Interactions between Demand Side Management and Climate Change

Research Report No 1
Task XVIII of the International Energy Agency Demand Side Management Programme

Final version
19 November 2010

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Undertaken with participation and support from:
Australia (Sustainability Victoria)
France (Agence de l'Environnement et de la Maitrise de l'Énergie)
India (Bureau of Energy Efficiency, Ministry of Power)
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DISCLAIMER

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THE IEA DEMAND SIDE MANAGEMENT PROGRAMME

The International Energy Agency (IEA) was established in 1974 as an autonomous agency within the framework of the Economic Cooperation and Development (OECD) to carry out a comprehensive program of energy cooperation among its 25 Member countries and the Commission of the European Communities.

An important part of the Agency's program involves collaboration in the research, development and demonstration of new energy technologies to reduce excessive reliance on imported oil, increase long-term energy security and reduce greenhouse gas emissions. The IEA's R&D activities are headed by the Committee on Energy Research and Technology (CERT) and supported by a small Secretariat staff, headquartered in Paris. In addition, three Working Parties are charged with monitoring the various collaborative energy agreements, identifying new areas for cooperation and advising the CERT on policy matters.

Collaborative programs in the various energy technology areas are conducted under Implementing Agreements, which are signed by contracting parties (government agencies or entities designated by them). There are currently over 40 Implementing Agreements, including the IEA Demand-Side Management Programme. Since 1993, the following 20 member countries have been working to clarify and promote opportunities for DSM.

Australia	France	New Zealand
Austria	Greece	Norway
Belgium	Italy	Spain
Canada	India	Sweden
Denmark	Japan (Sponsor)	Switzerland
European Commission	Republic of Korea	United Kingdom
Finland	Netherlands	United States

A total of 22 Tasks (multi-national collaborative research projects) have been initiated by the IEA DSM Programme, 15 of which have been completed. Each Task is managed by an Operating Agent (Project Director) from one of the participating countries. The Operating Agent is responsible for overall project management including project deliverables, milestones, schedule, budget and communications. Overall control of the program rests with an Executive Committee comprised of one representative from each contracting party to the Implementing Agreement. In addition, a number of special ad hoc activities–conferences and workshops–have been organized.

The actual research work for a Task is carried out by a combination of the Operating Agent and a group of Country Experts, depending on the nature of the work to be carried out. Each country which is participating in a Task nominates one or more persons as its Country Expert. Each Expert is responsible for carrying out any research work within his/her country which is required for the Task All the Experts meet regularly to review and assess the progress of the work completed by the Operating Agent and by the group of Experts. Experts meetings are usually held between two and four times a year.

The IEA DSM Programme has undertaken the following Tasks to date:

Task I*	International Database on Demand-Side Management
Task II*	Communications Technologies for Demand-Side Management
Task III*	Cooperative Procurement of Innovative Technologies for Demand-Side Management
Task IV*	Development of Improved Methods for Integrating Demand-Side Management
Task V*	Investigation of Techniques for Implementation of Demand-Side Management Technology in the Marketplace
Task VI*	Mechanisms for Promoting DSM and Energy Efficiency in Changing Electricity Businesses
Task VII*	International Collaboration on Market Transformation
Task VIII*	Demand Side Bidding in a Competitive Electricity Market
Task IX*	The Role of Municipalities in a Liberalized System
Task X*	Performance Contracting
Task XI*	Time of Use Pricing and Energy Use for Demand Management Delivery
Task XII*	Cooperation on Energy Standards (not proceeded with)
Task XIII*	Demand Response Resources
Task XIV*	Market Mechanisms for White Certificates Trading
Task XV*	Network-Driven Demand Side Management
Task XVI	Competitive Energy Services
Task XVII	Integration of Demand Side Management, Energy Efficiency, Distributed Generation and Renewable Energy Sources
Task XVIII	Demand Side Management and Climate Change
Task XIX	Micro Demand Response and Energy Saving
Task XX	Branding of Energy Efficiency
Task XXI	Standardisation of Energy Savings Calculations
Task XXII	Energy Efficiency Portfolio Standards

* Completed Task

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FOREWORD

This report is a result of work which was completed within Task XVIII of the International Energy Agency Demand-Side Management Programme. The title of Task XVIII is "DSM and Climate Change." Task XVIII is a multinational collaborative research project which is investigating circumstances in which DSM can contribute to mitigating greenhouse gas emissions and emissions mitigation measures can achieve benefits for electricity systems.

Task XVIII is organised into six subtasks as follows:

- **Subtask 1:** Interactions between DSM and Climate Change;
- **Subtask 2:** Principles for Assessing Emissions Reductions from DSM Measures;
- **Subtask 3:** Mitigating Emissions and Delivering Electricity System Benefits;
- **Subtask 4:** Fungibility of DSM and Emissions Trading;
- **Subtask 5:** TOU Pricing and Emissions Mitigation;
- **Subtask 6:** Communicating Information about DSM and Climate Change.

This report summarises the results from Subtask 1.

The Operating Agent (Project Director) for Task XVIII is Energy Futures Australia Pty Ltd, based in Sydney, Australia.

The work of Task XVIII is supported (through cost and task sharing) by the four participating countries: Australia, France, India and Spain. Participants provided one or more Country Experts who were responsible for contributing to the work of the Task and for reviewing work as it was completed.

Information for this report was collected, and the document was reviewed by, Country Experts and representatives from the organisations listed in the Table on page vi.

The Principal Investigator for, and main author of, this report is Dr David Crossley who also provides Operating Agent services for Task XVIII through his consultancy company Energy Futures Australia.

Any errors and omissions are the responsibility of Dr Crossley.

Country Experts and Representatives Participating in Task XVIII		
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* Country Expert		

EXECUTIVE SUMMARY

The purpose of this report is to present detailed case studies of DSM and GHG emissions mitigation projects as the first stage in identifying circumstances in which DSM may mitigate GHG emissions and in which emissions mitigation programs may deliver benefits to the electricity system.

The country Experts identified in their countries DSM projects which may have mitigated greenhouse emissions, and emissions mitigation projects which may have delivered benefits to the electricity system. The information collected about each project included details about: the objectives of the project; the DSM measures employed; the emissions mitigation measures employed; the market segments addressed; the regulatory regime under which the project was implemented, the cost of the project; and the impact of the project in terms of the load reduction (MW or MVA), energy saving (MWh), and the greenhouse emissions reduction (tCO_2-e) achieved.

This report contains 30 case studies of projects from the four countries participating in Task XVIII: Australia, France India and Spain. There are 17 case studies of DSM projects and 13 case studies of GHG emissions mitigation projects. The case studies are very diverse in terms of the DSM and emissions mitigation measures used. The case studies are also diverse in terms of the size of the projects and of the consequent emissions reductions.

All of the 17 DSM projects considered in this report achieved GHG emissions reductions and therefore contributed to mitigating emissions. Changing DSM activities to better mitigate GHG emissions involves mainly electricity distributors, technically-achievable outcomes, and reasonably familiar applications. This is considered further in Task XVIII Research Report No 3.

In contrast to the effect of DSM projects in reducing GHG emissions, it is much more difficult to determine whether emission mitigation projects deliver benefits to the electricity system. In particular, the case studies of the 13 emissions mitigation projects considered in this report do not contain enough information to establish whether any of the projects delivered electricity system benefits.

Modifying emissions reduction measures to achieve benefits for electricity systems comprises a plethora of activities, driven by a multitude of stakeholders, usually without a deep appreciation of the technical parameters. This is also considered further in Task XVIII Research Report No 3.

PART 1: INTRODUCTION

1. INTRODUCTION

1.1 Demand-side Management

In the electricity industry, the term 'demand-side management' (DSM) is used to refer to actions which change the electrical demand on the system.

Task XVIII takes a broad view of demand-side management and includes the following measures within the definition of DSM:

- distributed generation, including standby generation and cogeneration;
- energy efficiency;
- fuel substitution;
- load management, including interruptible loads, direct load control, and demand response;
- power factor correction;
- pricing initiatives, including time of use and demand-based tariffs.

1.2 Purpose of Task XVIII

The purpose of Task XVIII is to investigate the potential contribution to mitigating greenhouse gas (GHG) emissions that can be made by DSM measures and the extent to which emission mitigation measures can achieve benefits for electricity systems.

Currently, DSM and emission mitigation measures are implemented quite independently:

- DSM measures are implemented primarily to assist and improve the operation of electricity systems. Any impacts (positive or negative) of DSM measures on climate change are only a minor consideration, if they are considered at all;
- efforts to mitigate GHG emissions from electricity production have focussed on improving the efficiency of both electricity generation and end-use. However, emission mitigation measures focussed on increasing end-use efficiency have usually not considered any benefits to the electricity system (eg peak load reduction) that might be gained through implementing the measures.

The overall aim of Task XVIII is to reconcile these two different approaches so as to identify circumstances in which DSM can contribute to mitigating GHG emissions and emission mitigation measures can achieve benefits for electricity systems. Task XVIII then determines what is required to maximise the emissions reductions and electricity system benefits from these two types of measures.

1.3 Purpose of this Report

The purpose of this report is to present detailed case studies of DSM and GHG emissions mitigation projects as the first stage in identifying circumstances in which DSM may mitigate GHG emissions and in which emissions mitigation programs may deliver benefits to the electricity system.

The country Experts identified in their countries DSM projects which may have mitigated greenhouse emissions, and emissions mitigation projects which may have delivered benefits to the electricity system. The information collected about each project included details about: the objectives of the project; the DSM measures employed; the emissions mitigation measures employed; the market segments addressed; the regulatory regime under which the project was implemented, the cost of the project; and the impact of the project in terms of the load reduction (MW or MVA), energy saving (MWh), and the greenhouse emissions reduction (tCO_2-e) achieved.

The report is structured as follows. Part 1 introduces the case studies and Part 2 comprises the detailed case studies themselves.

2. CASE STUDIES

2.1 Overview

Part 2 of this report contains 30 case studies of projects from the four countries participating in Task XVIII: Australia, France India and Spain. As shown in Table 1, there are 17 case studies of DSM projects and 13 case studies of GHG emissions mitigation projects. The case studies are very diverse in terms of the DSM and emissions mitigation measures used. The case studies are also diverse in terms of the size of the projects and of the consequent emissions reductions.

Table 1. Case Studies Included in Part 2 of this Report	
DSM Projects	
DSM-AU01	ETSA Utilities Air Conditioner Direct Load Control Program
DSM-AU02	Drummoyne Demand Management Program
DSM-AU03	Binda-Bigga Demand Management Project
DSM-AU04	Castle Hill Demand Management Program
DSM-ES01	Efficient Street Lighting in Alcalá de Henares
DSM-ES02	GAD Active Demand Side Management
DSM-ES03	Hourly Demand Tariff
DSM-ES04	Load Interruption Contract
DSM-ES05	The OPTIGES Project
DSM-ES06	Trasluz Bioclimatic Office Building
DSM-FR01	Daylight Saving Time in France
DSM-FR02	Tempo Electricity Tariff
DSM-IN01	Separation of Agricultural Feeders for Load Control, Gujarat
DSM-IN02	Model for Mitigating Load Shedding in Pune Urban Circle
DSM-IN03	Pilot Agricultural Demand Side Management Project at Solapur, Maharashtra
DSM-IN04	Efficient Lighting Programme, Mumbai
DSM-IN05	Street Light Replacement Programme, Mumbai

Table 1. Case Studies Included in Part 2 of this Report (continued)	
GHG Emissions Mitigation Projects	
EMR-AU01	Victorian Energy Efficiency Target Phase 1
EMR-AU02	Minimum Energy Performance Standards for Residential Refrigerators and Freezers
EMR-AU03	Minimum Energy Performance Standards for Single-Phase Air Conditioners
EMR-AU04	Earth Hour Victoria
EMR-AU05	Victorian Five Star Housing Standard
EMR-ES01	Hybrid Electric Vehicle Development
EMR-ES02	Environmental Program of Torres Papel
EMR-ES03	Electricity Generation from Biomass
EMR-ES04	ULCOS - Ultra Low CO2 Steel Making
EMR-IN01	CFL Lighting Scheme – Bachat Lamp Yojana
EMR-IN02	Energy Efficiency in Cement Milling, West Bengal
EMR-IN03	Bundle of 100 Village Biomass-based Power Plants in Bihar
EMR-IN04	Energy Efficiency Improvement in Electric Arc Furnace, Maharashtra

2.2 Mitigation of GHG Emissions by DSM Projects

All of the 17 DSM projects considered in this report achieved GHG emissions reductions and therefore contributed to mitigating emissions.

In the case studies, emissions reductions are estimated mainly by using average emissions factors, which are quick to use but not very accurate. In four Australian DSM projects, emissions are estimated using marginal emissions factors. Using marginal factors is more accurate, but takes a long time and requires large amounts of data – this is discussed more fully in Task XVIII Research Report No 2[1].

Changing DSM activities to better mitigate GHG emissions involves mainly electricity distributors, technically-achievable outcomes and reasonably familiar applications. This is considered further in Task XVIII Research Report No 3[2].

1 Crossley, D. J. and Pujari, A. (2010). *Principles for Assessing Emissions Reductions from DSM Measures*. International Energy Agency Demand Side Management Programme, Task XVIII Research Report No 2. Hornsby Heights, NSW, Australia, Energy Futures Australia Pty Ltd.

2 Watt, G. and Crossley, D. J. (2010). *Mitigating GHG Emissions and Delivering Electricity System Benefits*. International Energy Agency Demand Side Management Programme, Task XVIII Research Report No 3. Hornsby Heights, NSW, Australia, Energy Futures Australia Pty Ltd.

2.3 Delivering Electricity System Benefits through Emissions Mitigation Projects

In contrast to the effect of DSM projects in reducing GHG emissions, it is much more difficult to determine whether emission mitigation projects deliver benefits to the electricity system. In particular, the case studies of the 13 emissions mitigation projects considered in this report do not contain enough information to establish whether any of the projects delivered electricity system benefits.

Modifying emissions reduction measures to achieve benefits for electricity systems comprises a plethora of activities, driven by a multitude of stakeholders, usually without a deep appreciation of the technical parameters. This is considered further in Task XVIII Research Report No 3[3].

[3] Watt, G. and Crossley, D. J. (2010). *Op. cit.*

PART 2:
CASE STUDIES

DSM-AU01 ETSA UTILITIES AIR CONDITIONER DIRECT LOAD CONTROL PROGRAM

Last updated	27 October 2010
Location of Project	Various suburbs in Adelaide, South Australia
Year Project Implemented	2005
Year Project Completed	Continuing
Name of Project Proponent	ETSA Utilities
Name of Project Implementor	ETSA Utilities
Type of Project Implementor	Electricity distribution (wires) business
Purpose of Project	Deferring augmentation of the electricity network
Project Objective	Increasing operating reserve
Project Target	Network region
DSM Measure(s) Used	Direct load control
Specific Technology Used	Remote load switching device
Market Segments Addressed	Residential electricity end users

REGULATORY REGIME

ETSA Utilities is the sole distributor of electricity in the State of South Australia, serving over 800,000 customers with a distribution network covering 178,000 square kilometres.

In September 2003, the electricity industry regulator, the Essential Services Commission of South Australia (ESCOSA), established processes that required ETSA Utilities to publish information regarding forecast limitations or constraints on the distribution system, and to seek proposals for non-network alternatives to address such constraints, including demand side management.

These processes address a significant barrier to successful take-up of DSM opportunities, ie a lack of publicly available information regarding distribution system limitations that might be addressed through DSM. ESCOSA's intention is that DSM providers will be able to assess opportunities and make bids to ETSA Utilities on the basis of the information provided.

