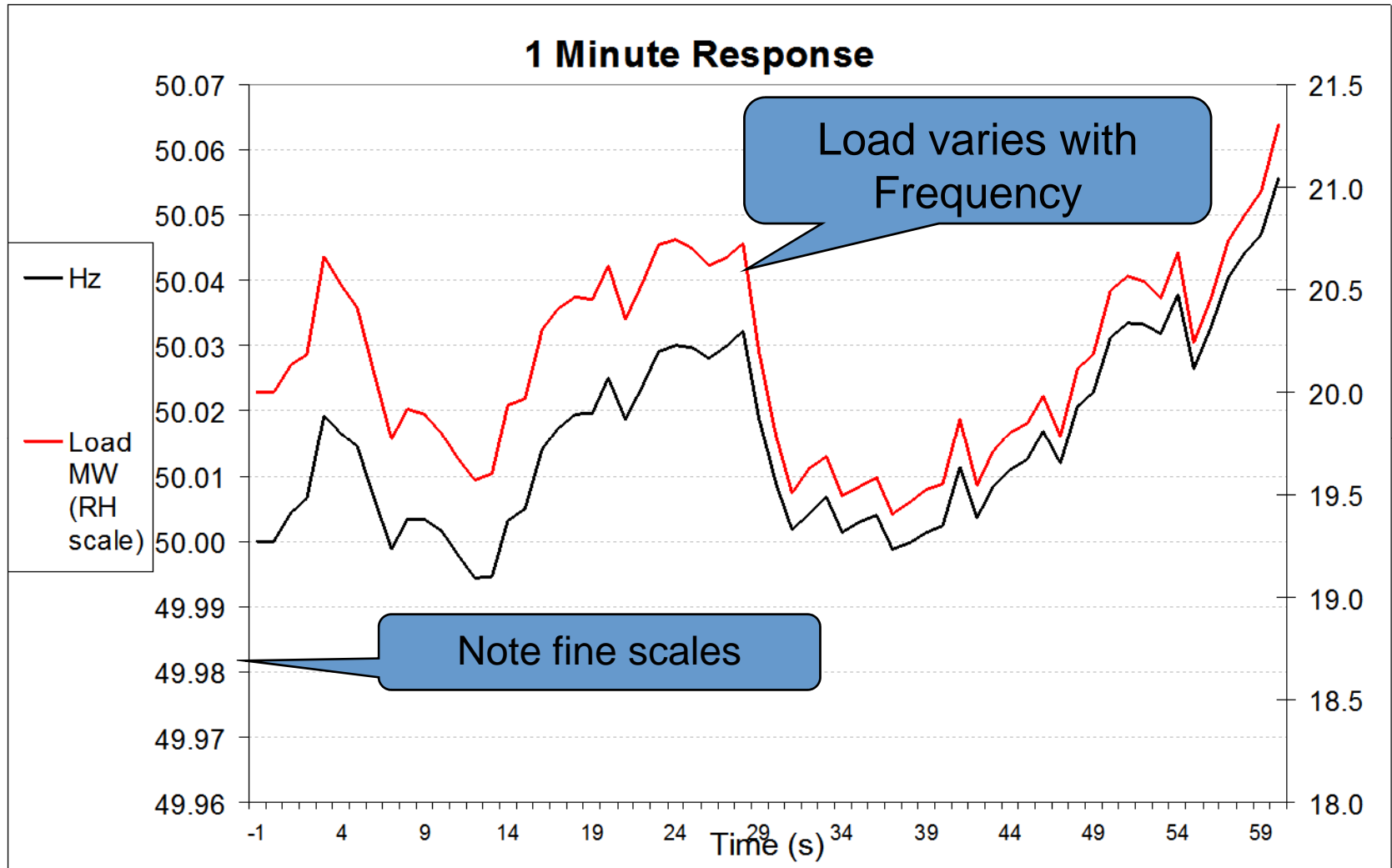
Drop to 49.5 Recover to 49.8
Range 0.8Hz



Rise to 50.5 no recovery
Range equivalent 2.86Hz



Randomly varying frequency Range 0.5Hz.

