International Experience in Using DSM to Support Electricity Grids

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Workshop on Using DSM to Support Electricity Grids

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Presentation Topics

- 25 years of DSM
- Using DSM to support electricity networks
- Regulator support for network DSM
- Selected case studies
- Conclusions
- Information resources

25 Years of
Demand Side Management

What is Demand Side Management?

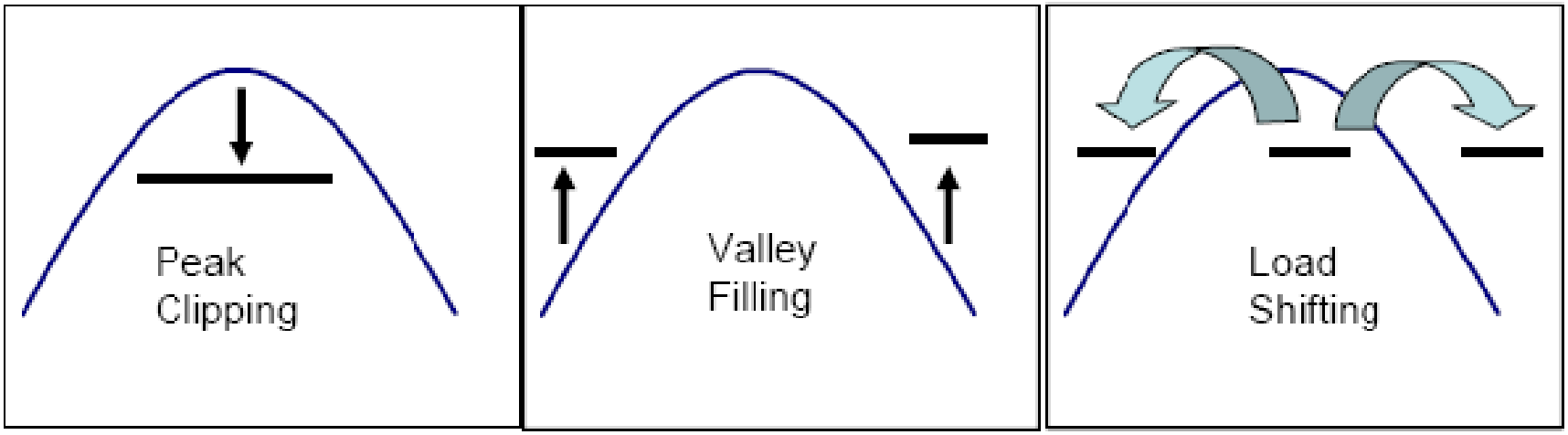
- Demand side management (DSM) refers to actions which change the demand on the electricity system, including:
  - actions taken on the customer side of the electricity meter (the 'demand side'), eg energy efficiency and load shifting
  - arrangements for reducing loads on request, such as interruptibility contracts, direct load control and demand response
  - fuel switching, such as changing from electricity to gas for water heating
  - power factor correction
  - distributed generation, such as stand by generators in office buildings or photovoltaic modules on rooftops; and
  - pricing initiatives, including time of day and demand-based tariffs based on some form of smart metering

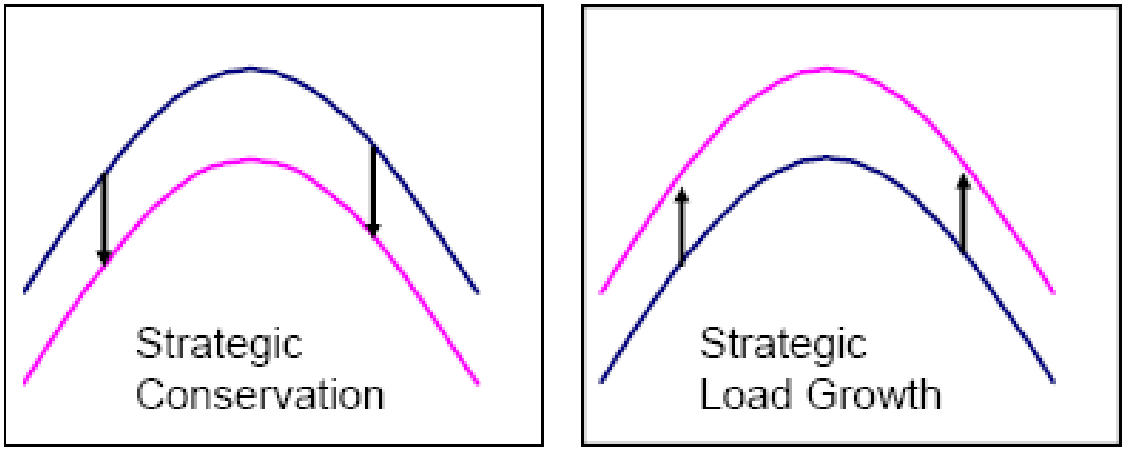
Origins of DSM (1)

- The term “demand side management” (DSM) was introduced to the electricity industry in 1981 by Clark Gellings, a senior executive at the Electric Power Research Institute (EPRI) in the United States
- Gellings coined the term to describe measures taken by electricity utilities to influence the way end use customers purchase and use electricity
- DSM measures are designed to influence and, if necessary, change customer behaviour to achieve benefits for both the customer and the electricity industry

Origins of DSM (2)

Clark Gelling's Conceptualisation of DSM (1981)





Characteristics of DSM

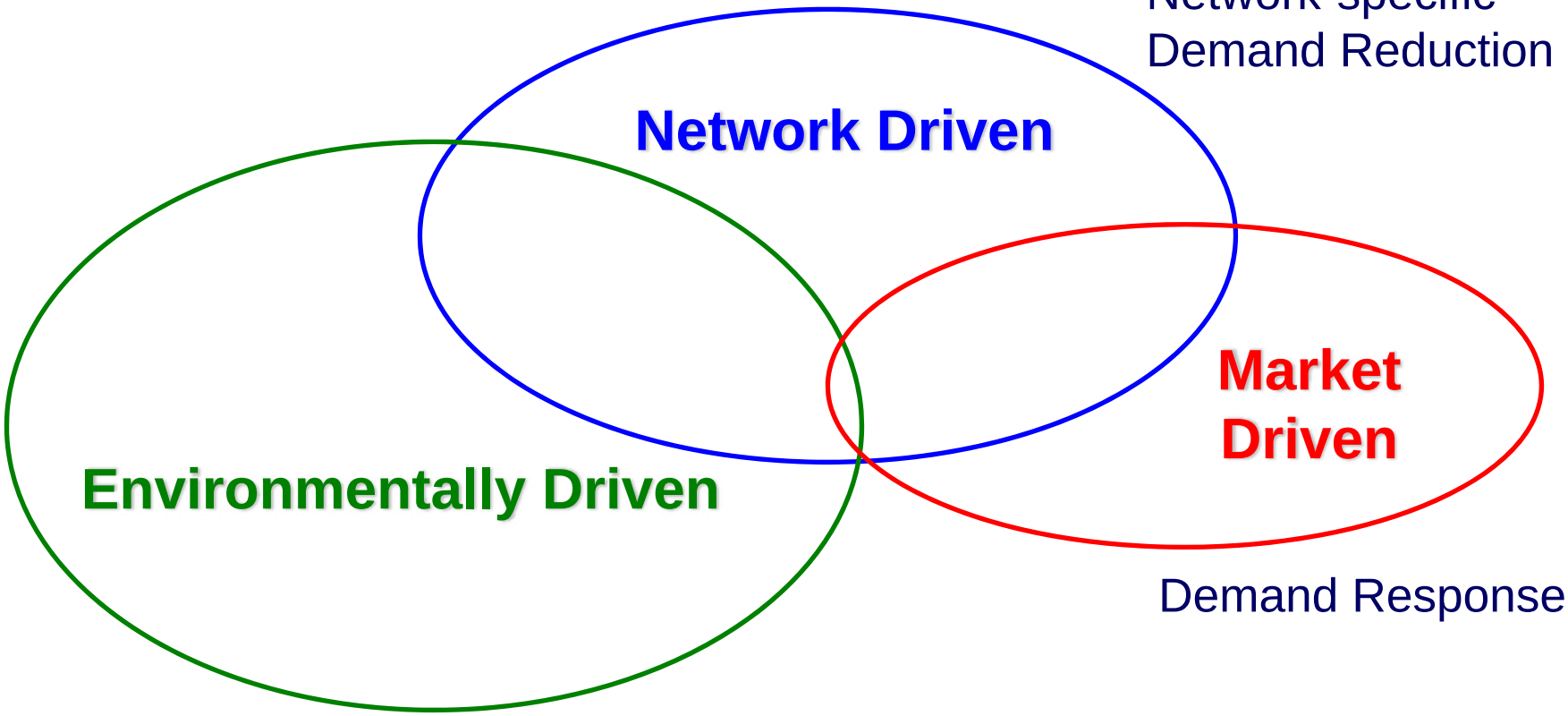
- **Timing** – DSM programs may be designed to achieve specific outcomes at particular times of day
- **Pre- or post-contingency** – DSM programs may be designed to achieve specific outcomes either prior to a contingency or in response to a particular event
- **Geographical locations** – DSM programs may be targeted to specific locations, eg
  - whole of the grid
  - regions of the grid
  - grid element, eg a particular line or substation
- **Market segments** – DSM programs may be targeted to specific segments, eg residential, commercial or industrial customer classes