The form of regulation imposed on ETSA Utilities by ESCOSA is expressed as a control placed on the average revenue ($/MWh) that ETSA Utilities can earn in a year. This form of regulation provides an incentive to ETSA Utilities to maximise energy sales, and conversely penalises ETSA Utilities if sales are below forecast levels (eg due to greater than expected impact of DSM measures).

To reduce the disincentive to implement DSM, ESCOSA incorporated into its regulatory determination a correction factor designed to reduce the financial risks faced by ETSA Utilities because of variations in forecast sales. This factor is more directly relevant to application of energy efficiency measures than to reduction of peak demand, but may be relevant to peak reduction measures that also reduce energy sales (eg installation of more efficient reverse cycle air conditioners).

In addition, ESCOSA approved an amount of AUD20.4 million (December 2004 values) as operating expenditure over the 2005-2010 regulatory period for ETSA Utilities to trial specified network DSM measures that may reduce the requirement for peak-driven network expansion. The DSM measures mandated by ESCOSA comprised:

- power factor correction;
- direct load control;
- voluntary and curtailable load control;
- standby generation;
- critical peak pricing; and
- aggregation of demand reductions.

DRIVERS FOR PROJECT

South Australia has a very peaky electricity demand profile. Figure 1 shows the electricity demand profile on the ETSA Utilities network on 17th March 2008, the last day of Adelaide's record 15 day heat wave with temperatures consistently above 35°C, when demand peaked at just over 3,000 MW. In Figure 1, this peak day load profile is compared with the average daily load profile for the 2008 summer.

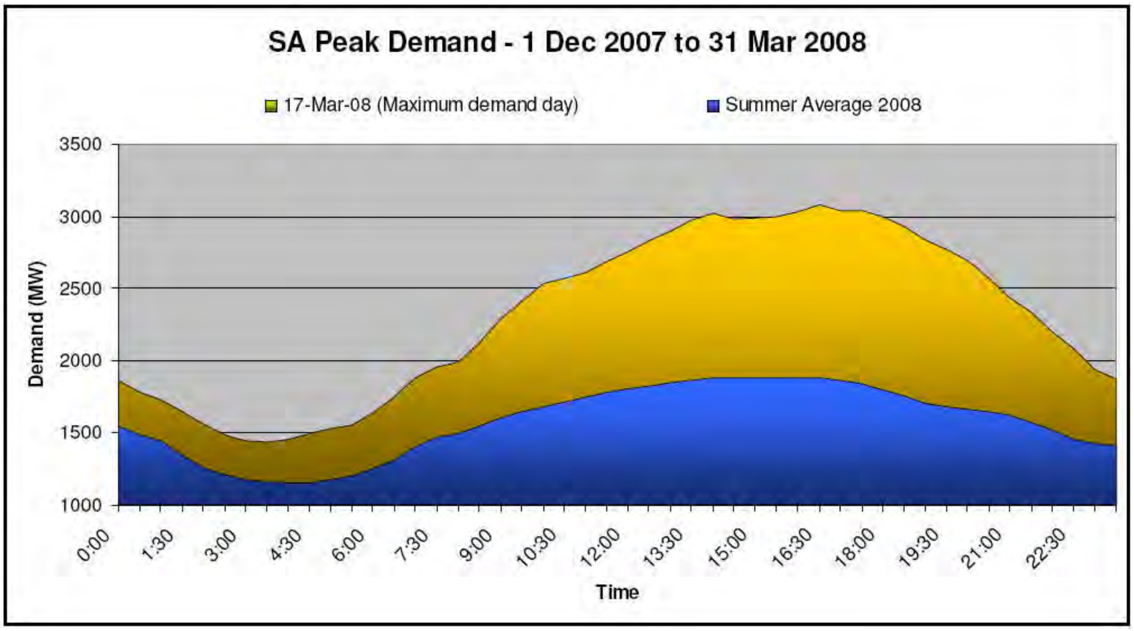

Figure 1. Peak Day Load Profile for the ETSA Utilities System, 17 March 2008, Compared with Summer Average Load Profile

Figure 2 (page 9) shows that 20% of the capacity of the distribution system in South Australia is used for 2% of the time during the year.

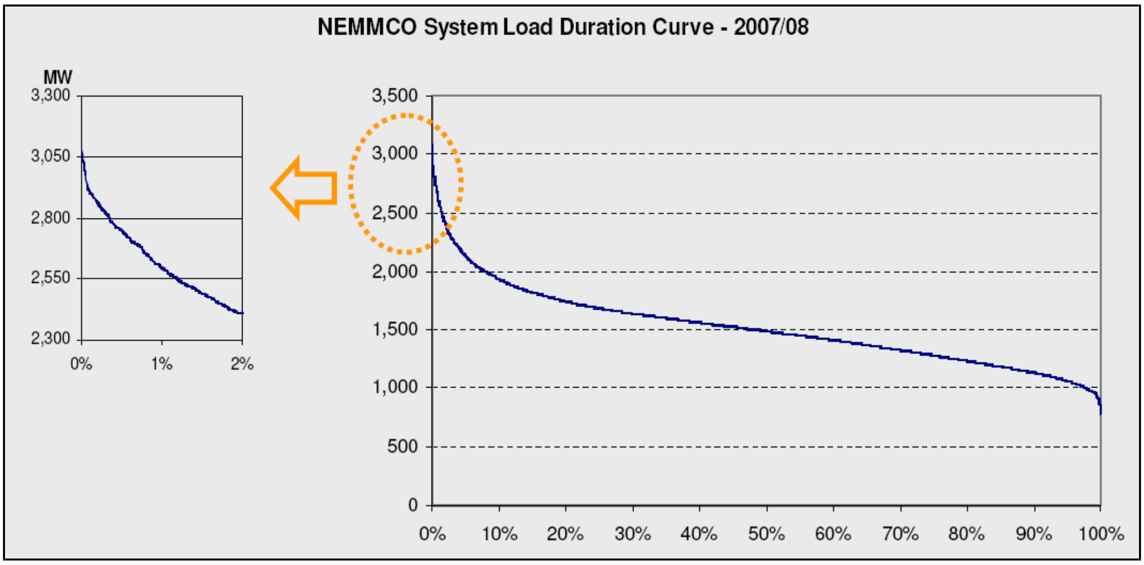

Figure 2. Load Duration Curve for the ETSA Utilities System, 2007/08

The major contribution to the peak is from the residential sector, particularly air conditioning use on hot days. ETSA Utilities estimates that peak demand on hot days, primarily due to air-conditioning load, is about 1,000 MW higher than average daily peak demand over the summer.

DESCRIPTION OF PROJECT

To implement the DSM program funded through the ESCOSA determination, ETSA Utilities is identifying a range of possible projects within each of the program's approved categories of DSM measures. The suggested projects are short-listed by a Steering Committee on the basis that the projects are meritorious, are consistent with the regulator's determination, meet budgetary expectations, and have good prospects of producing net benefits in a widespread network roll-out.

In June 2008, the DSM program portfolio consisted of 27 individual projects at various stages of implementation. Several of these projects involved direct load control (DLC) of air conditioners.

DLC Phase I: Summer 2005/06

An initial trial of DLC technology applied to residential air conditioners was launched in the summer of 2005/06. The primary aim of this trial was to determine customer perception of change in comfort levels resulting from the remote management of domestic air conditioners. Secondary aims were:

- to determine the impact on aggregate demand for the sites in the trial;
- to gain experience in the installation and operation of proprietary DLC technology;
- to test the performance of the selected DLC technology; and
- to gain experience in quantification, metrics and verification.

The trial involved 20 residential customers in the Adelaide metropolitan area. Customers were paid an incentive of AUD100 to participate. The customers were recruited by demographic, geographic area and equipment type. During the trial customers were able to contact a named ETSA staff person to provide feedback and to report adverse impact or problems. After the trial customers were de-briefed on the results of the trial and their perceptions were recorded.

A variety of reverse cycle air conditioners (either split or ducted) were included in the trial. Only air conditioners with an electrical load in excess of 2.5 kW were selected. The compressor load of the air conditioners in the trial ranged from 2.5 to 10.3kW, with the average being 4.27kW.

The air conditioners were controlled using Comverge load control units (LCUs) that had the capacity to cycle air conditioner compressors. The LCUs were located external to the customer premises adjacent to the air conditioner compressor unit (see Figure 3). Each LCU had two integral relays rated at 5 and 30 amps. The relays could be remotely controlled using a variety of communication media. For practical purposes, in this trial ETSA's radio network was used as the communication medium. Each sample site was also fitted with an interval meter for load monitoring purposes.

Figure 3. Comverge Load Control Unit Used in the ETSA Utilities Air Conditioner DLC Phase I Project

Application of direct load control occurred during a period of high temperature days in March 2006. Cycling strategies involved compressors being switched off (with fans continuing to operate) for either 7.5 minutes or 15 minutes in each 30 minute period during the late afternoon (see Table 1, page 11).

Table 1. Application of Direct Load Control in the ETSA Utilities Air Conditioner DLC Phase I Project, March 2006			
Date	**Time**	**Maximum External Temperature (°C)**	**Cycle**
2 March	16.15 to 17.15	36	7.5 min off in 30 min
3 March	16.05 to 18.05	35	7.5 min off in 30 min
4 March	14.15 to 16.15	35	7.5 min off in 30 min
11 March	16.30 to 18.30	37	15 min off in 30 min
12 March	12.09 to 14.09	34	15 min off in 30 min

DLC Phase II: Summers of 2006/07 and 2007/08

Based on the results of the initial trial, a much larger air conditioner DLC pilot program was developed for the summers of 2006/07 and 2007/08. An area in metropolitan Adelaide (Glenelg/Morphettville) was selected for this project. This area was chosen because it is supplied by two substations that are expected to become constrained by 2011. In the absence of initiatives to reduce peak demand, augmentation of the distribution network would be required by that date.

A target load reduction of 2.2 MVA was established for the pilot program.

The objectives of DLC Phase II were:

- - to further test customer acceptance;
- - to gain further experience with DLC technology; and
- - to assess the impact and ultimately the potential for wide scale roll out of the technology.

ETSA Utilities initiated DLC Phase II in June 2006 with a media marketing and community education campaign, entitled “Beat the Peak”. The campaign primarily targeted the 12,000 residential customers in the selected region and was designed to secure volunteers to participate in the program. Participating customers were offered a cash incentive of AUD100. A direct marketing campaign (mailout, local advertising, etc) was also used. The marketing campaign attracted significant media coverage, with general support expressed for DSM.

Approximately 4,000 residential customers expressed interest in participating in DLC Phase II as a result of the overall marketing campaign. From this response, ETSA Utilities identified about 1,700 residential air conditioners that were suitable for the program, comprising either split or ducted refrigerative systems. In many cases, air conditioners were deemed unsuitable, being either window installed or portable refrigerative systems, ducted or portable evaporative systems, or ceiling fans.

ETSA Utilities also visited every commercial customer in the trial area and identified a further 700 air conditioners in commercial premises that were suitable for the trial.

In total, about 2,400 air conditioners were identified for DLC Phase II. To monitor demand impacts during the project, ETSA Utilities installed metering equipment in some customer premises, as well as on ten 11 kV feeders and 86 street transformers.

For DLC Phase II, ETSA Utilities, in conjunction with the Adelaide-based Saab Systems Pty Ltd, developed a small DLC device (the "Peak Breaker") to be attached to the external compressor of air conditioners (see Figure 4). This device requires only a simple installation procedure lasting up to 30 minutes with no internal access to premises needed.

Figure 4. Saab Systems "Peak Breaker" Direct Load Control Device Used in the ETSA Utilities Air Conditioner DLC Phase II Project

However, about half of the 2,400 air conditioners initially deemed suitable for the pilot program were found to be "new generation" units with advanced internal electronic diagnostics that effectively prevented the Peak Breaker from overriding the compressor. These air conditioners were unsuitable for the installation of the Peak Breaker.

The penetration of new generation air conditioners was far higher than had been expected (the air conditioning industry had advised a likely figure of 10%). Ultimately, ETSA Utilities determined that approximately 1,100 (from the sample of 2,400) air conditioners were suitable for installation of the Peak Breaker, while a further 1,160 new generation units would require the development of a different form of DLC device.

Consequently, the DLC Phase II project was subdivided into Phase II(a) and II(b) catering for both "Type 1" and "new generation" air conditioning units.

DLC Phase II(a)

For the summers of 2006/07 and 2007/08, approximately 750 air conditioners (from the pool of 1,100) were fitted with the simple "P1" Peak Breaker device that switched the air conditioner compressors directly. The system for communicating with the devices is shown in Figure 5.

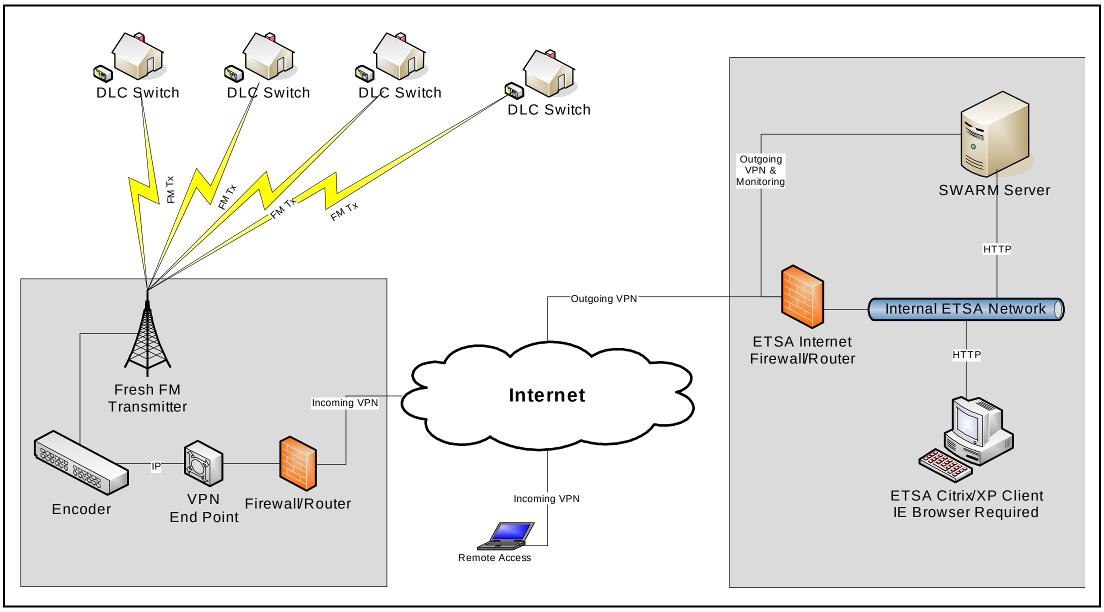

Figure 5. Communication System for the ETSA Utilities Air Conditioner DLC Phase II Project

The Peak Breakers were activated in a random sequence when signals were sent via the internet to a public radio station which then transmitted the signals to the Peak Breakers. The system was able to communicate with subsets of the Peak Breakers based on substation, product group or individual customer level. Switching the "P1" controllers was performed by ETSA Utilities personnel who had access to the switching system. The switching signals were sent via FM radio from a radio transmitter tower.

Site level monitoring with interval meters was carried out during peak demand days at 90 randomly selected sites, with the remaining sites being monitored at the street transformer level. Monitoring also occurred through the SCADA system operated by ETSA Utilities to demonstrate the impact at the 66 kV sub-transmission system at times of peak demand. In addition, the distribution transformers and 11 kV substation feeders were equipped with metering equipment with remote communications capability allowing interval data to be collected as required.

Application of direct load control at the 750 sites commenced in December 2006. A range of control strategies were tested at various times on peak demand days, including cycling the air-conditioners for different lengths of time over different periods of the day. The following switching periods were used to assess the impacts of different switching protocols:

- 8 minutes off in 30 minutes;
- 15 minutes off in 30 minutes (the 'normal' switching period used in the United States);
- 30 minutes off in 60 minutes – used twice on selected street transformers;
- 25 minutes off in 60 minutes – used for one period.