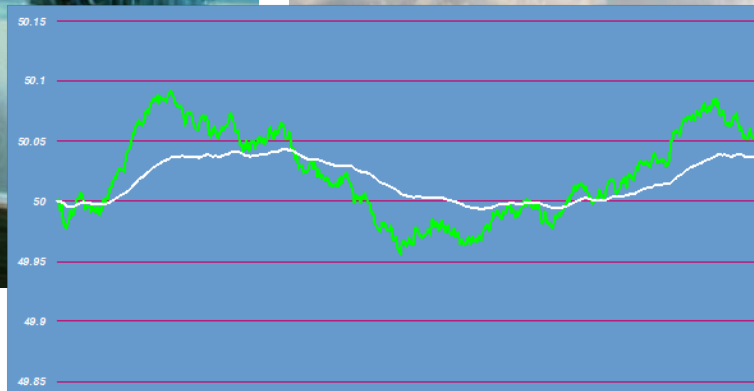
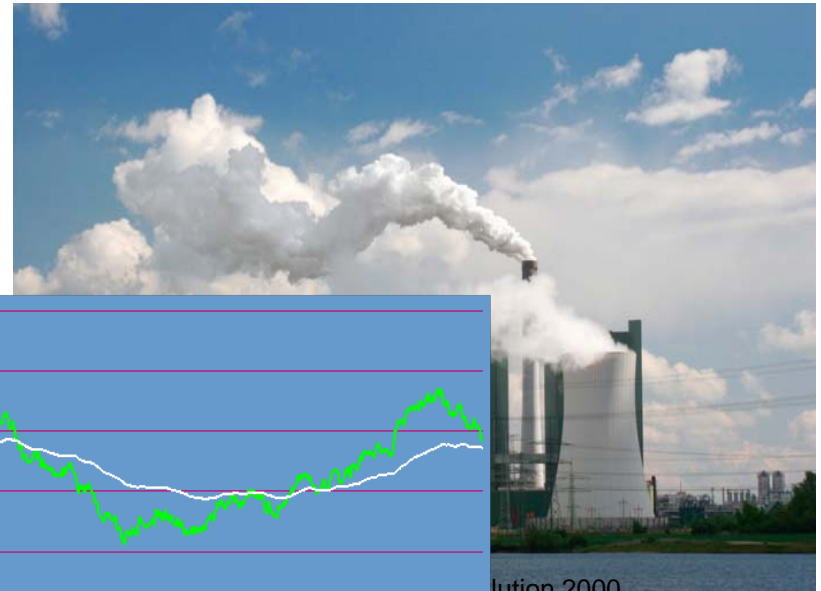
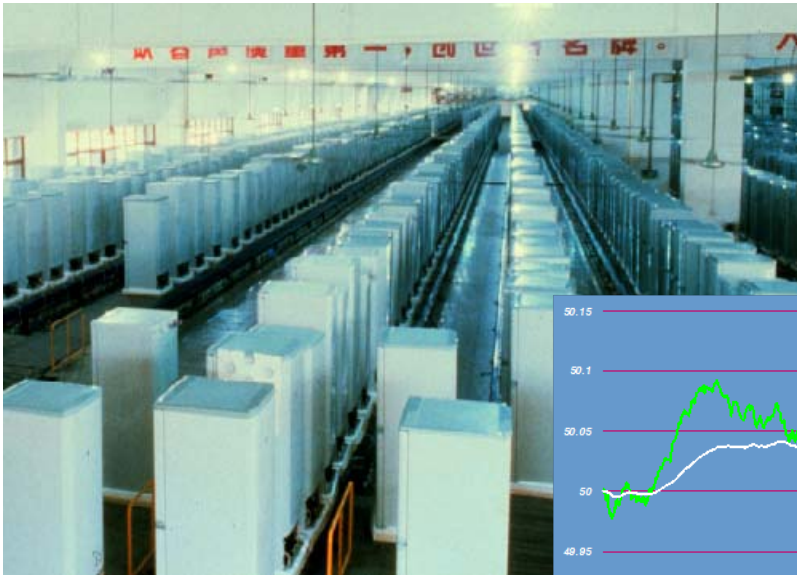