Types of DSM

There are three types of DSM based on the overall purpose of the DSM program:

- **Environmentally-driven** – achieves environmental and/or social goals by reducing energy use, leading to increased energy efficiency and/or reduced greenhouse gas emissions
- **Network-driven** – deals with problems in the electricity network (grid) by reducing demand in ways which maintain system reliability in the immediate term and over the longer term defer the need for network (grid) augmentation
- **Market-driven** – provides short-term responses to electricity market conditions ('demand response'), eg by reducing load during periods of high market prices caused by reduced generation or network capacity

Interactions between DSM Types



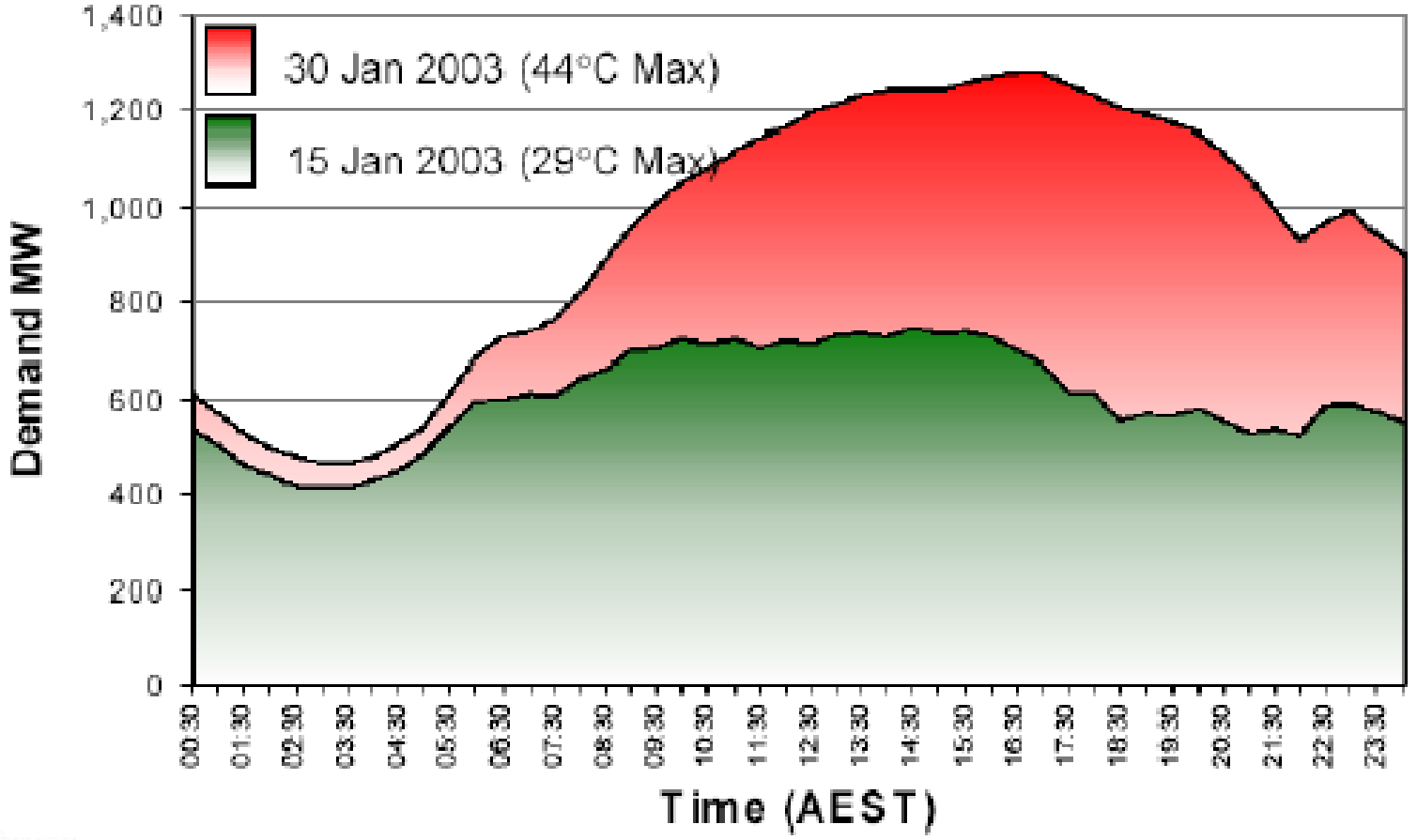
Changing Nature of DSM

- Early DSM programs were broadly-targeted and environmentally-driven
- Currently, this type of DSM program is used mainly for abatement of greenhouse gas emissions
- There is also a new generation of DSM programs which are more narrowly targeted with very specific objectives, comprising mainly network- and market-driven DSM
- Network-driven DSM is currently growing in importance in many countries
- India (BEE) has recently joined an International Energy Agency multi-national research project on network-driven DSM (Task XV)

Using DSM to Support Electricity Grids

Why Use DSM? (1)