Switching of 15 minutes off in 30 minutes was tested on four occasions and no customer complaints were received regarding comfort levels. ETSA Utilities concluded that residential air conditioning customers can sustain that level of switching.

DLC Phase II(b)

The aim of this project was to trial the operation and installation of enhanced DLC systems on "new generation" air conditioners using "P2" and "P3" DLC controllers.

"P2" controllers were installed on "new generation" Daikin ducted air conditioners and required an additional component to the "P1s". This was an interface card (a standard Daikin accessory) that was installed at the same time as the Peak Breaker.

"P3" controllers were for "new generation" air conditioners from a range of other manufacturers and required an additional device known as an "emulator" to be installed as an integral component of the Peak Breaker installation. The installation procedure was different for different air conditioning systems and could take up to 120 minutes and require entry into the home and access to the head unit for the air conditioner inside the home's roof space.

Given the complexity of the installation process, only 54 "P2" and seven "P3" DLC controllers were installed.

One important operational conclusion from DLC Phase II was that achieving effective load reductions requires a random overlapping switching protocol. Simultaneous switching early in the switching period caused a 'sawtooth' effect on the demand profile (as shown in Figure 6) with repetitions of a majority of the load switching early in the switching period and little load switching later.

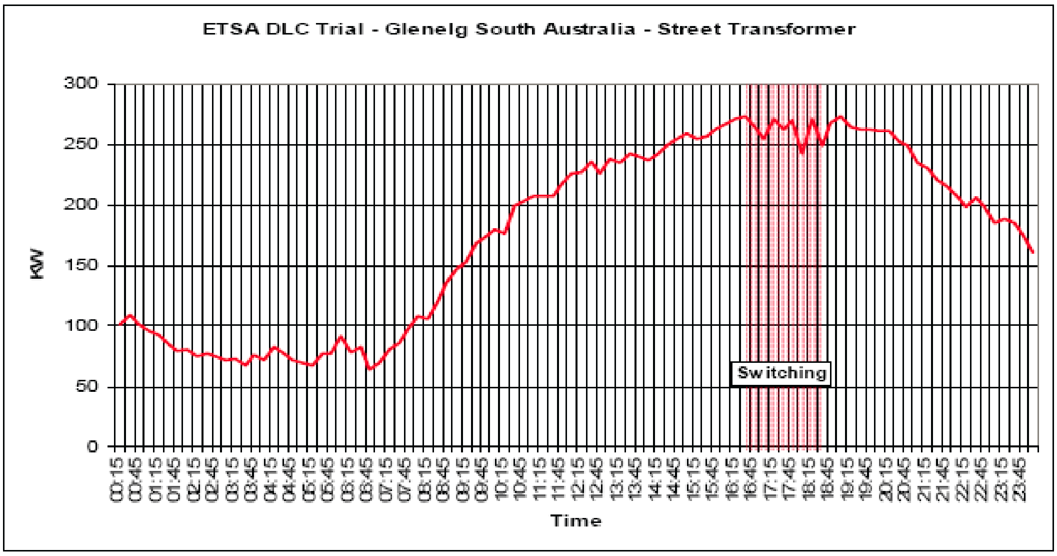

Figure 6. An Example of the "Sawtooth" Effect from the ETSA Utilities Air Conditioner DLC Phase II Project

This ‘sawtooth’ effect negated any peak reduction. Randomised switching of individual loads required monitoring to ensure that the managed load was evenly distributed throughout the entire switching period. A process of reassigning the DLC units into distinct controllable segments, so as to overcome the ‘sawtooth’ effect, allowed the load to be more evenly switched during each control event.

DLC Phase III: Summers of 2006/07 and 2007/08

DLC Phase III drew on the findings of the Phase II(a) and II(b) projects and in addition targeted the northern suburbs of Mawson Lakes and Northgate in the city of Adelaide plus the regional centre of Murray Bridge.

Specifically this project aimed:

- to gain more information on the cost benefit of DLC for large ducted air-conditioners;
- to gain further information on the effect of DLC on distribution networks;
- to gather information on the possible maximum customer participation in DLC programs; and
- to compare the impact of DLC in the targeted areas compared with the impact in other geographical areas.

The total sample pool for all three areas was 1,100 potential participants, selected on the basis of their network connection type, tariff assigned and summer consumption. All of the potential participants are characterised by having three phase power, being on residential tariffs and having high summer consumption compared to their annual consumption.

Of the pool of 1,100 customers the most suitable comprised 465 units in Mawson Lakes, 300 units in Northgate and 40 units in Murray Bridge requiring either “P1”, “P2” or “P3” controllers. Ultimately after a concerted recruitment campaign, 125 units at Mawson Lakes, 12 at Northgate and five at Murray Bridge were installed. These installations were monitored by interval meters.

For the DLC Phase III project, there was a total of 935 installations in the homes and commercial premises of volunteers in Adelaide suburbs and South Australian country locations. The Peak Breaker device was improved and adapted to over 50 different types of air conditioners. ETSA Utilities provided a comprehensive 24 hour support service and developed a sophisticated digital control system that allows tailored switching on an individual customer level. Customer parameters can be changed remotely even during switching events.

The main locations for DLC Phase III were Mawson Lakes and Glenelg. Mawson Lakes is a new suburb located on 620 hectares in the northern Adelaide metropolitan area about 12 kilometres from the CBD and 10 kilometres inland from the coast. Glenelg on the other hand is an old established Adelaide suburb, dating back to the founding of Adelaide in 1836, on the coast with a diverse mix of house styles, construction and architecture.

In general, houses in Mawson Lakes have larger indoor open plan areas than those in Glenelg and are reliant on air conditioning to maintain comfort levels during temperature peaks of either heat or cold. Also, temperatures in Mawson Lakes during the summer tend to be two to three degrees higher than those experienced in the coastal Glenelg area and Mawson Lakes tends not to have the cooling effects of an afternoon sea breeze.

A particular study of the effect of DLC switching was carried out during a period of hot weather in March 2008. To allow statistical analysis to be undertaken, participants from Glenelg and Mawson Lakes were paired based on air conditioner input power requirements. Each member of a pair was then allocated to different groups and switched on alternate days (two groups per trial area). Only one member from each pair was switched for each DLC event. This methodology accounted for: differences in the types of air conditioners between Mawson Lakes and Glenelg; Mawson Lakes having on average larger air conditioners; and Glenelg having a broader range of air conditioner sizes.

The air conditioner compressors were switched over a cycle of 15 minutes off and 15 minutes on. Base load was calculated for each participant using the load data recorded on mild days during March 2008 and air conditioner load was calculated by removing the base load.

RESULTS

Residential Customers Participating	Commercial and Small Industrial Customers Participating		Agricultural Customers Participating	Large Industrial Customers Participating	Additional Generation Installed
Approx 750	Not stated				
Peak Load	**Peak Load Reduction**	**Duration of Peak Load Reduction**	**Overall Load Reduction**	**Energy Savings**	**Greenhouse Emissions Reduction**
	2.2 MVA				429.9 tC02-e

DLC Phase I

The results of DLC Phase I showed that the external control of air conditioners significantly reduced the electricity demand of the sample customers, and that no reduction in thermal comfort level accompanied the reduced demand.

For example, Figure 7 (page 17) shows the aggregate demand on 11 March 2006 for the houses involved in DLC Phase 1. Each bar in the chart represents the total average demand in a half-hour period. The area highlighted in red shows the period under direct load control when the air conditioner compressors were switched off for 15 minutes in each 30 minute period. It is clear that aggregate demand was reduced during the control period.

The approximate load reduction resulting from cycling of compressors in the initial trial was 5 kW in a total demand of about 30 kW, ie a reduction of about 17%. Customers reported no reduction in their thermal comfort levels, with several commenting that they noticed no difference at all.

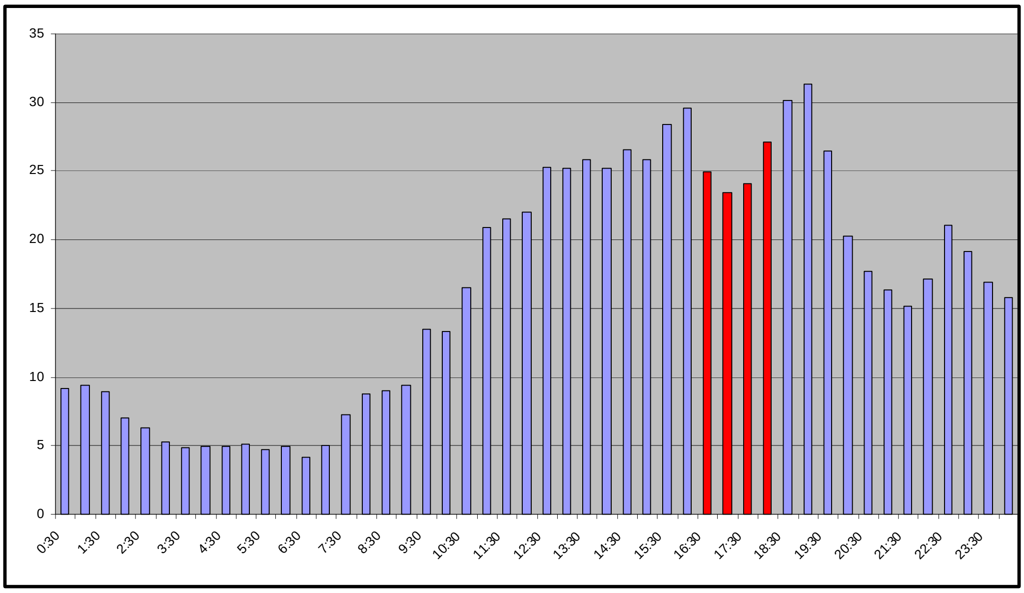

Figure 7. Aggregate Demand on 11 March 2006
for the Houses Involved in the
ETSA Utilities Air Conditioner DLC Phase I Project

DLC Phases II and III

Figure 8 demonstrates the impacts on peak demand resulting from the cycling of air conditioners in a group of 68 premises in Glenelg. The Figure shows the aggregate load profile, with no load curtailment, for days with maximum temperatures of 35 degrees and 40 degrees Celsius, and the average profile for those two days.

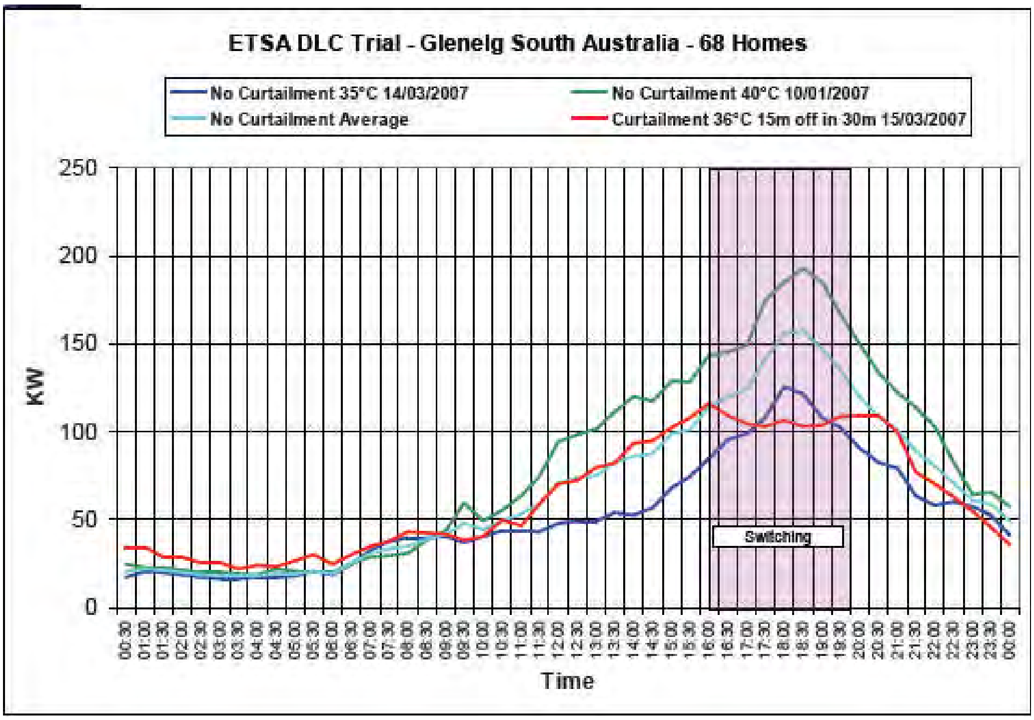

Figure 8. Load Reductions Achieved in the
ETSA Utilities Air Conditioner DLC Phase II Project

Figure 8 also shows the profile for a day with maximum temperature of 36 degrees Celsius in which the air conditioner at each premises was cycled between 4pm and 7.30pm. A significant reduction in peak demand was achieved for this day, equivalent to about 40 kW, in comparison with the average peak demand of the two days for which there was no air conditioner cycling.

Figure 9 shows a significant load reduction of about 150 kilowatts achieved across 187 homes in Glenelg and Mawson Lakes during a DLC event from 3.30 to 7.30 pm on a very hot day in March 2008.

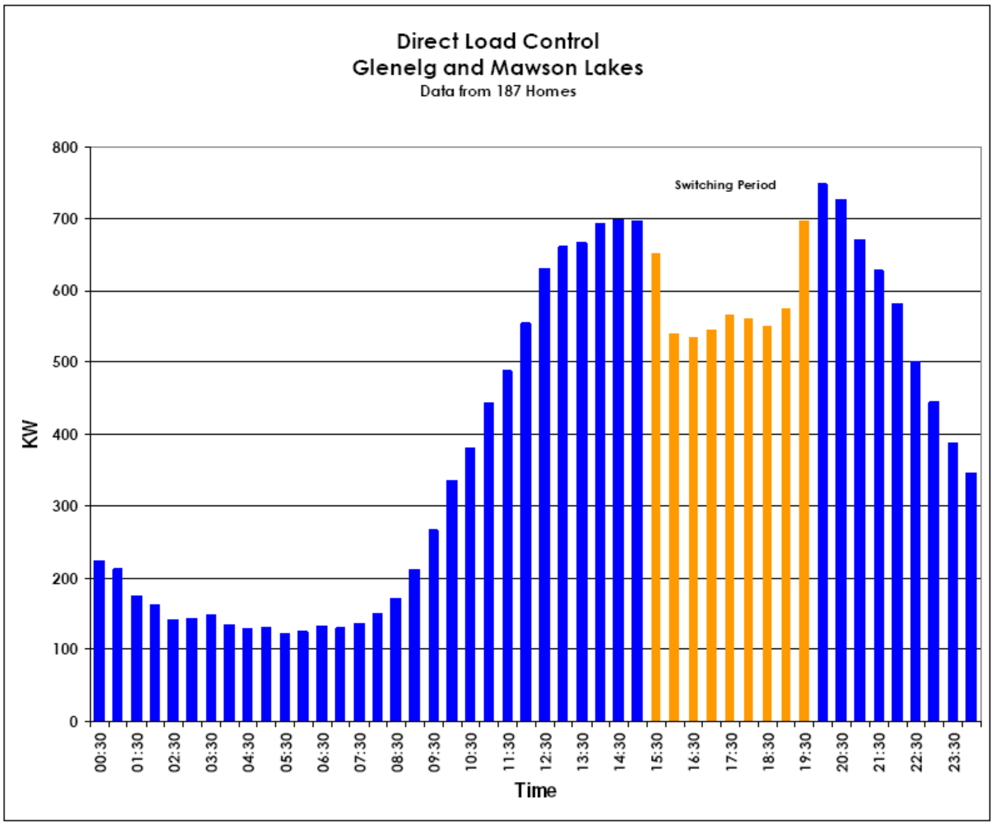

Figure 9. Load Reductions Achieved in the ETSA Utilities Air Conditioner DLC Phase III Project

Figure 10 (page 19) illustrates the impact of a DLC event on separate groups of participants in Glenelg and Mawson Lakes. It can be clearly seen that DLC has an impact under all circumstances but that its impact was more pronounced in Mawson Lakes than in Glenelg because of housing composition, mix and diversity and distance from the coast. Another important feature highlighted by Figure 10 is that because Mawson Lakes is a newer suburb with homogeneity of housing style and reliance on air conditioning, more load reduction can be achieved there during a DLC event than in more established suburbs such as Glenelg.