Key features of fridge frequency response

- Large population gives modulating response
- Base load firm response with some additional low frequency response in summer
- Response delivered in about 100ms
- For prolonged periods at low frequency load does not rise above normal - it merely increases to normal (25W per fridge average) with a shorter on/off cycle
- Choice of larger high frequency response or similar to low frequency with longer duration of response
- Some approximations in above e.g. minimum compressor off time neglected

Demand response - solutions

- Fridges – 30,000,000
 - ~600MW
 - No running cost
 - No storage loss
 - Near instantaneous
- Typical “Genset”
 - 600MW
 - “Hot Standby”
 - CO2 no Power, inefficient
 - 9% Transmission losses
 - >9 minutes lag



Benefits of Smart Appliances

- CO2 emission savings
 - 1,000,000 ton annually in the UK
- Potentially lower energy costs to the consumer
 - providing up to 600MW of “fast response” grid balance
- Improved “security of supply”





Benefits to Manufacturer

- Demonstrates corporate “green” agenda
 - CO2 verifiable emission reduction certificates
 - Carbon credits have financial value
 - Demonstrates pro-activity to regulators
- Product differentiation feature
 - Branded feature with consumer appeal
 - Prospect of new energy label
 - Higher product margins
- Assists “Developing Nations” electricity infrastructure
 - Sell more appliances

Energy		Fridge-Freezer
Manufacturer Model		
More efficient		
A		A
B		
C		
D		
E		
F		
Less efficient		
G		
Energy consumption kWh/year (Based on standard test results for 24h)		325
Actual consumption will depend on how the appliance is used and where it is located		
Fresh food volume l		190
Frozen food volume l		126
Noise (dB(A) re 1 pW)		
Further information is contained in product brochures		
Note: EN 151 May 2005 Refrigerator Label Directive 84/50/EEC		

The Reality of ABS: Just Do It!

- A Population of Fridges
 - Changes demand, not supply
 - Responds instantly (~100ms or less)
 - Smooths the frequency 24 * 7
 - Is distributed, autonomous and very reliable
- Changes System Optimisation – lower costs
- Reduces CO₂ from Power Stations
- Very low cost CO₂ abatement
- 4.1m p.a. new refrigeration appliances sold

Who gets the CO₂ Benefit?

Case study - South Africa

- Peak demand a problem – much (deferrable) electric water heating
- Possible (and possibly acceptable) deliberately to drive frequency below nominal when more demand wanted and above nominal when more demand acceptable
- Could therefore use frequency instead of tariff broadcast as input to intelligent water heater timing
- Several GW of peak shaving possible without the need for additional communication system

Questions ?

Light bulb

Victor Hugo

Effect of different time cycles

- Above illustrations based on a 20 minute on 60 minute off compressor cycle
- In practice many modern fridges / freezers cycles are subtly different
- Difference in cycle time changes persistence of response and length of time for recovery to normal state after persistent extreme event
- Intend to quantify actual compressor cycles for each device type to evaluate its response characteristics

Establishing how a population of fridges behaves

- Modelling work being undertaken. Aggregate and detailed models being refined
- Proposal for a “100 fridge” trial with variable mains frequency
- Trial may actually be of a lower number of fridge freezers with independent compressors so will be at least 100 independent devices
- Preparation for trial in hand and should be complete in early autumn

RLtec

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Innovative energy solutions



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www.rltec.com

Presentation to

London November xx

Agenda

- **Intro to RLtec**
- **Product**
- **Current/New Activities**
- **Proposition**
- **Benefits**