Sydney West Bulk Supply Point Load Profile



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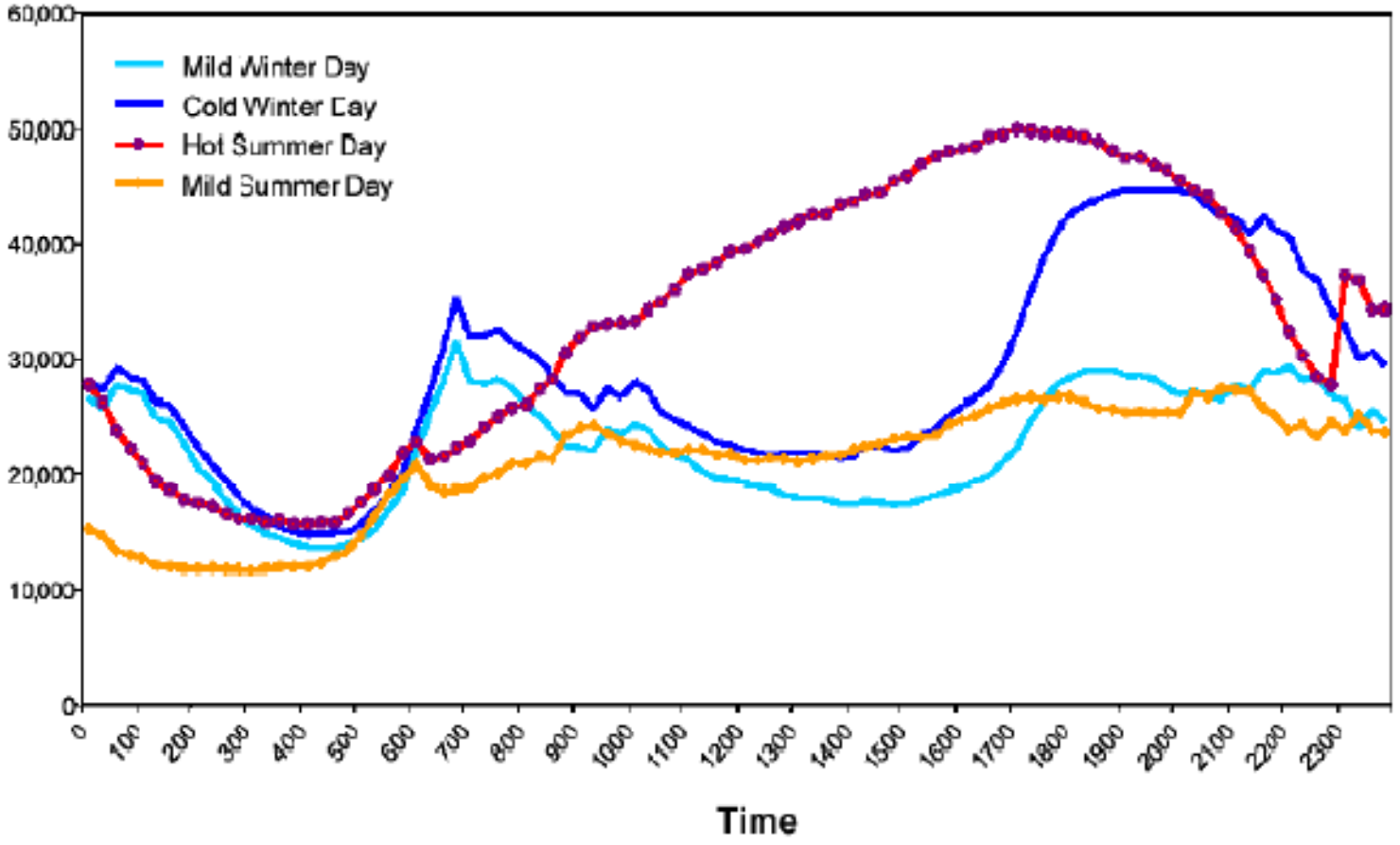
Why Use DSM? (2)

Predominantly Residential Load Profile



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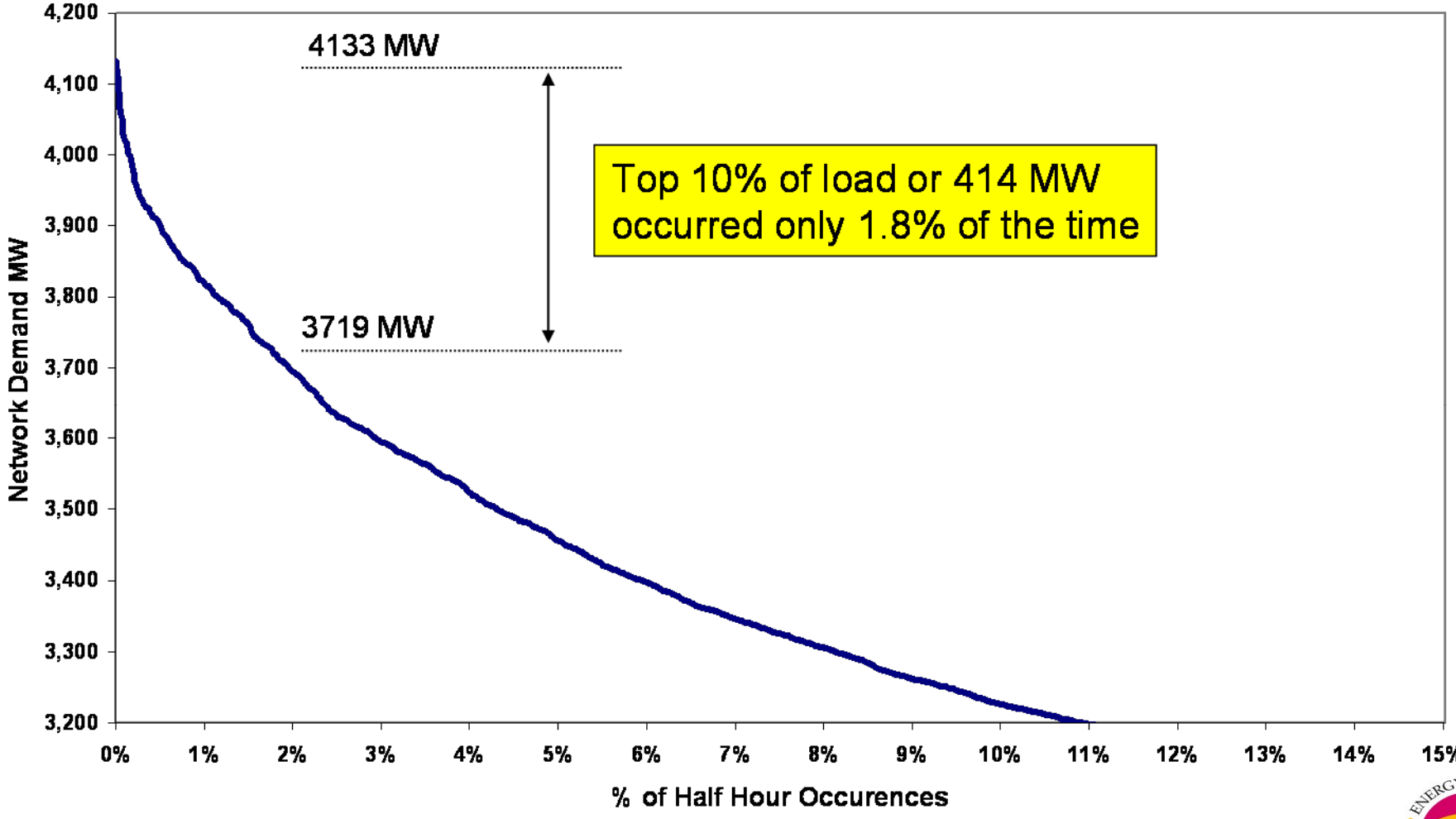
Why Use DSM? (3)


4133 MW
3719 MW
Top 10% of load or 414 MW occurred only 1.8% of the time
Network Demand MW
4,200
4,100
4,000
3,900
3,800
3,700
3,600
3,500
3,400
3,300
3,200
0%
1%
2%
3%
4%
5%
6%
7%
8%
9%
10%
11%
12%
13%
14%
15%
% of Half Hour Occurences

What is Network-driven DSM (1)?