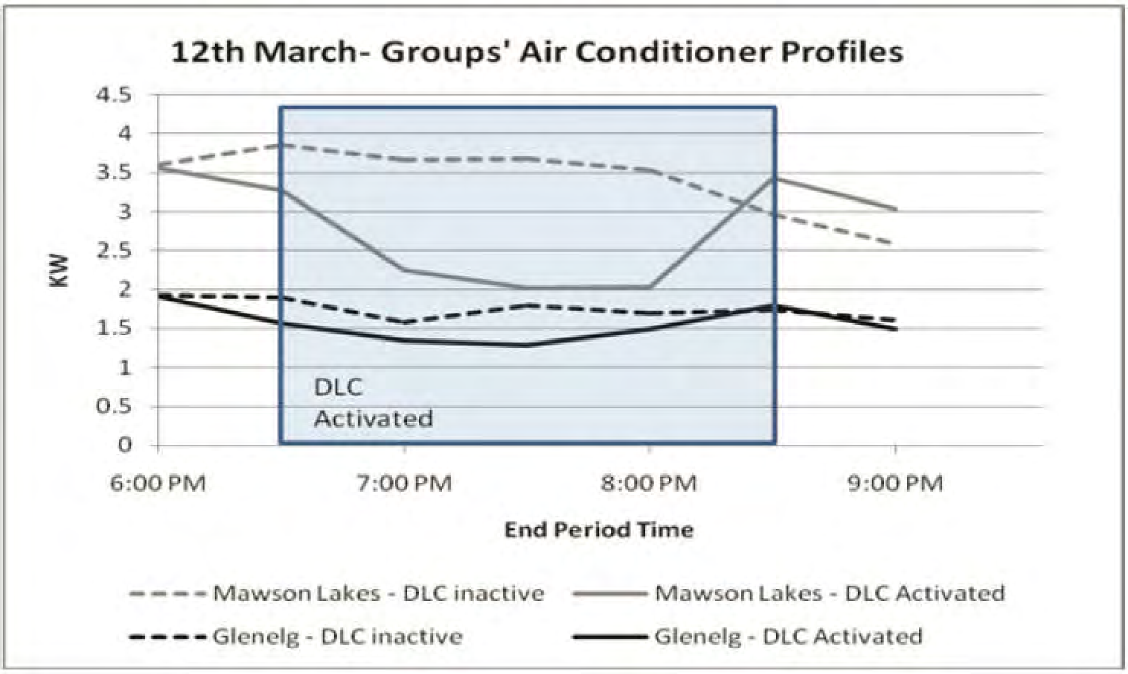

Figure 10. Load Reductions Achieved by Separate Groups of Participants in the ETSA Utilities Air Conditioner DLC Phase III Project

The average reduction for Glenelg and Mawson Lakes is shown in Table. This table shows that the load reduction from a DLC event is highly dependent on location. Also, the load reduction is highly variable as illustrated by the standard deviation of the load reduction in Table 2.

Table 2. Average Load Reduction Achieved in the ETSA Utilities Air Conditioner DLC Phase III Project

Location	Average Air Conditioner Capacity (kW)	Average kW Reduction per A/C	Standard Deviation kW Reduction per A/C	95% Confidence Interval for Proportion of A/C Capacity Reduced by DLC
Glenelg	3.08	0.45	1.88	(0.057, 0.214)
Mawson Lakes	5.07	1.34	3.01	(0.155, 0.354)

Figure 11 (page 20) shows the demand (kW) for DLC activated households during the periods immediately prior to (the “fore” period), and during, a DLC event. Statistical analysis of these results show that the households participating in the trial can be divided into four categories illustrated by four regions in Figure 11:

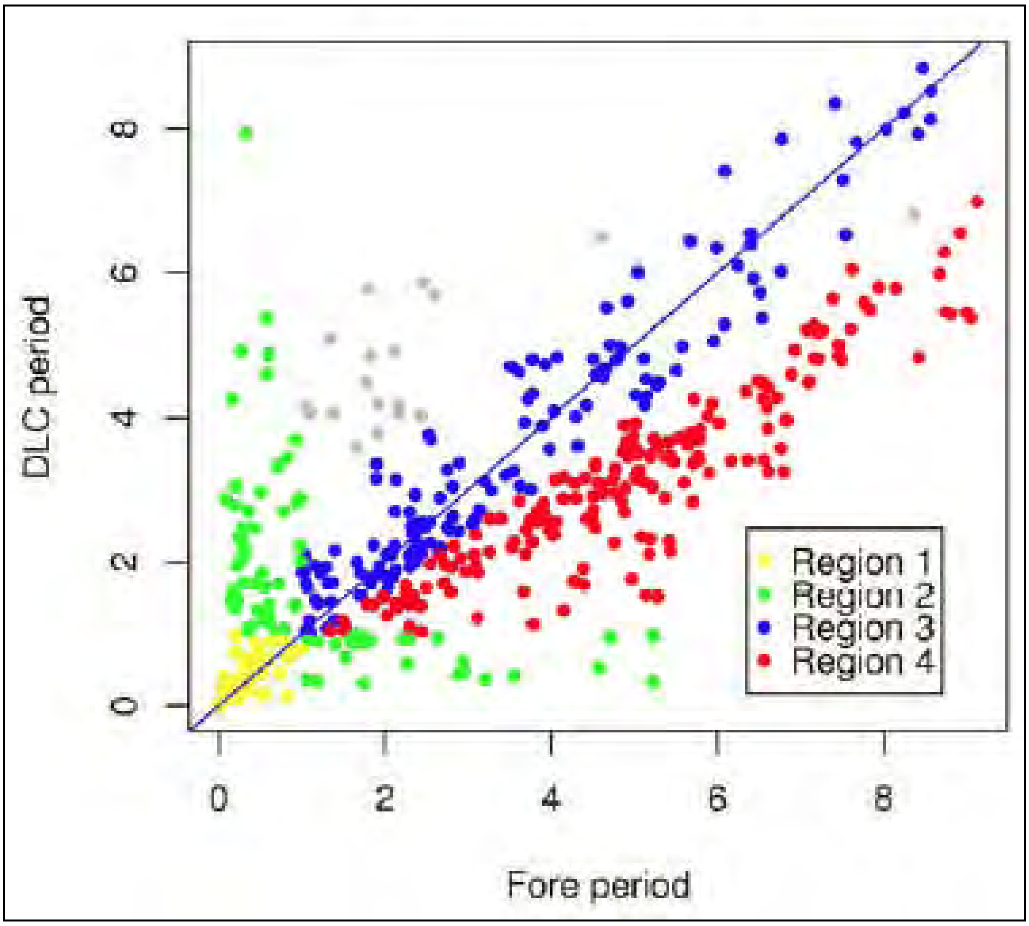

Figure 11. Demand (kW) for DLC Activated Households Before and During a DLC Event in the ETSA Utilities Air Conditioner DLC Phase III Project

Region 1: These are households with low demand in both periods. It is reasonable to infer that no significant air conditioner usage occurred in these households and that a DLC event did not reduce load.

Region 2: These are households with low demand in one of the two periods. This could happen if, for example, the air conditioner was off during the fore period and on during the DLC period.

Region 3: These are households where the demand was high and differed little between the two periods. It is reasonable to infer that for these households there was a significant source of load not controlled by DLC.

Region 4: These are households where the demand was high in both periods but significantly lower during the DLC period. It is reasonable to infer that these were the households in which DLC had the intended effect.

The interpretation of the demand patterns suggests that the impact of a DLC event is likely to be lower than its theoretical maximum (eg 50% for a 15 minutes off, 15 minutes on switching protocol) because not all houses will be using their air conditioners during a DLC event.

HOW LOAD REDUCTION WAS MEASURED

Interval meter

HOW GREENHOUSE EMISSIONS REDUCTION WAS CALCULATED

The example calculation of the emissions reduction achieved by the air conditioner cycling program was carried out for the six month period from October 2008 to March 2009 (spring and summer in the southern hemisphere). We assumed that air conditioner cycling was carried out on all hot days during this period with maximum temperatures of 30 degrees Celsius or more. Cycling of air conditioners was assumed to occur between 1 pm and 5 pm, achieving a load reduction of 2.2 MVA throughout these four hours.

The calculation of emissions reductions was based on the Marginal Historical Emissions method, modified to work with the available data. Historical data were obtained of the electrical energy (MWh) sent out daily by each major power plant located in the South Australia region of the Australian National Electricity Market (NEM). The NEM-Review program was used to tabulate the energy sent-out data in each of the 48 daily half hour trading periods in the NEM during the period from October 2008 to March 2009.

Visual inspection of the table of generation output data was used to identify the marginal power plant for the period between 1 pm and 5 pm on each day when the temperature with maximum temperatures of 30 degrees Celsius or more. The table showed which power plants had varying generation output during the selected time period. Ignoring must-run power plants, the plant with the most varied output was determined to be the marginal plant. Most power plants had steady generation output over the time period selected. Only plants with varying output would be backed off in response to load reductions resulting from the operation of the air conditioner cycling program.

When the marginal power plant changed during the 1 pm to 5 pm time period, the marginal plant was deemed to be the plant that was on the margin for the longest proportion of the period.

The electrical energy (MWh) displaced by the air conditioner cycling program was calculated by multiplying the load reduction of 2.2 MVA by 4.0, representing the four hours between 1 pm and 5 pm. The product of this calculation was then multiplied by the emissions factor (tCO2-e/MWh) for the marginal power plant to give the daily emissions reductions achieved by the project.

TIMING OF LOAD/EMISSIONS REDUCTION

Cycling of air conditioners was assumed to occur between 1 pm and 5 pm, on all hot days with maximum temperatures of 30 degrees Celsius or more.

AVOIDED COSTS

ACTUAL PROJECT COSTS

PROJECT COST FROM THE SOCIETAL PERSPECTIVE

ASSESSMENT OF OVERALL PROJECT EFFECTIVENESS

PROJECT INFORMATION RESOURCES

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DSM-AU02 DRUMMOYNE DEMAND MANAGEMENT PROGRAM

Last updated	29 October 2010
Location of Project	Drummoyne, a suburb of Sydney, Australia
Year Project Implemented	2006
Year Project Completed	2006
Name of Project Proponent	EnergyAustralia Network
Name of Project Implementor	EnergyAustralia Network and Low Energy Supply and Services Pty Ltd
Type of Project Implementor	Electricity distribution (wires) business ESCO/Energy management company
Purpose of Project	Deferring augmentation of the electricity network
Project Objective	Reducing peak loads
Project Target	Network element (eg a specific line or substation)
DSM Measure(s) Used	Energy efficiency
Specific Technology Used	Compact fluorescent lamps
Market Segments Addressed	Residential electricity end users Commercial and small industrial electricity end users

REGULATORY REGIME

At the time this project was carried out, EnergyAustralia was a holding company for two businesses, an electricity retailer and an electricity distribution business. The two businesses were ring-fenced so that they operated independently.

The distribution business, EnergyAustralia Network, operated one of the leading electricity networks in Australia, distributing electricity to the Sydney, Central Coast and Hunter regions of the State of New South Wales within a 22,275 square kilometre radius.

At the time, electricity distributors in New South Wales were regulated mainly by a State-based regulator, the Independent Pricing and Regulatory Tribunal (IPART).

In determining the new regulatory framework for 2004 to 2009, IPART aimed to ensure that regulatory barriers to demand management were removed, and to neutralise the potential disincentive for demand management created by a change from revenue regulation to a weighted average price cap form of regulation (which links revenue to volumes sold). IPART decided that it would introduce a D-factor into the weighted average price cap control formula that allowed electricity distributors to recover:

- approved non-tariff-based demand management implementation costs, up to a maximum value equivalent to the expected avoided distribution costs;
- approved tariff-based demand management implementation costs;
- approved revenue foregone as a result of non-tariff-based demand management activities.

IPART also decided to treat electricity distributor rebates and payments for load reduction as negative prices under the weighted average price cap.

In addition, electricity distributors in New South Wales are subject to a Code of Practice on Demand Management. Distributors must take the Code into account in the development and implementation of their network management plans. In particular, the network management plan must specify where it or its implementation departs from the provisions of the Code and, if so, what arrangements are in place to ensure an equal or better outcome.

The Code requires electricity distributors in New South Wales to:

- publish information that makes transparent the underlying assumptions and decision-making process relating to investments that expand their distribution networks;
- publish detailed information regarding the need for network expansion in a way that enables interested parties to identify likely locations of forthcoming constraints;
- use a formal process to determine whether demand management investigations are warranted for identified emerging constraints, and publish the results;
- carry out demand management investigations that provide opportunities for market participation;
- analyse demand management and network expansion options on an equal basis according to the published methodology and assumptions and publish the result of those determinations;
- implement demand management options where they are determined to be cost effective; and
- prepare and publish reports on these activities annually.

DRIVERS FOR PROJECT

Drummoyne is a suburb in the inner west of Sydney, in New South Wales, located six kilometres west of the Sydney central business district. Drummoyne is mostly residential with some commercial developments, and still retains some of its industrial heritage.

EnergyAustralia's objective for the Drummoyne demand management project was to implement DSM measures that would maintain network performance at the required level at a lower cost than investing AUD4 million for an additional transformer at the Drummoyne zone substation.

The Drummoyne zone substation comprised two 45MVA 132/11kV transformers and was supplied at 132kV from two subtransmission substations. The capacity limits of the substation were 66.6 MVA in summer and 72 MVA in winter.

Peak demand in the Drummoyne area had grown steadily. Loads were growing more rapidly in summer than in winter, but off a lower base. Figure 1 (page 25) shows actual and forecast winter / summer peak load in the Drummoyne area, the loading limits and the expected demand growth. Peak demand was forecast to exceed the capacity limit by 0.5MVA in the winter of 2008 unless action was taken to increase capacity or reduce demand. The forecast summer peak demand indicated no overload issue during the summer in the foreseeable future.

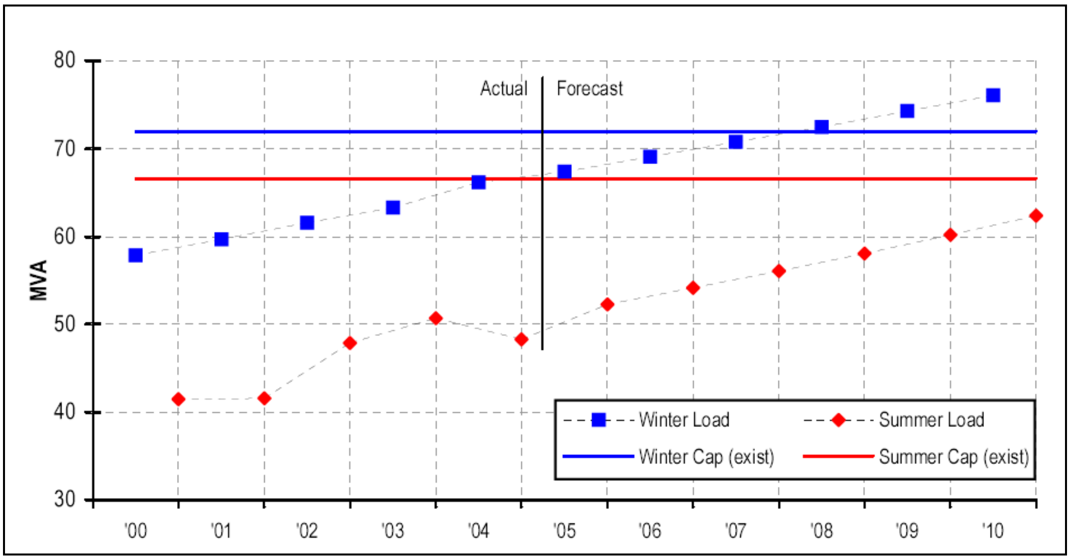

Figure 1. Forecasted and Expected Peak Demand and Actual Supply Capacity in the Drummoyne Area

Based on the load profiles, the key drivers for load growth appeared to be a mix of residential loads and a sizeable proportion of retail or commercial load. The area had experienced steady load growth in the years prior to 2005 that might be attributable to new residential development and multi-unit residential construction.