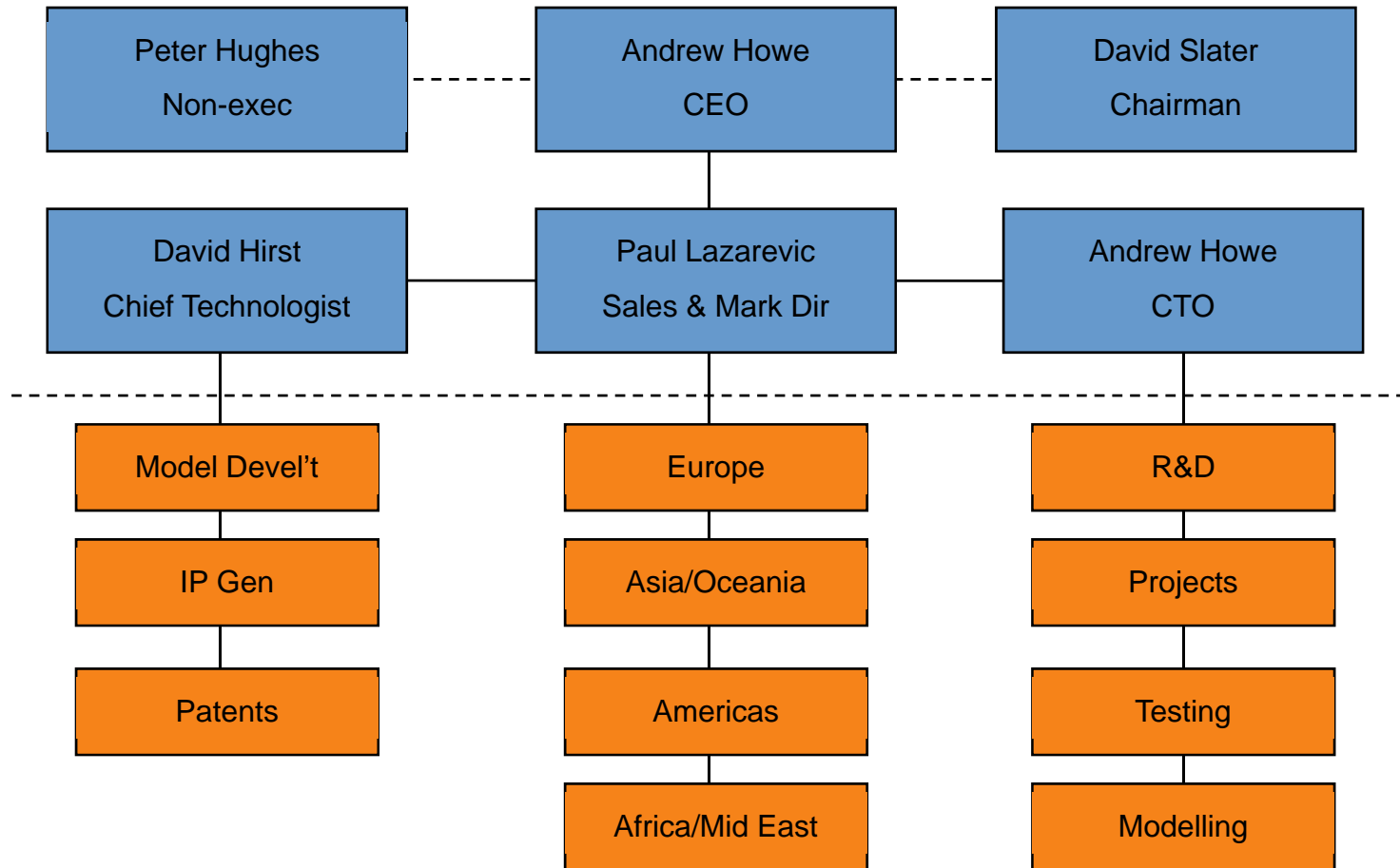
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The Company