- Network-driven DSM comprises demand-side measures used to relieve network (grid) constraints and/or to provide services for network system operators
- In Task XV, network-driven DSM is defined as follows:

  Network-driven demand-side management is concerned with reducing demand on the electricity network in specific ways which maintain system reliability in the immediate term and over the longer term defer the need for network augmentation

What is Network-driven DSM (2)?

- Task XV identifies the following two prime objectives for network-driven DSM:
  - to relieve constraints on distribution and/or transmission networks (grids) at lower costs than building ‘poles and wires’ solutions; and/or
  - to provide services for network system operators, achieving peak load reductions with various response times for network operational support

Characteristics of Network Constraints

- Network-driven DSM measures must address the particular characteristics of network constraints
- In relation to timing, network constraints may be:
  - narrow peak related – occurring strongly at the time of the system peak and lasting seconds, minutes or a couple of hours; or
  - broad peak related – less strongly related to the absolute system peak, occurring generally across the electrical load curve and lasting several hours, days, months, years or indefinitely
- In relation to the spatial dimension, network constraints can:
  - occur generally across the network; or
  - be associated with one or more specific network elements such as certain lines or substations

Legislative and Regulatory Support for Network-driven DSM

Legislative Provisions in Australia

- In the State of New South Wales in Australia, electricity distributors are subject to a *Code of Practice* in relation to DSM
- This Code was imposed by the relevant Minister under NSW legislation passed in 1995
- Before distributors can augment or reinforce their networks, the *Code* requires them to investigate the cost-effectiveness of avoiding or postponing this work by implementing demand-side options, including DSM
- Similar provisions have now been included in the *National Electricity Rules*, so that all distributors that operate in areas covered by Australia's National Electricity Market must consider demand-side options as alternatives to network augmentation

Regulatory Determinations in Australia (1)

- In its 2004 determination, the New South Wales electricity regulator provided incentives for distributors to undertake DSM
- The regulator introduced a D-factor into the weighted average price cap control formula that allowed distributors to recover:
  - non-tariff-based DSM implementation costs, up to a maximum value equivalent to the expected avoided distribution costs;
  - tariff-based DSM implementation costs;
  - revenue foregone as a result of non-tariff-based DSM activities
- Regulation of electricity distribution has recently been taken over by a national regulator who has confirmed that it will retain the NSW D-factor scheme, essentially unchanged

Regulatory Determinations in Australia (2)

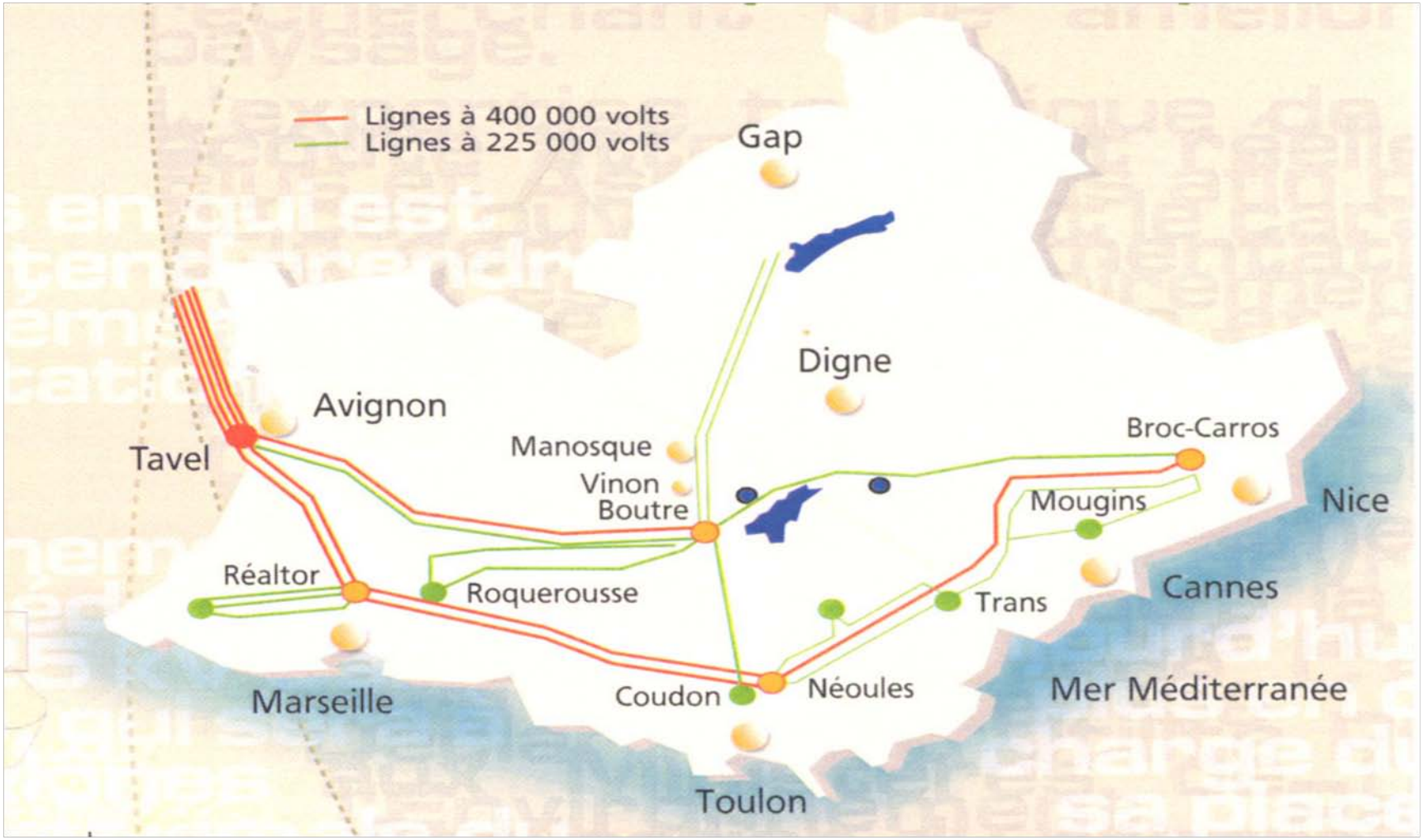
- Regulators in other States have adopted different approaches from the New South Wales regulator
- In Victoria, the electricity industry regulator has allowed a specific provision for DSM initiatives of AUD600,000 (Rs 80 lakhs) for each of the four distributors in the State over the five-year regulatory period
- In South Australia, the regulator has provided AUD20 million (Rs 60 crores) for DSM initiatives by the single distributor in the State over five years
- In Queensland and Tasmania, the regulators have provided no regulatory support for network-driven DSM

Selected Case Studies

Classification of Case Studies

- In Task XV, projects were classified by the major DSM measure:
  - demand response
  - direct load control
  - distributed generation, including standby generation and cogeneration
  - energy efficiency
  - fuel substitution
  - interruptible loads
  - integrated DSM projects
  - load shifting
  - power factor correction
  - pricing initiatives, eg time of use and demand-based tariffs
  - smart metering

French Riviera Integrated DSM Project (1)