Figure 2 shows the electrical load profile of the Drummoyne zone substation on 19 July 2004 - a typical winter peak day. The winter peak demand usually occurred on weekday evenings between 6:00 and 9:30 pm. The peak demand on this day was 66.3MVA. The red line in Figure 2 represents the acceptable winter loading limit for the substation.

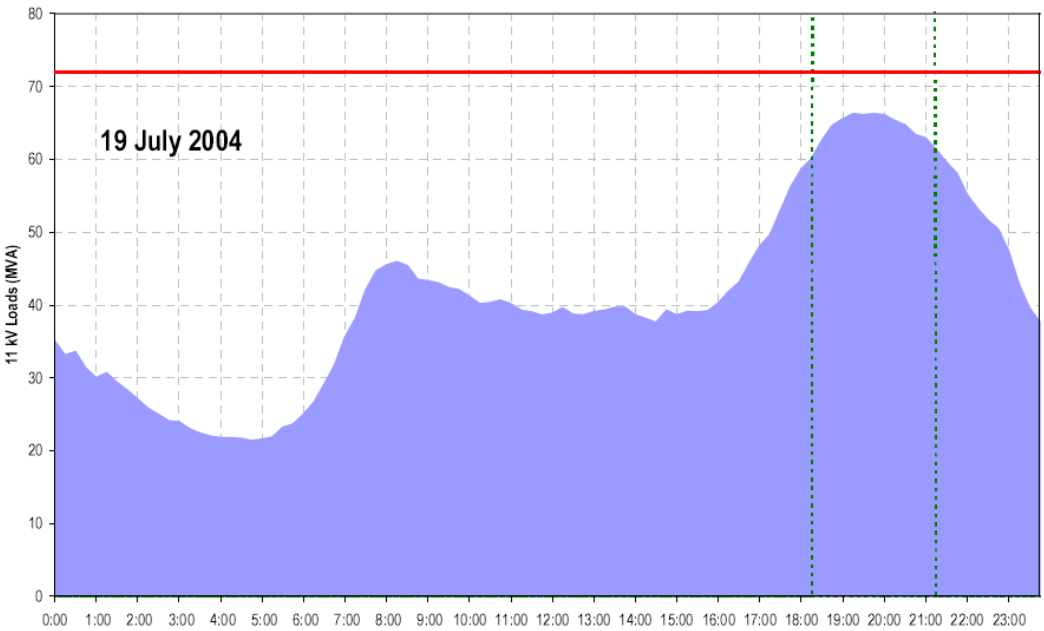

Figure 2. Typical Winter Load Profile at Drummoyne Zone Substation

Figure 3 shows the electrical load profile of the zone substation on 8 February 2005 - a typical summer peak day. Summer peak demand usually occurred later in the evening as compared with a winter day – in this case 8:45pm. The peak demand on this day was 48.3MVA. The red line in Figure 3 represents the acceptable summer loading limit for the substation.

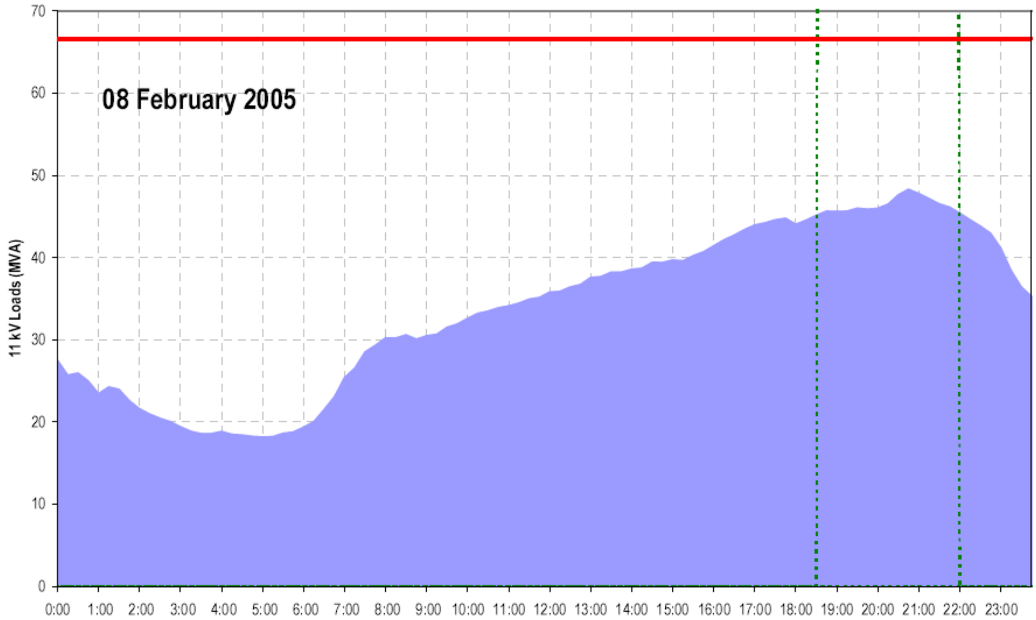

Figure 3. Typical Summer Load Profile at Drummoyne Zone Substation

Both winter and summer peak loads occurred relatively infrequently and were of short duration. In winter 2004, the top 5% of load was reached on two separate days, lasting 0.5 and 2.5 hours (totalling three hours). In summer 2004/05, the top 5% of load was also reached on two separate days, lasting 1.5 and 2.5 hours (totalling four hours).

The preferred supply side solution was to install a third transformer in the Drummoyne zone substation and extend the 11kV switchboard at an estimated cost of AUD4 million. A final decision to proceed would need to be made before the end of 2006 to enable the installation to be completed before winter 2008.

To defer this investment by one year (that is until 2009), EnergyAustralia would need to implement demand reductions totalling 500kVA prior to winter 2008. Because a decision had to be made by late 2006, EnergyAustralia would also need to be confident before then that the demand reductions were going to be delivered in time.

Further deferral would require a 2.3MVA reduction in peak demand before winter 2009 and a 3.7MVA reduction before winter 2010. All demand reductions would have to be effective on winter evenings.

In assessing the cost effectiveness of options, the cost to EnergyAustralia of the DSM options was compared to the value of the avoided costs from the change in timing of supply side expenditure. This provided a broad indication of the level of funding that might be available for a portfolio of DSM projects. However, the determination of cost effectiveness is complex and the value EnergyAustralia assigned to individual projects might be higher or lower than this figure.

The value of avoided costs at various levels of demand reduction is shown in Figure 4. A 0.5MVA reduction would enable a one year deferral and have a value of about AUD280,000 or AUD550/kVA (2005 values). For a two year deferral, the value rose to about AUD540,000, but significantly larger demand reductions would be required and the relative value reduced to approximately AUD220/kVA. To be considered cost effective, the overall cost to EnergyAustralia of the required portfolio DSM options had to be below these amounts.

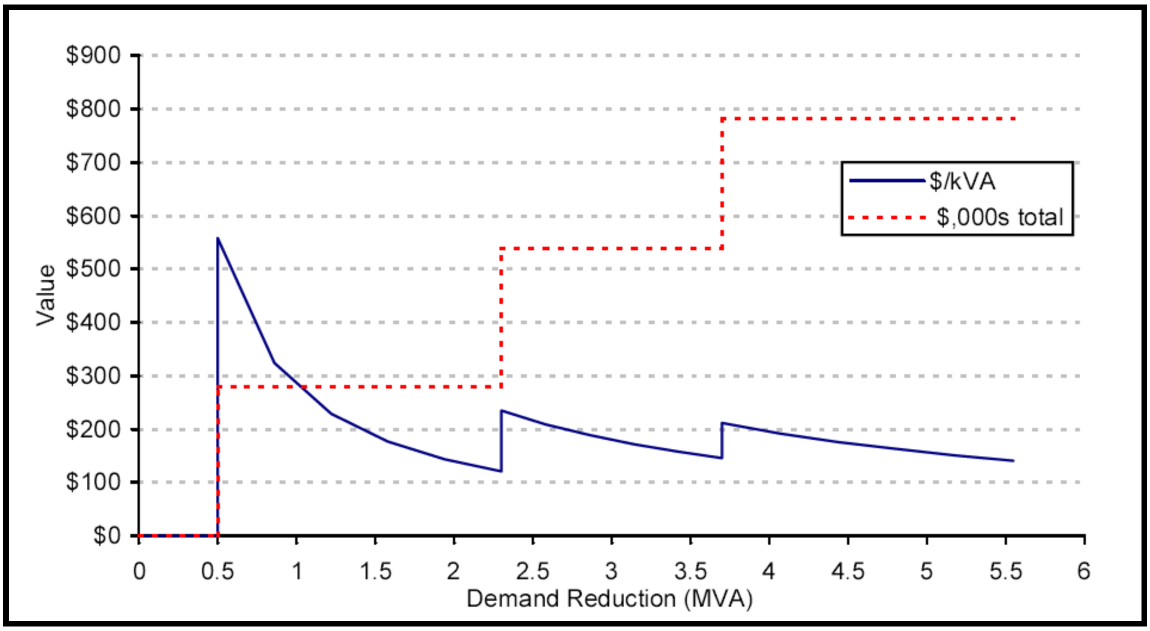

Figure 4. Value of Avoided Distribution Costs for Various Levels of Demand Reduction

DESCRIPTION OF PROJECT

Investigation of DSM Options

EnergyAustralia's overall investigation approach identified potentially cost-effective DSM options, analysed each of the options and their potential impact and cost, and then shortlisted the options that might form feasible DSM projects. The most cost-effective DSM options were then developed further and compared with the supply-side solution.

EnergyAustralia prepared a Demand Management Options Consultation Paper seeking proposals for DSM options capable of contributing to deferring the construction of a new transformer at Drummoyne zone substation. The consultation paper was advertised in July 2005 in newspapers and on EnergyAustralia's website. Notifications were also sent to parties in the EnergyAustralia register of organisations interested in DSM. Nine submissions were received.

In addition, EnergyAustralia identified 20 major customers in the Drummoyne area, based on their peak demands, visited their sites and collected information about their usage of energy and possible DSM options.

Using these various sources and information from experience in other areas, EnergyAustralia assembled a list of DSM options for analysis. Each of the options was assessed in relation to the likely size of demand reduction that would result at the time of network peak at the Drummoyne zone substation. The cost to EnergyAustralia of establishing and utilising each option at this level for varying periods of availability from one to three years was also estimated. Based on these estimates, EnergyAustralia ranked the options and compared them to the value of deferring the proposed investment.

Eight possible DSM options were identified:

- contracting with customers who had standby diesel generators to enable the use of the generators to provide short period demand reduction when required;
- installation of power factor correction equipment at customers' premises;
- installation of fixed dimming systems for commercial lighting;
- upgrading of commercial lighting systems using retrofitted efficient lighting kits;
- peak load control by advanced control system;
- peak demand reduction by using advanced residential metering and control devices;
- residential compact fluorescent lamp (CFL) direct distribution program;
- installation of thermal storage systems.

Table 1 summarises the estimated size and cost of each identified DSM option.

Table 1. DSM Options Identified in the Drummoyne Demand Management Project

DSM Options	Winter Peak Load Reduction	Total Cost to EA (SNPV)	Cost to EA ($/kVA)	No of Customers Involved	Time for Implementation
Ice storage system	40kVA	–	–	1	1 to 2 years
Power factor correction	66kVA	AUD9,400	AUD142	5	1 to 2 years
Residential CFL program Proposal 1	1,052kVA	AUD180,000	AUD171	10,000	1 to 2 years
Residential CFL program Proposal 2	1,165kVA	AUD295,000	AUD253	12,500	1 to 2 years
Peak load control by advanced control system	234kVA	AUD44,000 to AUD89,000	AUD187 to AUD380	3	1 to 2 years
Standby diesel generator	170kVA	AUD67,000	AUD394	1	1 to 2 years
Combined demand reduction projects	600kVA	AUD238,000	AUD398	2,226	1 to 2 years
Fixed dimming for lighting system	175kVA	AUD87,500	AUD500	17	1 to 2 years
Installation of Cent-a-Meter energy monitoring device	712kVA	AUD706,000	AUD992	9,410	1 to 2 years
Upgrade of lighting system	106kVA	AUD123,700	AUD1,166	11	1 to 2 years

Figure 5 compares the cost and demand reduction impact of the identified DSM options with the value of avoided distribution costs. Stacking the options from lowest relative cost to highest showed that sufficient demand reduction to achieve a one year deferral could be identified at a lower cost than the value of the avoided costs. However, a two year deferral would be unlikely to be cost effective.

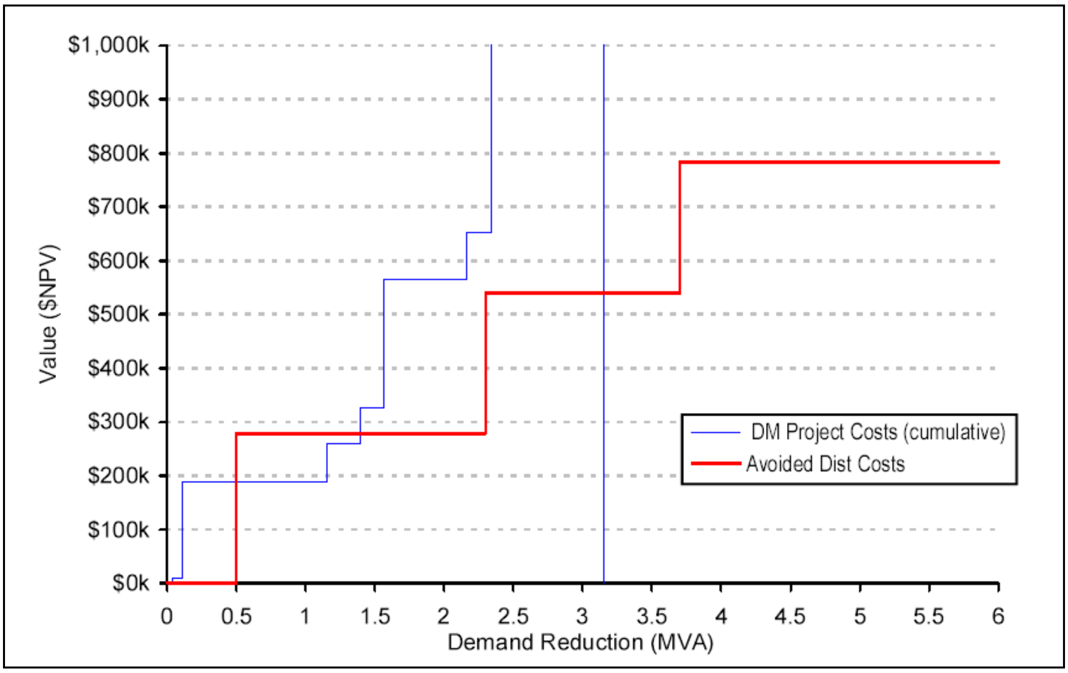

Figure 5. Cost and Demand Reduction Impact of DSM Options Compared with the Value of Avoided Distribution Costs

Figure 5 suggests that all demand reductions would be cumulative. However, because several of the identified DSM options targeted the same opportunities, some demand reductions would not be cumulative. Therefore, achieving sufficient demand reductions for a two year deferral would be more difficult and more expensive than Figure 5 indicates.