- **UK based**
- **Portfolio of Intellectual Property & patents granted**
- **VC funded by Low Carbon Accelerator (LCA)**
 - £50m AIM fund, focus on “green” products in UK, Europe and US
- **Development of Green energy management products**
 - Provision of dynamic response solutions to electrical grids
- **Accelerating growth**
 - Marketing in US, Europe and South Africa

Organisation



Background to the Product

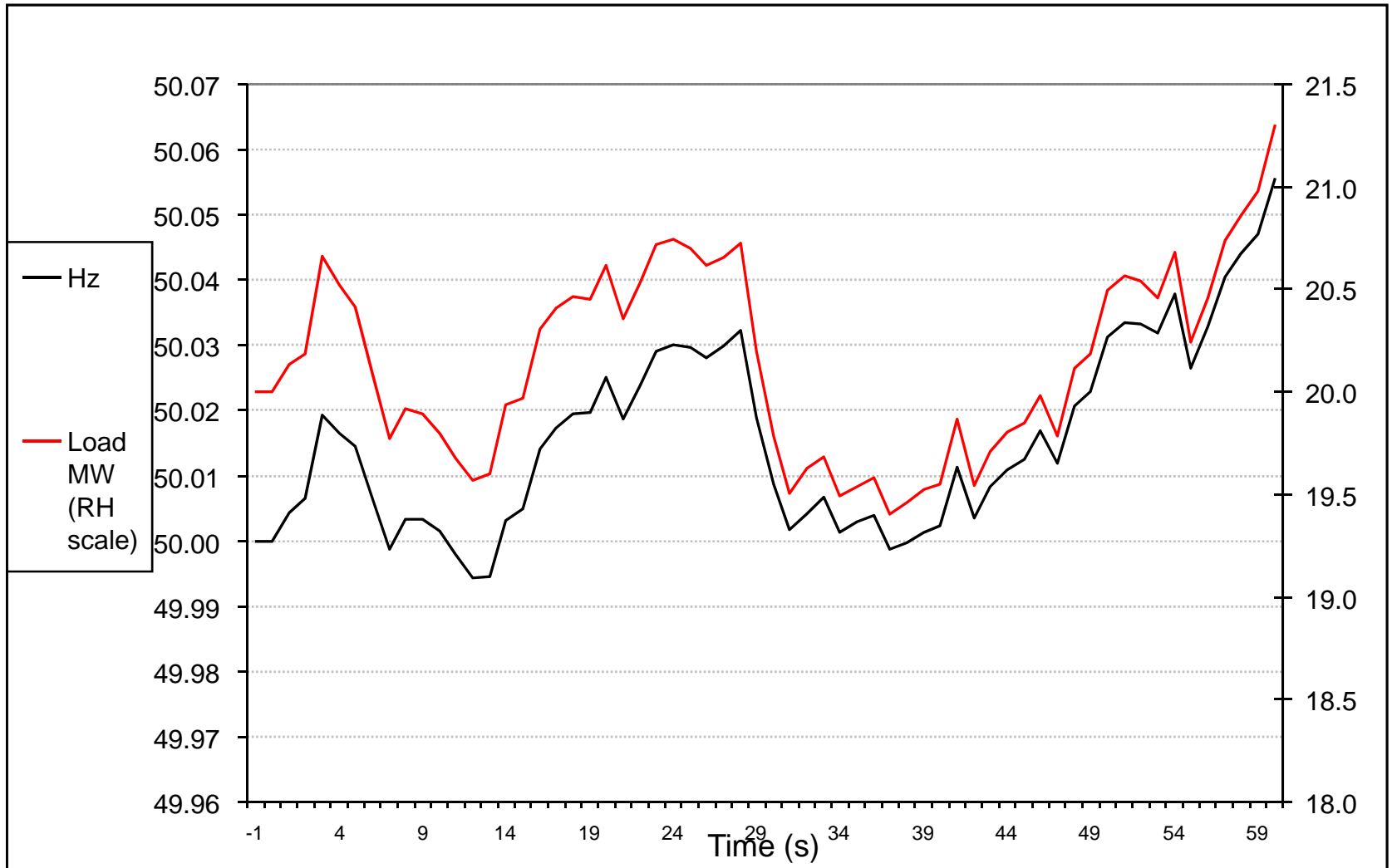
- **National Grid Transco pay generators and/or I&C consumers ~£400m/y to balance the national grid**
- **Balancing services are numerous:**
 - Majority based on standby generation
 - Based on reacting to grid frequency
 - Centrally dispatched with variable reaction times
- **“Frequency Response” (FR) is one of main vehicles used**