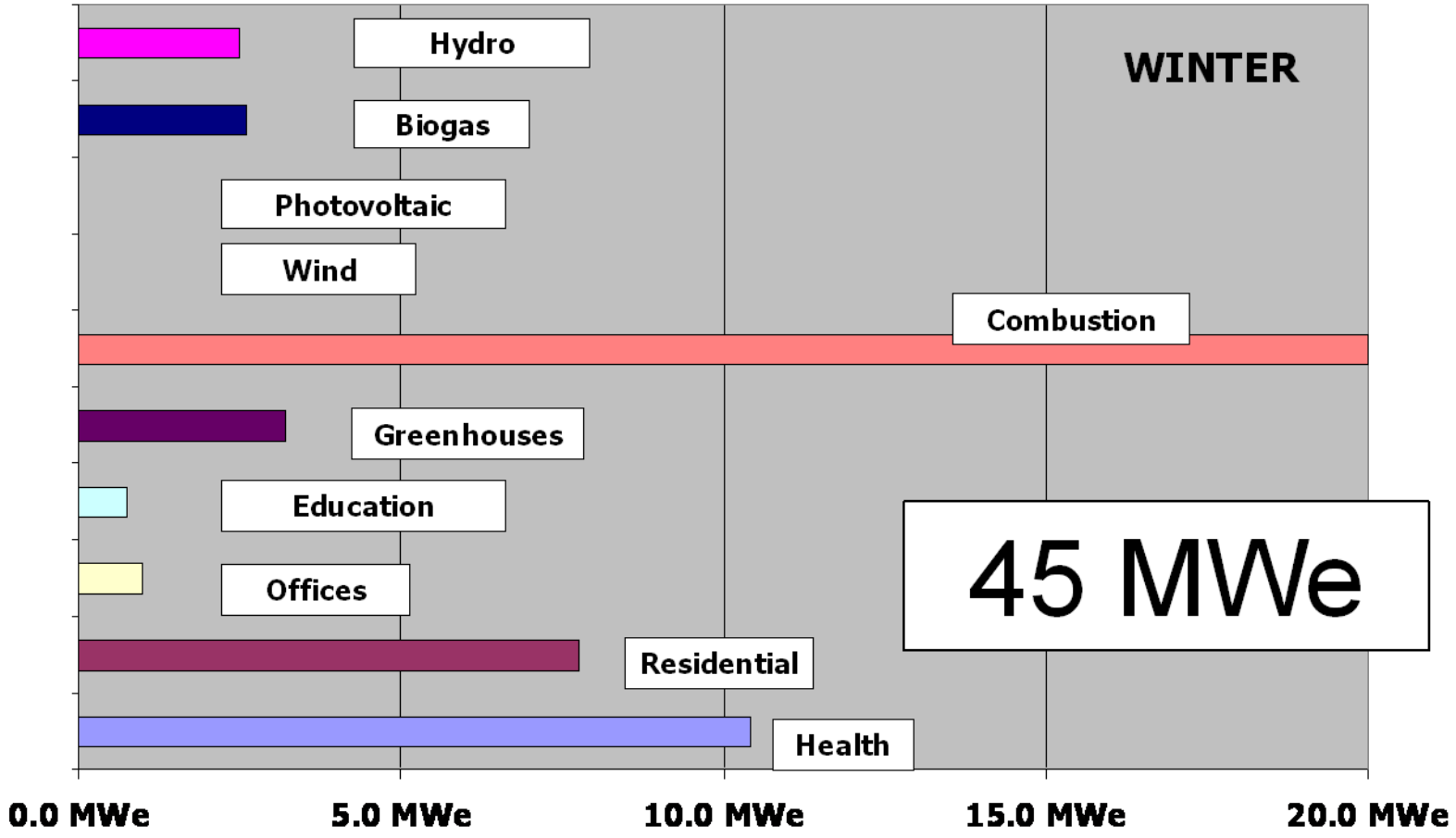
French Riviera Integrated DSM Program (2)

- Planning for the upgrading of the Boutre-Carros line to supply increasing load growth in the area commenced in 1983; however, there was strong opposition because the new lines would pass through a scenic regional park
- In 2000, a decision was made on an alternative solution:
  - replacement of the existing 225 kV line by a single 400 kV line on the same easement;
  - implementation of a DSM and renewable energy distributed generation program to slow down the growth in demand
- In May 2006, the state court refused planning permission for the upgrading of the line
- The DSM program is now the only way to secure supply to the region by keeping load growth within the line capacity

French Riviera Integrated DSM Program (3)

- Areas in which DSM measures are being implemented include:
  - communication and information campaigns;
  - new building construction;
  - efficient lighting and domestic electrical appliances;
  - large consumers and distributed generation;
  - demonstration projects by institutional partners of the DSM project;
  - public housing;
  - existing buildings; and
  - tourism

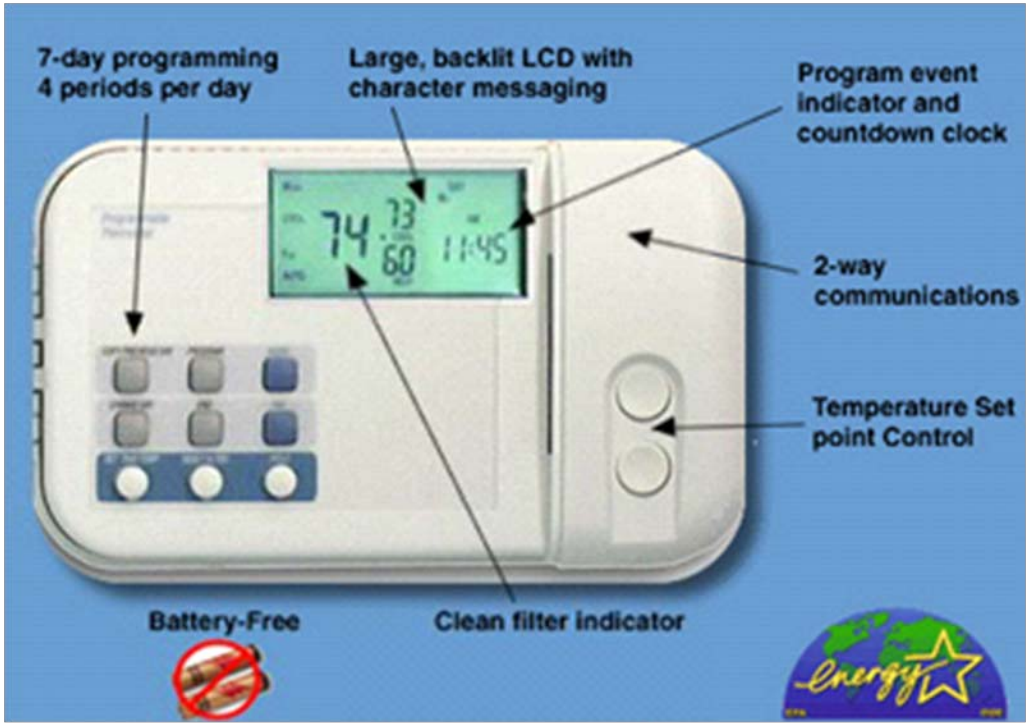
French Riviera Integrated DSM Project (4)



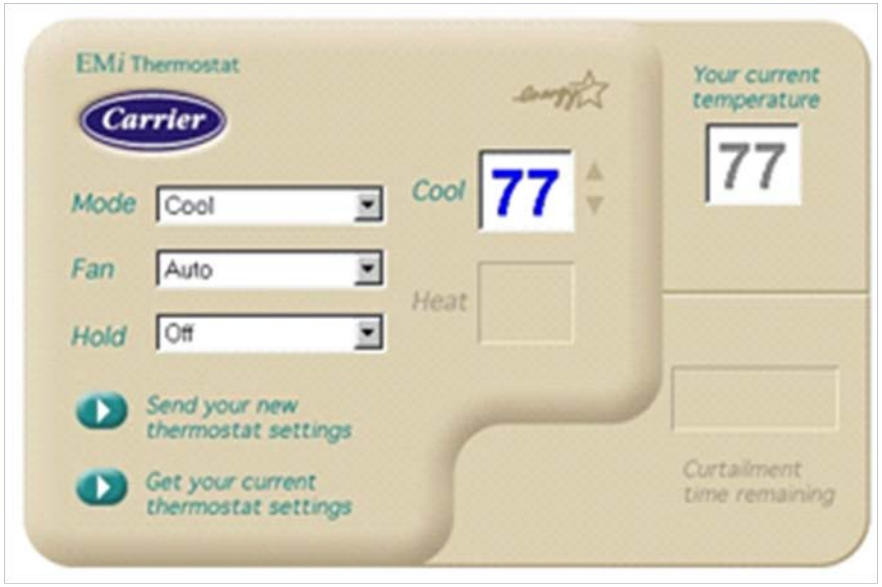
LIPAedge Direct Load Control Program (1)