On the basis of this analysis, the power factor correction project and the first of the CFL proposals appeared likely to be cost effective. The CFL project was selected for implementation.

Installation of CFLs

Mass distributions of CFLs to households had become common in the State of New South Wales as a way of creating tradeable emission abatement certificates under a State-wide emission trading scheme. However, in the Drummoyne project, the distribution of CFLs was much more closely targeted and monitored to ensure that the lamps were actually installed.

The project was initiated by EnergyAustralia's network business rather than by its retailer arm, even though the abatement certificates generated were used by the retail business to help meet its obligations under the New South Wales emission trading scheme.

The CFL installations were carried out by a third party contractor who had proposed the measure in response to EnergyAustralia's Demand Management Options Consultation Paper.

The CFL project commenced with an advertising campaign in the target area that involved local municipal councils. Marketing activities were employed to promote the program, including posters sent to local businesses, letterbox drops, calling cards, outdoor banners, press advertisements and targeted media reactions.

High power factor, 15 watt CFLs were packaged in boxes of five for distribution to households in the target area. Each household was given one box of five CFLs and these were installed free of charge. Door-to-door delivery and installation were carried out during specific times and days to maximise the number of people at home.

For each box of CFLs delivered, delivery staff completed forms that included the householders' names, addresses and signatures plus answers to a short survey. The signed forms provided verification of the number of boxes of CFLs distributed. For households where no one was home, a flyer containing project information and a mail order form was left at the house. A follow-up phone survey was conducted during the delivery period to assess how many CFLs were actually installed.

RESULTS

Residential Customers Participating	Commercial and Small Industrial Customers Participating		Agricultural Customers Participating	Large Industrial Customers Participatin g	Additional Generation Installed
5,747	118				
Peak Load	**Peak Load Reduction**	**Duration of Peak Load Reduction**	**Overall Load Reduction**	**Energy Savings**	**Greenhouse Emissions Reduction**
0.9 MVA					786.2 tC02-e

The overall penetration rate for the installation of CFLs was about 26.1%. The project installed 81,347 CFLs in 5,865 properties and achieved an estimated 0.9 MVA reduction in winter evening peak demand (153 VA per household).

HOW LOAD REDUCTION WAS MEASURED

Based on analysing SCADA data in Drummoyne, it was estimated that the winter peak demand reduction was 0.9 MVA at 9 pm.

HOW GREENHOUSE EMISSIONS REDUCTION WAS CALCULATED

The example calculation of the emissions reduction achieved by the Drummoyne Demand Management Program was carried out for the 12 months between October 2008 and September 2009. We assumed that lighting was switched on for two hours a day (8.00 to 10.00 pm) from October to March ("summer") and for 3.5 hours a day (6.30 pm to 10.00 pm) from April to September ("winter"). We also assumed that the load reduction from the use of CFLs during these periods was 0.9 MVA (as reported by EnergyAustralia).

The calculation of emissions reductions was based on the Marginal Historical Emissions method, modified to work with the available data. Historical data were obtained of the electrical energy (MWh) sent out daily by each major power plant located in the New South Wales region of the Australian National Electricity Market (NEM). The NEM-Review program was used to tabulate the energy sent out data in each of the 48 daily half hour trading periods in the NEM during the 12 months between October 2008 and September 2009.

Visual inspection of the table of generation output data was used to identify the marginal power plant each day for the periods between 8.00 and 10.00 pm from October to March and between 6.30 pm and 10.00 pm from April to September. The table showed which power plants had varying generation output during the selected time periods. Ignoring must-run power plants, the plant with the most varied output was determined to be the marginal plant. Most power plants had steady generation output over the time periods selected. Only plants with varying output would be backed off in response to load reductions resulting from the operation of the Drummoyne Demand Management Program.

When the marginal power plant changed during a selected time period, the marginal plant was deemed to be the plant that was on the margin for the longest proportion of the period.

The electrical energy (MWh) displaced by the Drummoyne Demand Management Program was calculated by multiplying the load reduction of 0.9 MVA by 2.0 in "summer" and 3.5 in "winter", representing the number of hours the lights were switched on. The product of this calculation was then multiplied by the emissions factor (tCO2-e/MWh) for the marginal power plant to give the daily emissions reductions achieved by the program.

TIMING OF LOAD/EMISSIONS REDUCTION

We assumed that lighting was switched on for two hours a day (8.00 to 10.00 pm) from October to March (“summer”) and for 3.5 hours a day (6.30 pm to 10.00 pm) from April to September (“winter”).

AVOIDED COSTS

ACTUAL PROJECT COSTS

The total cost of the program to EnergyAustralia was AUD315,254 at an average cost of AUD350/kVA load reduction, including AUD305/kVA as the cost of the external contractor and AUD45/kVA as the cost of internal project management by EnergyAustralia.

PROJECT COST FROM THE SOCIETAL PERSPECTIVE

ASSESSMENT OF OVERALL PROJECT EFFECTIVENESS

PROJECT INFORMATION RESOURCES

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Sources

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DSM-AU03 BINDA-BIGGA DEMAND MANAGEMENT PROJECT

Last updated	30 October 2010
Location of Project	The rural communities of Binda and Bigga near Crookwell in New South Wales, Australia
Year Project Implemented	2004
Year Project Completed	2005
Name of Project Proponent	Country Energy Network
Name of Project Implementor	New South Wales Sustainable Energy Development Authority (now the Department of Environment, Climate Change and Water)
Type of Project Implementor	State or federal government agency
Purpose of Project	Deferring augmentation of the electricity network
Project Objective	Reducing peak loads Regulating system voltage and/or frequency
Project Target	Network element (eg a specific line or substation)
DSM Measure(s) Used	Energy efficiency Fuel substitution
Specific Technology Used	Fuel substitution of residential appliances from electricity to bottled gas
Market Segments Addressed	Residential electricity end users

REGULATORY REGIME

The implementor for this project, the Sustainable Energy Development Authority (SEDA), was established in 1996 by the State Government of New South Wales, with a mandate to reduce greenhouse gas emissions through promoting energy efficiency and increased use of renewable energy. SEDA operated as an independent government agency until 2004 when it was merged with another New South Wales Government department.

At the time this project was carried out, the project proponent, Country Energy, was the holding company for two businesses as the owner and operator of an electricity distribution network and as a retailer of electricity, natural gas, bottled gas and water. The two businesses were ring-fenced from each other and carry out their functions independently.

The electricity distribution business, Country Energy Network manages Australia's largest energy supply network in regional and rural areas across 95 per cent of the State of New South Wales, serving around 870,000 customers.

At the time, electricity distributors in New South Wales were regulated mainly by a State-based regulator, the Independent Pricing and Regulatory Tribunal (IPART).

In determining the new regulatory framework for 2004 to 2009, IPART aimed to ensure that regulatory barriers to demand management were removed, and to neutralise the potential disincentive for demand management created by a change from revenue regulation to a weighted average price cap form of regulation (which links revenue to volumes sold). IPART decided that it would introduce a D-factor into the weighted average price cap control formula that allowed electricity distributors to recover:

- approved non-tariff-based demand management implementation costs, up to a maximum value equivalent to the expected avoided distribution costs;
- approved tariff-based demand management implementation costs;
- approved revenue foregone as a result of non-tariff-based demand management activities.

IPART also decided to treat electricity distributor rebates and payments for load reduction as negative prices under the weighted average price cap.

In addition, electricity distributors in New South Wales are subject to a Code of Practice on Demand Management. Distributors must take the Code into account in the development and implementation of their network management plans. In particular, the network management plan must specify where it or its implementation departs from the provisions of the Code and, if so, what arrangements are in place to ensure an equal or better outcome.

The Code requires electricity distributors in New South Wales to:

- publish information that makes transparent the underlying assumptions and decision-making process relating to investments that expand their distribution networks;
- publish detailed information regarding the need for network expansion in a way that enables interested parties to identify likely locations of forthcoming constraints;
- use a formal process to determine whether demand management investigations are warranted for identified emerging constraints, and publish the results;
- carry out demand management investigations that provide opportunities for market participation;
- analyse demand management and network expansion options on an equal basis according to the published methodology and assumptions and publish the result of those determinations;
- implement demand management options where they are determined to be cost effective; and
- prepare and publish reports on these activities annually.

DRIVERS FOR PROJECT

Binda and Bigga are two small rural settlements near Crookwell about 230 km south-west of Sydney. The Binda-Bigga area has about 250 electricity customers, mostly residential.

The electricity line that runs from Binda to Bigga and then further on to Grabine was installed by Country Energy several years prior to 2004. Overall load growth on the line was relatively low but, as peak electricity use increased in the area, the line was reaching its maximum capacity. The base electrical load used for the line was 750kVA, however peak demand had been registered at 1,000kVA.

Fault levels and voltage levels were a concern along the line, especially during storm events, due to the length of the line and the rugged country through which the line passes. Many customers in Binda and Bigga were experiencing unacceptable voltage fluctuations which could be resolved only by extensive reconductoring of the line.

Country Energy contracted SEDA in 2004 to relieve the electrical demand on the Crookwell to Grabine feeder during times of winter evening peaks. The aim of the contract was to defer the need for the upgrade of the Crookwell to Grabine feeder by reducing the demand for energy during the winter evening peak periods (the four hours from 6 pm to 10 pm).

DESCRIPTION OF PROJECT

Initial Investigation

There were two winter peaks on the Crookwell to Grabine feeder, one around midnight due to off-peak hot water controlled loads and an evening peak (see Figure 1). The evening peak tended to occur on days when the minimum temperature dropped as low as minus 9 degrees Celsius.

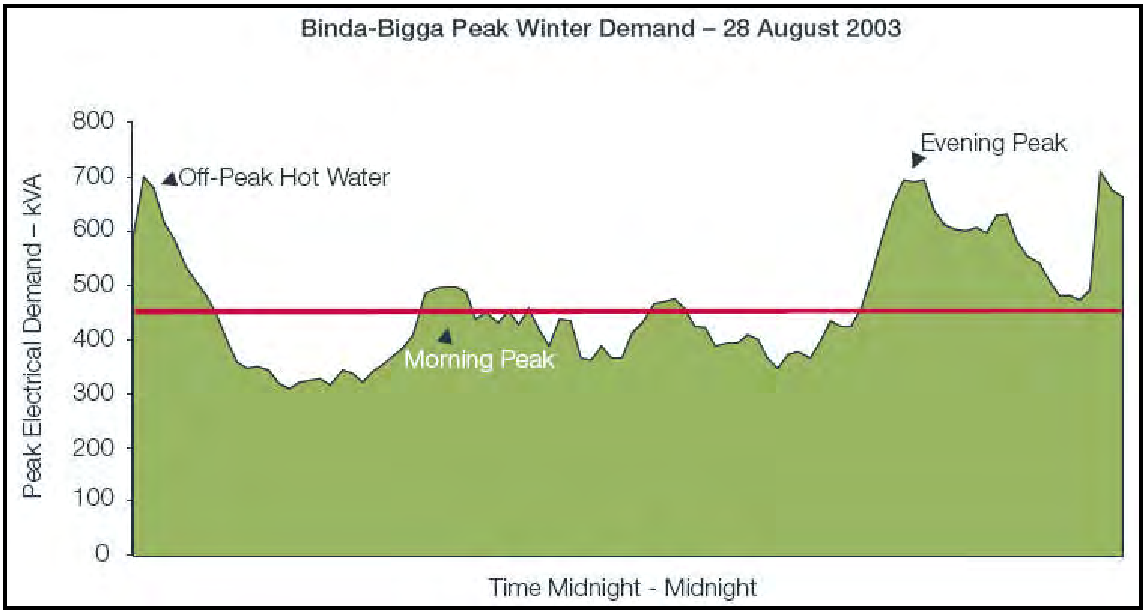

Figure 1. Peak Winter Demand on the Crookwell to Grabine Feeder

In January 2004, SEDA conducted a survey of Binda and Bigga residents to explore what might have been causing the peaks in electricity demand during winter evenings. Results showed that a typical winter energy bill was over AUD 250 each quarter – a large percentage due to room heating and cooking end-uses.

Project Objectives

The following objectives were established for the project:

- to reduce the electricity load on Country Energy's Crookwell to Grabine feeder by 200kVA by 2006 during winter evening peaks (the four hours from 6 pm to 10 pm);
- to deliver real benefits to rural customers through reducing their energy consumption and improving the quality of supply for residents on the Crookwell to Grabine feeder;
- to reduce greenhouse gas emissions through fuel substitution of electric appliances to gas.

DSM Strategies

Two DSM strategies were investigated:

- **Cogeneration Option:** the installation of a cogeneration plant at the Grabine State Recreation Park to achieve a reduction of 100kVA in peak electrical demand; and
- **Domestic Solution:** a range of strategies to facilitate the uptake of energy efficient products and measures, primarily achieved through fuel substitution of residential appliances from electricity to bottled gas to achieve a reduction of another 100kVA in peak electrical demand.

After an initial investigation, the Cogeneration Option proved uneconomic, so the Domestic Solution was the method by which the total required demand reduction of 200kVA was sought.

The Domestic Solution facilitated the uptake of energy efficient products and measures by residents through a range of residential DSM strategies. It integrated the following strategies:

- developing an Energy Saver Package;
- engaging local project partners;
- offering Energy Smart Home audits;
- implementing marketing and communications campaigns; and
- holding community forums in Binda and Bigga.

Energy Saver Package

The Energy Saver Package was developed as the primary mechanism to achieve the required demand management reduction of 200kVA. To reduce the demand on the electricity feeder during the peak time, the Package was structured around appliances that would reduce electricity demand from residents cooking an evening meal and heating their homes.

The Energy Saver Package enabled residents to affordably switch from electric to gas appliances (see Figure 2, page 37). It offered residents:

- discounted gas room heaters and cooking stoves (a maximum of two appliances per household);
- free installation of gas appliances and gas bottles, and removal of electrical appliances for metal recycling; and
- gas credits of AUD 170 per appliance – equivalent to free gas for a year.

To achieve the peak demand reduction target of 200kVA, the installation of 98 gas appliances was required.

Customers were required to meet a number of conditions to qualify for the Energy Saver Package. They had to:

- be connected to the Crookwell to Grabine Feeder, and be a Country Energy customer;
- agree to surrender their electric heaters and stoves at the time of installation of the new gas appliances;

- commit to leaving gas appliances installed and operational for a period of 5 years; and
- submit signed a Customer Form and payment by 30 September 2004 (extended to 31 October 2004).

Appliance	Rec. Retail Price	Price in Energy Saver Package (excl. GST)	Saving to the customer
Rinnai Granada (unflued heater)	$899	$250	$649
Rinnai EnergySaver (flued heater)	$1,699	$1,000	$699
Chef Stove	$699	$250	$449
Rinnai Granada + Chef Stove	$1,598	$470	$1,128
Rinnai EnergySaver + Chef Stove	$2,398	$1,200	$1,198

Figure 2. Cost of Gas Appliances Offered in the Energy Saver Package

The Energy Saver Package was designed to be easy for residents. The new gas appliances were delivered to the customers' homes and the appliances and gas bottles were installed. The old electric appliances were removed during the same visit and taken for recycling.