Costs of Frequency Response

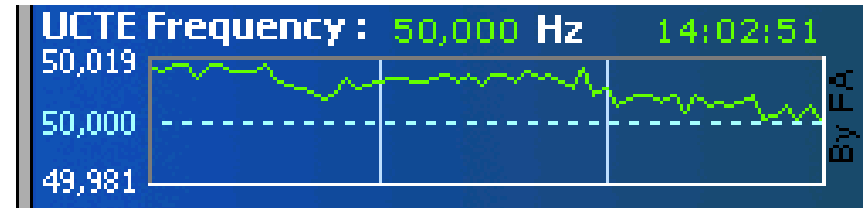
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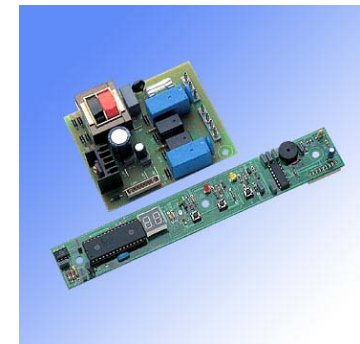
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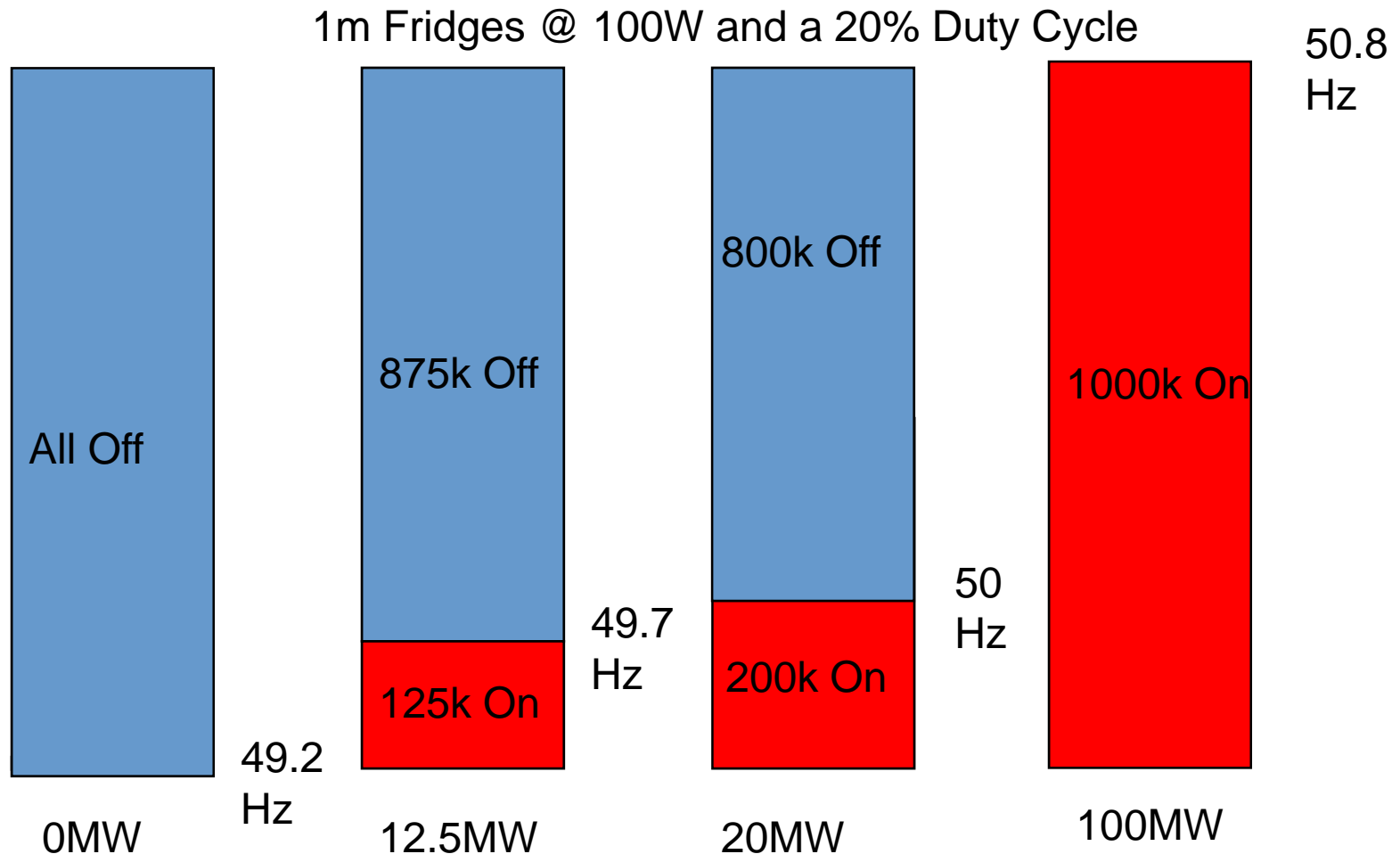
How does it work?