- The LIPAedge program is the largest residential/small commercial direct load control program using two-way communication in the United States
- Long Island Power Authority (LIPA) uses central control of thermostats in air-conditioning to achieve peak load reductions
- Carrier EMi thermostats are used in the LIPAedge program; they are programmable both locally and remotely through the internet; two-way communication is by radio paging
- Two-way communication allows LIPA to monitor capability and response; it also enables customers to control their individual thermostats via the internet, a benefit that motivates participation

LIPAedge Direct Load Control Program (2)



Carrier EMi Thermostat



Web-based User Interface

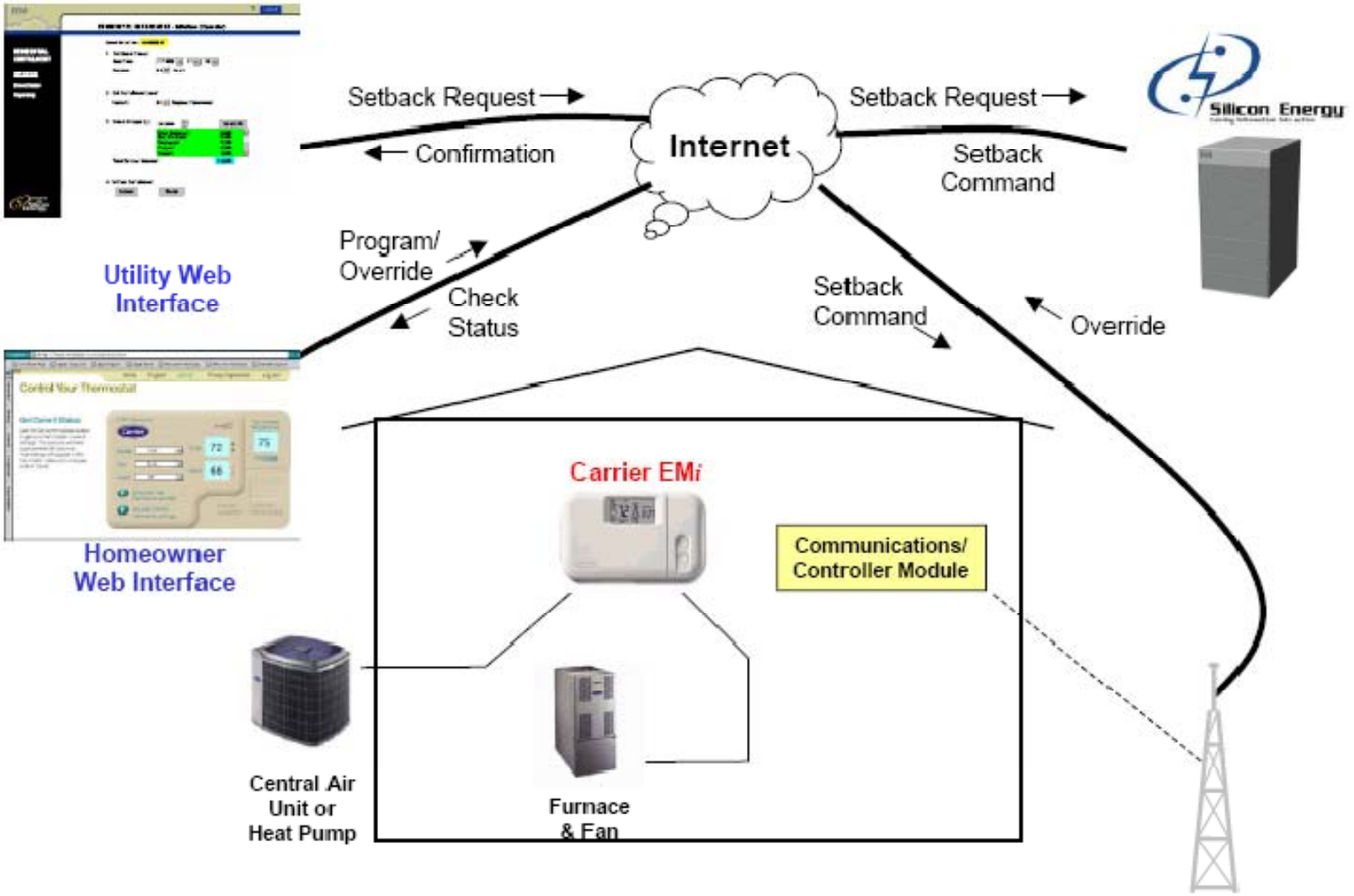
LIPAedge Direct Load Control Program (3)

- LIPA customers receive a thermostat and installation free of charge, plus a one-time bonus payment of USD 25 (residential) or USD 50 (small commercial)
- Customers agree to have their central air conditioning systems adjusted between 2 pm and 6 pm for a maximum of seven days throughout the four month summer season
- Customers have access to a dedicated web page for their thermostat and are able to remotely change the set point of their air conditioner at any time, overriding the LIPA setting
- About 20,400 residential and 3,000 commercial and small industrial customers are enrolled in the LIPAedge program, delivering about 25 MW of peak load reduction

LIPAedge Direct Load Control Program (4)

- The LIPA system operator uses a web-based control system; two-way pagers are used to transmit curtailment commands to 20,000 thermostats and to receive acknowledgment and monitoring information
- For a summer load curtailment, the system operator might send a command at 9:00 am directing all thermostats to move their set points up 4 degrees, starting at 2:00 pm and ending at 6:00 pm
- Alternatively, the system operator could send a command directing all thermostats to completely curtail immediately
- Commands are received and acted upon by all loads, providing full response within about 90 seconds; in contrast a generator response requires a 10-minute ramp time