Energy Smart Home Audits

Energy Smart Home audits were offered to residents in Binda and Bigga to facilitate the uptake of energy efficient products and measures. The audits also provided the opportunity for residents to have assessed the suitability of their home/appliances for the gas appliance offer.

The three components of an Energy Smart Home audit comprise a Star Rating, a virtual home audit and a personal visit from an Energy Assessor. The audit provides a measure of energy efficiency for a home by comparing its rating to an average. The result is a star rating between 1 and 5, with 5 being the most energy efficient. Moving up just one star can save AUD 150-300 per annum.

Residents were offered an Energy Smart Home audit for AUD 20, rather than the normal AUD 100, and the cost of the audit was redeemable against the purchase of a gas heater or stove (as part of the Energy Saver Package).

Marketing and Communications

The Energy Saver Package was promoted to residents through a brochure and poster detailing the Energy Saver Package options, advertising two community forums for residents and providing information on Energy Smart Home audits.

Two free community forums were held in Binda and Bigga. Topics covered included:

- the Energy Saver Package;
- Energy Smart Home audits;
- Green Power – electricity generated from renewable sources; and
- tips on saving energy around the home and reducing bills.

The Project Team was on hand to provide additional information on the Energy Saver Package products, gas connections and installations. Gas appliances were on display for residents to view the products included in the Package. Energy efficient prizes were on offer at the forums, including Energy Saver kits which featured a compact fluorescent light bulb, door snake, AAA-rated showerhead and toilet cistern weight.

Finally, a competition was held in which residents could win one of two solar hot water systems. All residents who purchased and qualified for an Energy Saver Package were entered into the competition.

RESULTS

Residential Customers Participating	Commercial and Small Industrial Customers Participating		Agricultural Customers Participating	Large Industrial Customers Participating	Additional Generation Installed
70					
Peak Load	**Peak Load Reduction**	**Duration of Peak Load Reduction**	**Overall Load Reduction**	**Energy Savings**	**Greenhouse Emissions Reduction**
	0.2 MW	4 hours	0.2 MW		54.6 tC02-e

Overall 70 customers purchased an Energy Saver Package, purchasing 106 appliances in total, between July and October 2004. This exceeded the target of 98 appliances and included:

- 60 unflued room heaters (56%);
- 42 cooking stoves (40%); and
- 4 flued room heaters (4%).

Of the 70 Energy Saver Packages purchased, the most popular package was the "unflued room heater + cooking stove package" (34 customers), followed by the sole purchase of an unflued heater (26 customers)(see Figure 3, page 39).

Only 17 customers were already connected to a bottled gas supply with 53 customers requiring gas connection including slab, bottle delivery, piping and wiring.

A total of 106 electric heaters and stoves (64 room heaters and 42 cooking stoves) were removed and recycled at the metal recycling facility at Crookwell Waste and Recycling Centre.

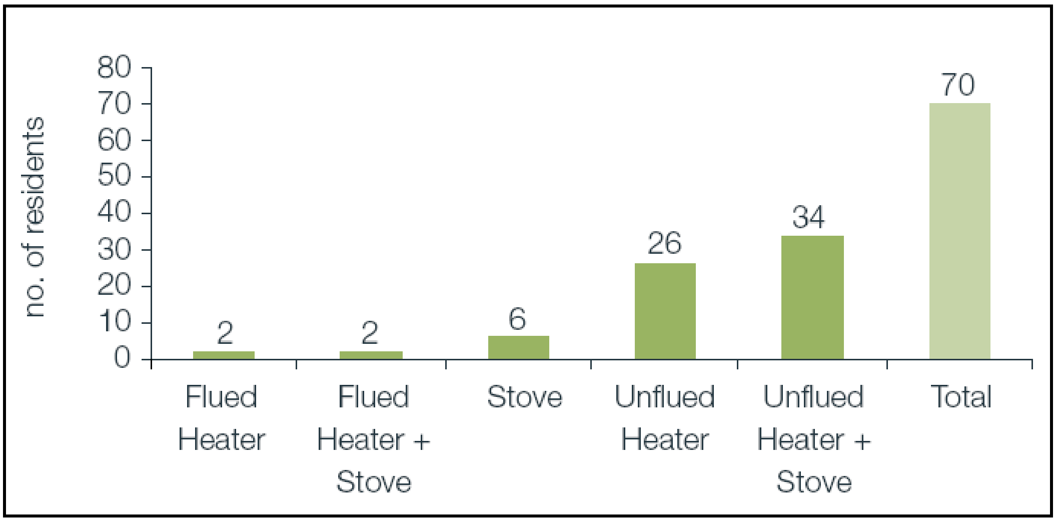

Figure 3. Type of Energy Saver Package Purchased

In the week of the 19th to 23rd July 2004, 13 Energy Smart Home audits were conducted, as well as a further six visits to homes to assess suitability of gas appliances being installed if residents purchased an Energy Saver Package. Residents at 16 of the 19 properties visited purchased the Energy Saver Package offer.

Country Energy estimated that the average electricity usage of households in the Binda-Bigga area was 4kWh per day for room heating and 3 kWh per day for cooking. The total electricity use by the households who converted to gas appliances was 188 kWh per day for room heating and 90 kWh per day for cooking.

Figure 4 shows the reduction in the peak load on the Crookwell to Grabine feeder after implementation of the Binda-Bigga Demand Management Project.

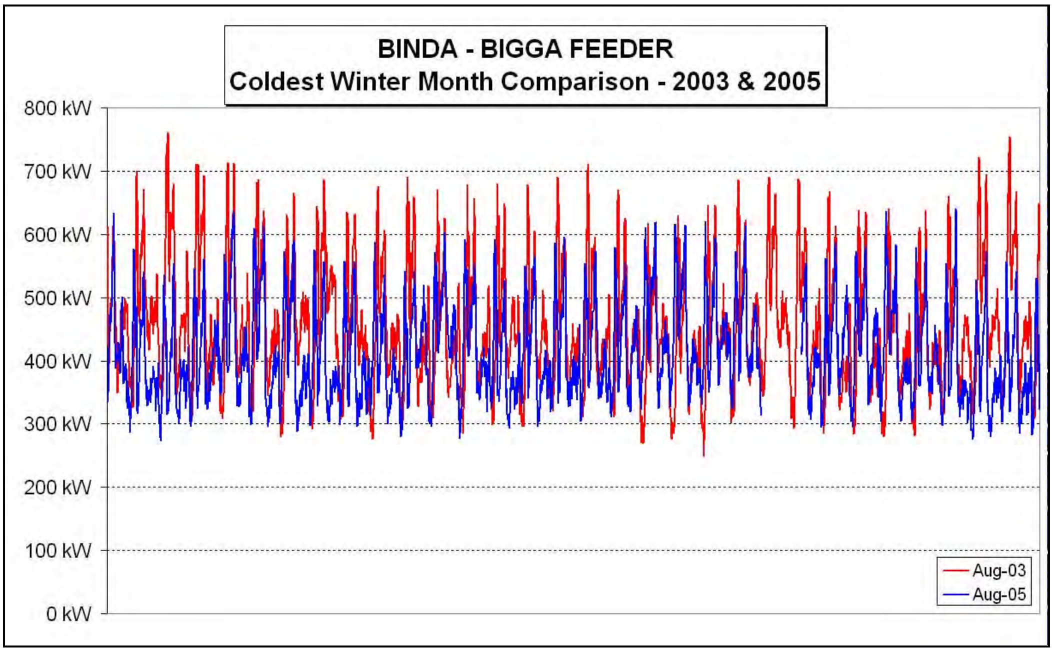

Figure 4. Load on the Crookwell to Grabine Feeder Before and After Implementation of the Bigga-Bigga Demand Management Project

HOW LOAD REDUCTION WAS MEASURED

Recloser logs

HOW GREENHOUSE EMISSIONS REDUCTION WAS CALCULATED

The example calculation of the emissions reduction achieved by the Binda-Bigga Demand Management Project was carried out for the 12 months between October 2008 and September 2009.

We assumed that the 30 households who switched from electrical to gas cookers spent 30 minutes every day cooking their evening meal between 6.30 and 7.00 pm. The total electricity use for cooking by these households was 90 kWh per day. We also assumed that the 47 households who switched from electrical to gas room heaters used room heating for two hours between 8.00 pm and 10.00 pm during September to March ("summer") and for four hours between 6.00 pm and 10.00 pm during April to September ("winter"). Heating was required in summer because the Binda-Bigga area is at an elevation of about 650 metres in Australia's Great Dividing Range. Minimum temperatures at night are quite low, seldom exceeding 18ºC even in the middle of summer.

We further assumed that the electricity usage by these households for room heating was 2 kWh per household per day in "summer" (a total of 94 kWh per day) and 4 kWh per household per day in "winter" (a total of 188 kWh per day).

The emissions reduction achieved by Binda-Bigga Demand Management Project was estimated by first calculating the total emissions that would be released by the households using electrical appliances for cooking and room heating. Then the total emissions released by the same households using gas appliances for cooking and room heating were calculated. The total emissions reduction achieved by the project was then the difference between these two figures.

The calculation of emissions released by the households using electrical appliances for cooking and room heating was based on the Marginal Historical Emissions method, modified to work with the available data. Historical data were obtained of the electrical energy (MWh) sent out daily by each major power plant located in the New South Wales region of the Australian National Electricity Market (NEM). The NEM-Review program was used to tabulate the energy sent out data in each of the 48 daily half hour trading periods in the NEM during the 12 months between October 2008 and September 2009.

Visual inspection of the table of generation output data was used to identify the marginal power plant each day for the relevant time periods. The table showed which power plants had varying generation output during the selected time periods. Ignoring must-run power plants, the plant with the most varied output was determined to be the marginal plant. Most power plants had steady generation output over the time periods selected. Only plants with varying output would be backed off in response to load reductions resulting from the operation of the Binda-Bigga Demand Management Project.

When the marginal power plant changed during a selected time period, the marginal plant was deemed to be the plant that was on the margin for the longest proportion of the period.

The total electrical energy (MWh) used for cooking and room heating over the relevant time periods was then multiplied by the emissions factor (tCO2-e/MWh) for the marginal power plant to give the daily emissions released from these end-uses.

The calculation of the total emissions released by the households using gas cookers and gas room heaters assumed that the same quantity of energy is used by the gas appliances as the electrical appliances: for cooking 90kWh per day of electricity = 0.324 GJ of gas; for room heating 94 kWh of electricity in "summer" = 0.3384 GJ of gas and 188 kWh of electricity in "winter" = 0.6768 GJ of gas).

The total quantity of gas (GJ) used for cooking and room heating over the relevant time periods was then multiplied by the emissions factor (tCO2-e/GJ) for LPG (bottled gas) to give the daily emissions released from these end-uses.

TIMING OF LOAD/EMISSIONS REDUCTION

We assumed that the 30 households who switched from electrical to gas cookers spent 30 minutes every day cooking their evening meal between 6.30 and 7.00 pm. The total electricity use for cooking by these households was 90 kWh per day. We also assumed that the 47 households who switched from electrical to gas room heaters used room heating for two hours between 8.00 pm and 10.00 pm during September to March ("summer") and for four hours between 6.00 pm and 10.00 pm during April to September ("winter").

AVOIDED COSTS

The network augmentation solution to these problems was estimated to cost AUD 412,500 over a 5 year period.

The DSM budget was AUD 108,000 (average rate of $540/kVA reduced). This represents the cost savings of deferring the investment for five years.

ACTUAL PROJECT COSTS

AUD 108,000 paid by Country Energy.

AUD 28,412 contribution by residents to cost of gas appliances.

PROJECT COST FROM THE SOCIETAL PERSPECTIVE

ASSESSMENT OF OVERALL PROJECT EFFECTIVENESS

The project achieved an extremely high take-up rate for fuel substitution.

PROJECT INFORMATION RESOURCES

Contacts

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Sources

Department of Energy, Utilities and Sustainability (2005). "Binda Bigga Demand Management Project: Case Study". Sydney, DEUS.

DSM-AU04 CASTLE HILL DEMAND MANAGEMENT PROGRAM

Last updated	2 November 2010
Location of Project	Castle Hill, a suburb of Sydney, Australia
Year Project Implemented	2003
Year Project Completed	2006
Name of Project Proponent	Integral Energy Network
Name of Project Implementor	New South Wales Sustainable Energy Development Authority (now the Department of Environment, Climate Change and Water)
Type of Project Implementor	State or federal government agency
Purpose of Project	Deferring augmentation of the electricity network
Project Objective	Reducing peak loads
Project Target	Network element (eg a specific line or substation)
DSM Measure(s) Used	Direct load control Distributed generation Energy efficiency Power factor correction
Specific Technology Used	Integrated project using a range of technologies
Market Segments Addressed	Commercial and small industrial electricity end users

REGULATORY REGIME

The implementor for this project, the Sustainable Energy Development Authority (SEDA), was established in 1996 by the State Government of New South Wales, with a mandate to reduce greenhouse gas emissions through promoting energy efficiency and increased use of renewable energy. SEDA operated as an independent government agency until 2004 when it was merged with another New South Wales Government department.

At the time this project was carried out, the project proponent, Integral Energy was the holding company for two businesses as the owner and operator of an electricity distribution network and as an electricity retailer. The two businesses were ring-fenced from each other and carried out their functions independently.

Integral Energy Network distributes electricity to over 2.1 million people in households and businesses across 24,500 square kilometres of Greater Western Sydney, the Illawarra region and the Southern Highlands of New South Wales.

At the time, electricity distributors in New South Wales were regulated mainly by a State-based regulator, the Independent Pricing and Regulatory Tribunal (IPART).

In determining the new regulatory framework for 2004 to 2009, IPART aimed to ensure that regulatory barriers to demand management were removed, and to neutralise the potential disincentive for demand management created by a change from revenue regulation to a weighted average price cap form of regulation (which links revenue to volumes sold). IPART decided that it would introduce a D-factor into the weighted average price cap control formula that allowed electricity distributors to recover:

- approved non-tariff-based demand management implementation costs, up to a maximum value equivalent to the expected avoided distribution costs;
- approved tariff-based demand management implementation costs;
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IPART also decided to treat electricity distributor rebates and payments for load reduction as negative prices under the weighted average price cap.

In addition, electricity distributors in New South Wales are subject to a Code of Practice on Demand Management. Distributors must take the Code into account in the development and implementation of their network management plans. In particular, the network management plan must specify where it or its implementation departs from the provisions of the Code and, if so, what arrangements are in place to ensure an equal or better outcome.

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- publish detailed information regarding the need for network expansion in a way that enables interested parties to identify likely locations of forthcoming constraints;
- use a formal process to determine whether demand management investigations are warranted for identified emerging constraints, and publish the results;
- carry out demand management investigations that provide opportunities for market participation;
- analyse demand management and network expansion options on an equal basis according to the published methodology and assumptions and publish the result of those determinations;
- implement demand management options where they are determined to be cost effective; and
- prepare and publish reports on these activities annually.

DRIVERS FOR PROJECT

Castle Hill is a rapidly developing suburb located 32km north west of the Sydney central business district. At the time this project was carried out, the Castle Hill local electricity network had 5,320 residential customer connections and 679 business and community connections. Over the five years from 2000 to 2005, electricity consumption in Castle Hill increased by 32% and Integral Energy forecasts showed that this would grow by a further 54% over the subsequent 10 years.

Increasing penetration and use of air conditioners in the Castle Hill commercial centre and surrounding residential areas would result in summer peak loads exceeding system capability. In 2003, Integral Energy forecast it would need to spend AUD 3.2 million to expand the Castle Hill zone substation by summer 2005 because of continued rapid development of the Castle Hill district.

Peak demand in the Castle Hill area is primarily driven by use of domestic and commercial air-conditioning on hot summer days, particularly when there have been several days in a row with temperatures exceeding 35 degrees Celsius (see Figures 1 and 2, page 45). The effect of air conditioning on peak electricity use on a mild summer day versus a hot summer day is illustrated in Figure 3 (page 46). Figure 4 (page 46) shows the forecast growth in demand on the Castle Hill zone substation.