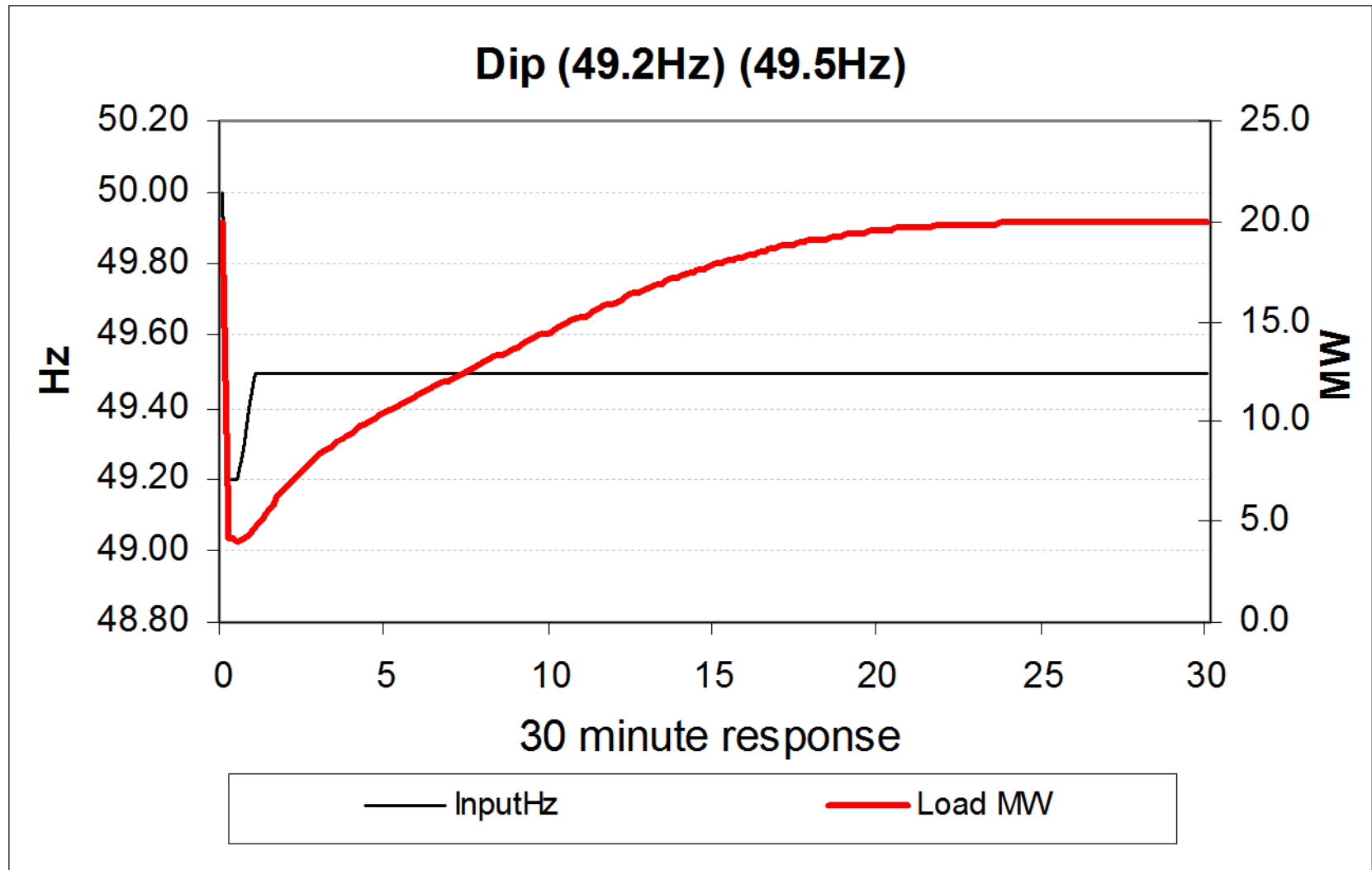


- **Monitors grid condition**
 - Frequency measurement
- **Controls the compressor motor etc**
 - Temperature measurement & grid condition
 - Works within built-in controls system
- **No functional impairment**
 - No reduction in performance
 - No material increase energy consumption
 - No decrease product lifetime
- **Implementation**
 - Software within “electronic controller”
 - Intelligent thermostat / motor



Fridge Population Behaviour at possible settings





The Benefits over Existing FR Products

- **Green product as CO₂ emitting generation plant is avoided**
 - Up to 2,000,000/y tonnes potential
- **Available 24x7x365**
 - Existing products tend to have windows of availability
- **Can be used for both high and low response**
 - It works in reverse when grid needs demand
 - No other demand side product available can do this

Current Status

- **Intellectual Property developed, patents granted and more in application**
- **Initial focus on domestic appliances**
 - Sales to refrigeration appliance manufacturers (UK + Europe)
 - Water heaters (South Africa)
 - Air conditioning (USA)
- **Discussions with various grids commenced**
- **Technology transferred and successfully tested by a leading refrigeration manufacturer to industry standards**
- **Now looking at I&C applications**

New Activities

- **Roll out application to UK I&C customers**
- **Looking for “partner companies” with high degree of stored load**
- **Ideally need 20MW with typical sources:**
 - Refrigeration
 - Electrical water heating
 - Pumping
 - HVAC
- **Sell the load to NGT as bespoke Frequency Response**

Proposition

- **Looking to partner with XXXXX**
- **Determine potential for RLtec products in your portfolio**
 - Identify applicable systems : refrigeration, heating etc
 - Assess type of implementation (software or hardware)
 - Trial products in sample xxxx
 - Calculate MW potential for portfolio
- **RLtec approach NGT for FR contract**
- **RLtec/XXXX share benefits**
 - Benefit dependent on size (MW) and time of response
 - Estimate at £50k/MW
 - 20MW = £1m

Benefits

■ **Benefits to XXXXX**

- Provides additional income stream to offset power costs
- Enhances green credentials
- Enables PR campaign – pioneering in new green technology

■ **Benefits to RLtec**

- Provides income stream
- Establishment in I&C market
- PR opportunities