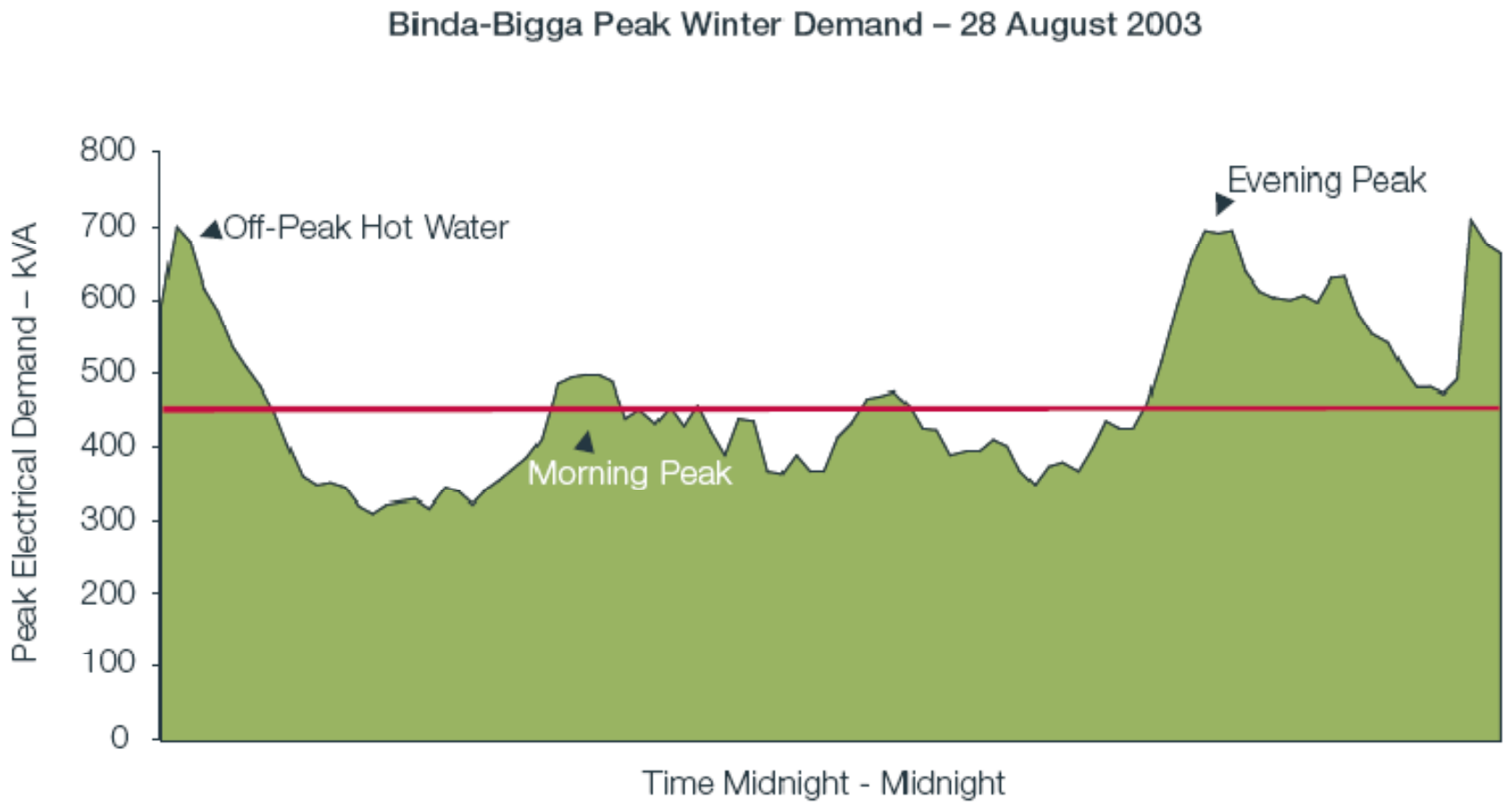
LIPAedge Direct Load Control Program (5)



Binda Bigga Fuel Substitution Project (1)

- Binda and Bigga are two small rural settlements in Australia about 230 km south-west of Sydney with about 250 electricity customers, mostly residential
- Overall load growth on the line that runs from Binda to Biggawas relatively low but, as peak electricity use increased in the area, the line was reaching its maximum capacity
- Fault levels and voltage levels were a concern along the lineand many customers were experiencing unacceptable voltage fluctuations which could be resolved only by extensive reconductoring of the line
- The aim of this project was to defer the need for the upgrade by reducing demand during the winter evening peak periods

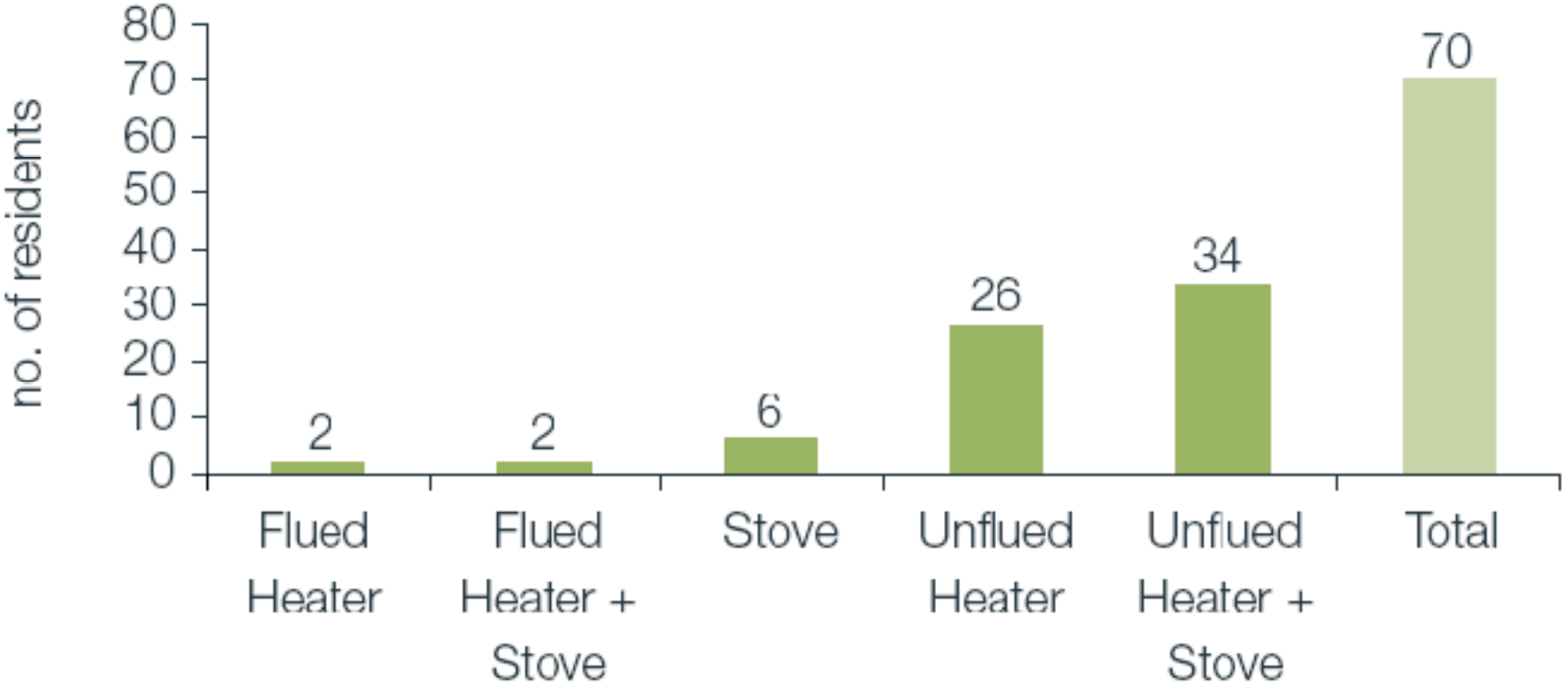
Binda Bigga Fuel Substitution Project (2)



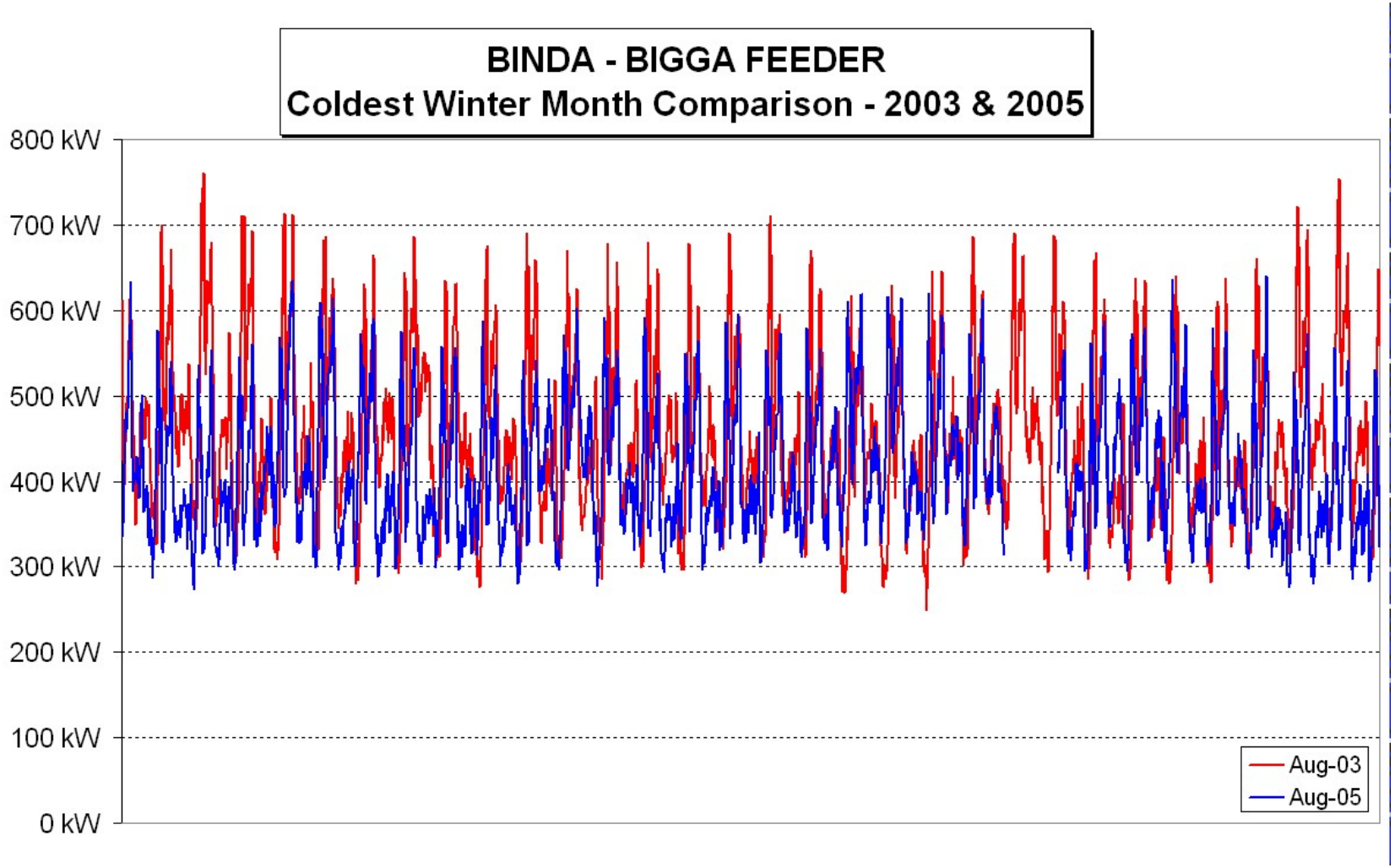
Binda Bigga Fuel Substitution Project (3)

- The local distributor, Country Energy developed a package that enabled local residents to affordably switch from electric to gas appliances; the package offered residents:
  - discounted gas room heaters and cooking stoves
  - free installation of gas appliances and gas bottles, and removal of electrical appliances for metal recycling
  - gas credits of AUD 170 per appliance
- Overall 70 customers purchased an Energy Saver Package, installing 106 appliances in total; this exceeded the target load reduction of 200kVA

Binda Bigga Fuel Substitution Project (4)



Binda Bigga Fuel Substitution Project (5)



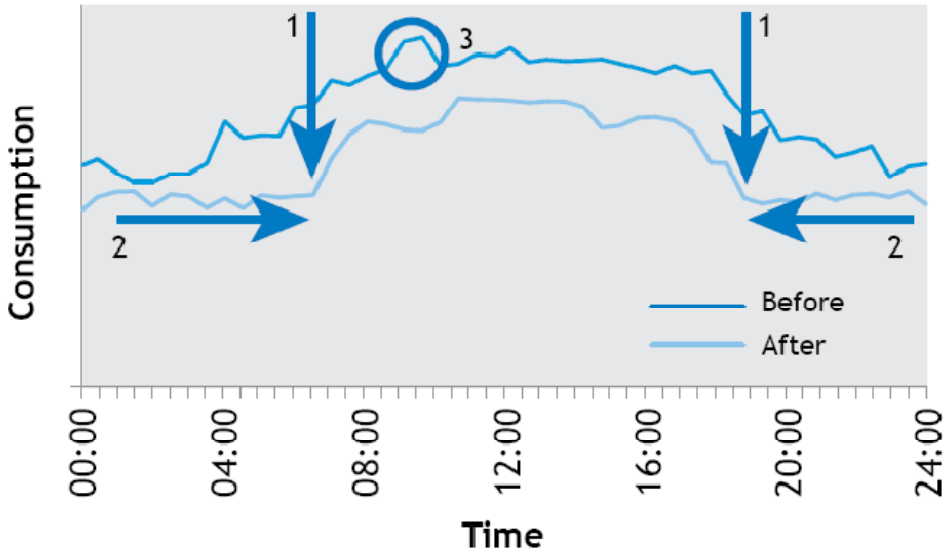
Carbon Trust Smart Metering Trial (1)

- This study was carried out from 2004 to 2006 by the United Kingdom Carbon Trust
- The study investigated how smart metering can enable businesses to identify energy, cost and carbon savings by providing detailed information about the way in which they use their energy
- A total of 582 advanced meters were installed in small and medium enterprises (SMEs) across the UK and metering services were provided to these sites by seven different consortia

Carbon Trust Smart Metering Trial (2)

- In addition to the installation of smart meters, a variety of different metering services were included in the trial, ranging from basic data provision to detailed advice on energy saving communicated through phone calls and site visits
- The highest peak load reductions and overall energy savings were achieved by providing energy consumption profiles and energy saving recommendations via email
- This is a significant finding which suggests that, in the future, low-cost metering services could be provided using automated systems

Carbon Trust Smart Metering Trial (3)



1. **Base load reductions** – the overall base load of the site could be reduced by identifying excessive constant energy use
2. **Process optimisation** – the profile could be used to identify what equipment is running and when; altering start-up and shutdown times could reduce consumption by limiting the duration of high-energy use at the start and end of shifts
3. **Peak usage reduction** – the profile could be used to analyse timings and frequencies to establish the causes of peaks in energy usage, and identifying specific activities/equipment contributing to the peaks

Conclusion

Conclusion (1)

- The Task XV survey showed that network-driven DSM options can effectively:
  - achieve load reductions on electricity networks that can be targeted to relieve specific network constraints; and
  - provide a range of network operational services

Conclusion (2)

- The Task XV survey also showed that all types of DSM measures can be used to relieve network constraints and/or provide network operational services
- However, whether a particular DSM measures is appropriate and/or cost effective in a particular situation will depend on:
  - the specific nature of the network problem being addressed; and
  - the availability and relative costs of demand-side resources in that situation

Information Resources

Information Resources

- David Crossley: crossley@efa.com.au
- Energy Futures Australia, my company's website: www.efa.com.au
- The International Energy Agency DSM Programme carries out multi-national research projects on demand side management. Website for information about the IEA DSM Programme: www.ieadsm.org
- The IEA DSM Programme is currently undertaking Task XV - a research project on DSM to support electricity grids. Website for information about this project: www.ieadsm.org/ViewTask.aspx?ID=16&Task=15&Sort=0