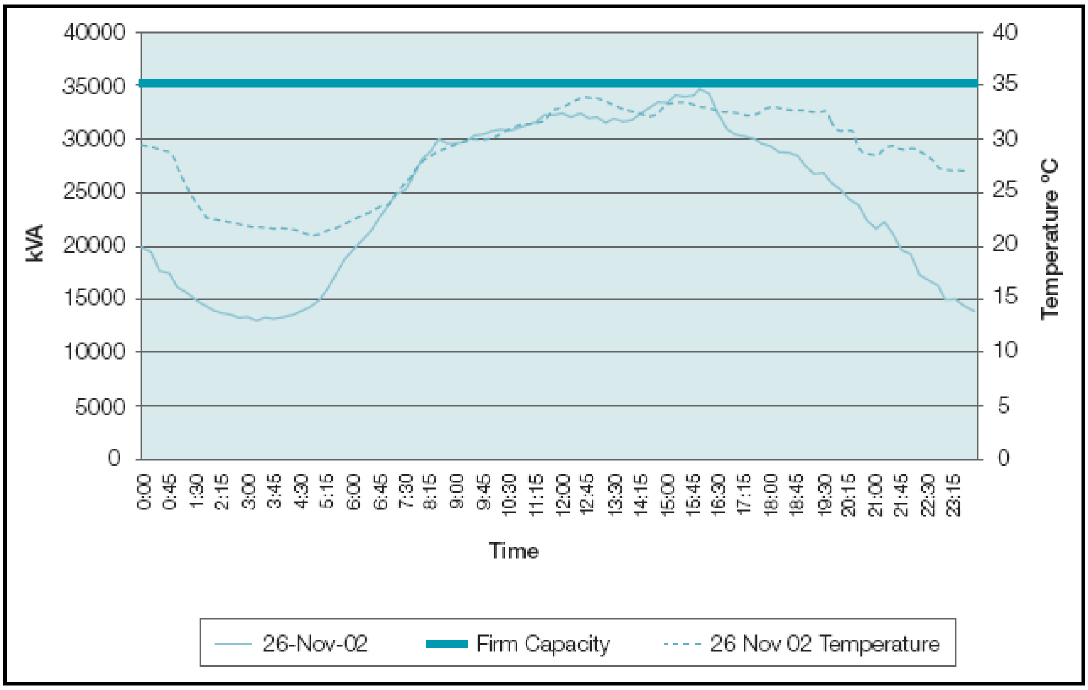

Figure 1. Castle Hill Zone Substation Profile on a 35 Degrees Celsius Day

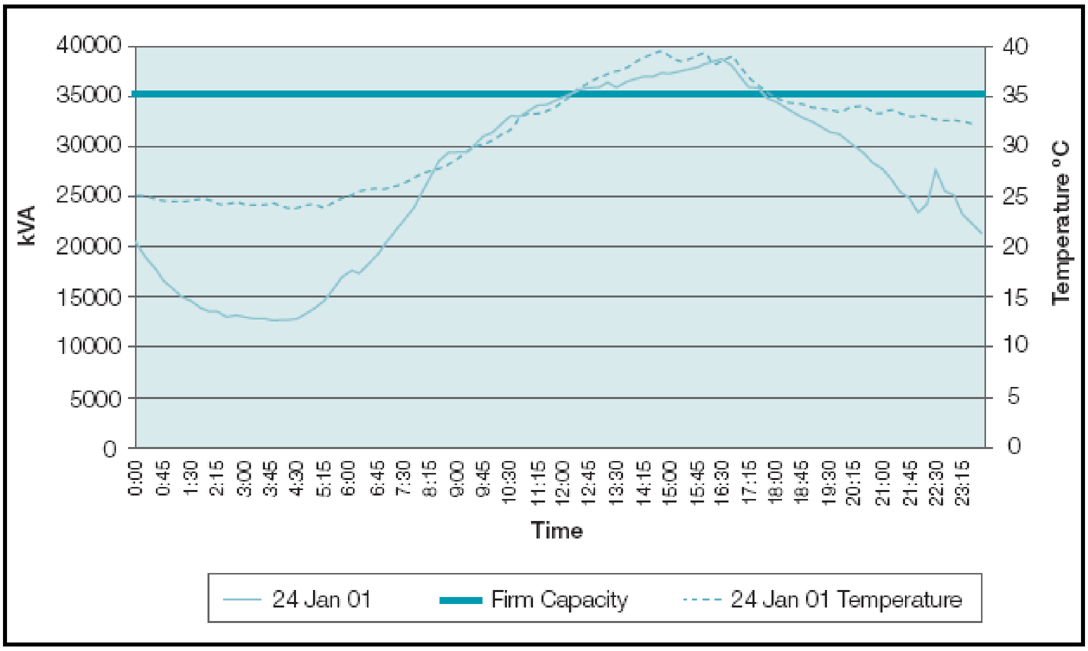

Figure 2. Castle Hill Zone Substation Profile after Two Consecutive Days at 39 Degrees Celsius

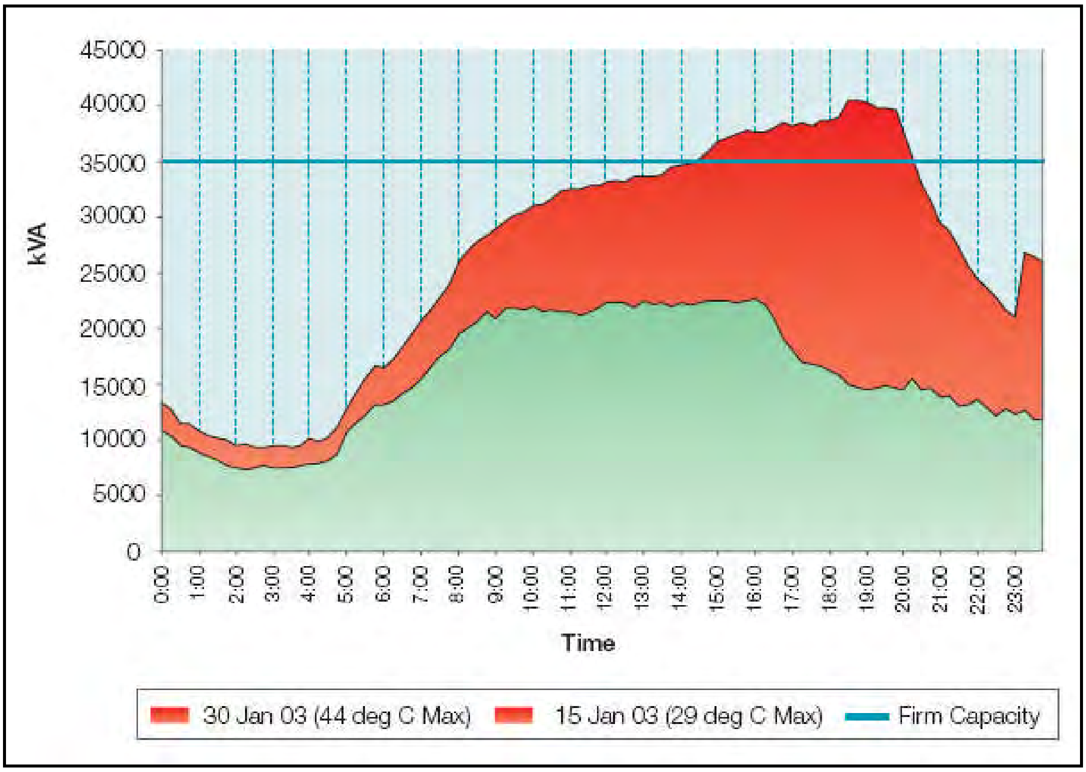

Figure 3. Castle Hill Zone Substation Profile Hot Day versus Mild Day

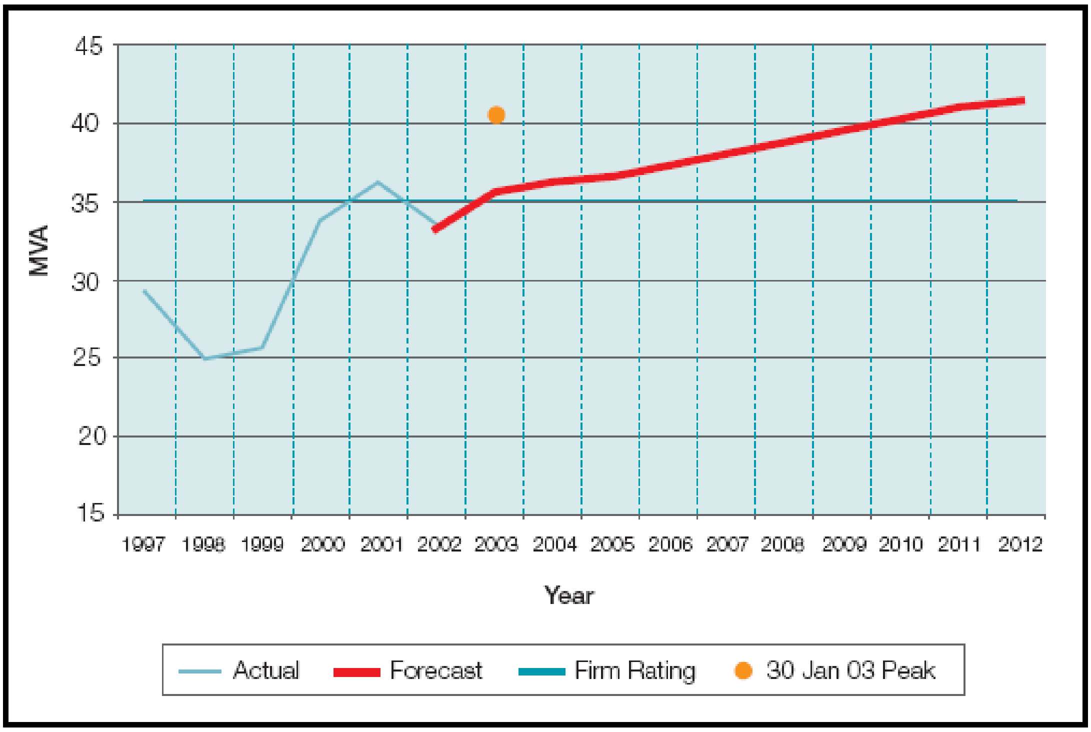

Figure 4. Castle Hill Zone Substation Actual and Forecast Demand

DESCRIPTION OF PROJECT

Initial Investigations

Despite the high levels of load growth, initial investigations by Integral Energy indicated that sufficient demand could be curtailed to defer the upgrade of the substation. Reductions in summer peak demand of 1 MVA initially, and further reductions of 0.5 MVA per annum were required to achieve deferral. A notional three-year deferral would provide a budget of sufficient value to warrant proceeding with a DSM option.

Integral Energy determined that a Request for Proposals for DSM strategies was warranted. However, this was supplanted by an offer from a New South Wales Government agency, the Sustainable Energy Development Authority (SEDA), to conduct a DSM program focussed on the commercial sector.

The Castle Hill Demand Management Project was developed via direct negotiation with SEDA. Integral Energy provided information on the level and timing of the required peak demand reduction and the level of financial support available.

Contractual Arrangements

SEDA was contracted by Integral Energy to work with electricity customers to relieve the peak summer electrical demand on the Castle Hill zone substation by 1,350kVA, approximately 4% of the peak electrical load on the local network, over a 3 year period.

The aim of the contract was to defer the need for the upgrade of the Castle Hill zone substation by reducing the demand for electricity during peak periods, namely from 1pm until 5pm on summer weekdays when the temperature reached or exceeded 35 degrees Celsius.

The overall contract target of 1,350 kVA was divided into three milestones of 450kVA of demand reduction to be achieved by the start of summer each year. The contract allowed for a budget of AUD150 per kVA of peak demand reduction, that is a total of AUD202,500 plus an 'establishment fee' of AUD50,000, bringing the overall project cost to AUD187/kVA.

However, using the framework for treatment of network utilities' DSM expenditure developed by the New South Wales electricity industry regulator, the value of deferring the capital upgrades to the Castle Hill zone substation was worth up to AUD566 per kVA (ie a total of AUD764,000). Consequently, if the contract target of 1,350kVA was exceeded, Integral Energy agreed to make payments of AUD135 per kVA for up to a further 352kVA reduction.

Program Objectives

The following objectives were set for the Castle Hill Demand Management Program:

- reduce the peak electricity load on Integral Energy's Castle Hill zone substation by 1,350kVA by summer 2005/2006;
- increase the energy efficiency of participating businesses and residents and decrease energy bills;
- reduce greenhouse gas emissions through energy efficiency and/or fuel switching to other energy forms;
- increase investment in sustainable energy technologies and services;
- demonstrate that DSM can be a profitable alternative to supply side solutions for an electricity distribution network facing peak demand constraints.

DSM Strategies

Three DSM strategies were identified:

- **Commercial/Industrial DSM:** investigate using a modified version of SEDA's award winning Energy Smart Business program to reduce peak demand by major commercial/ industrial customers, primarily through implementation of energy efficiency measures;
- **Distributed Generation:** investigate using existing or hired standby generators to relieve the network at peak times;
- **Residential DSM:** investigate the potential for energy efficiency, appliance interruption and load shifting in local residences.

Commercial/Industrial DSM

Initial investigations into the top 20 energy users in the area served by the Castle Hill zone substation identified the Castle Towers Shopping Centre and its major retail tenants as potential targets for peak demand management initiatives. The top ten commercial energy users had a combined electrical load of greater than 10MVA. Consequently, 1.35MVA represented an average reduction of 13% in their load.

Preliminary walk through energy audits of the shopping centre and the major retail tenants suggested good potential to improve the efficiency of lighting, ventilation and air conditioning systems. These systems account for an estimated 70% of commercial sector electricity demand during times of the peak summer load on the New South Wales network.

SEDA modified its existing Energy Smart Business program to assist these major energy consumers to identify and implement cost effective peak demand reduction projects.

Business forums and one-on-one meetings with major retail businesses were held during 2003 to recruit partners for the Castle Hill Demand Management Project. Free energy audits were offered to businesses to assess the potential for peak demand reduction and ongoing energy savings.

Following the energy audits, businesses were encouraged to make a public commitment to implement cost effective projects within 2 years. Businesses making this commitment became official "Partners" in the Castle Hill Demand Management Project and were provided with:

- a Partner Support Manager to give ongoing support and technical assistance to implement projects;
- participation in two advertising campaigns on local bus shelters and inside the Castle Towers Shopping Centre, as well as promotion in the project newsletter; and
- an AUD60/kVA bounty for measured and verified peak demand reductions.

The project targeted interruptible loads, the installation of high efficiency air conditioning (and the upgrading of existing air conditioning systems), and the installation of efficient lighting and power factor correction equipment in new and replacement applications. The contracts with electricity customers were performance based, with payment on verification of demand reduction.

Distributed Generation

Although initial estimates of peak demand reduction available from commercial businesses looked favourable, it was considered prudent to also investigate distributed generation as a complementary peak demand reduction option.

Recruitment of standby diesel generators able to dispatch at times of peak demand was the main distributed generation option investigated. Other generation options such as gas generation, cogeneration and solar power systems were not pursued because of the time constraints for project implementation and budgetary considerations.

Initial investigations found four standby generators in the Castle Hill area, two tenants at the Castle Towers Shopping Centre and two businesses outside the shopping centre.

The business with the largest capacity of standby generation (250kW) was considered to offer the best potential for a standby generation option. Initial discussions were held with the asset owner and a pre-feasibility study was undertaken based on manual start-up and synchronised, remote start–up options. The pre-feasibility study indicated the net return to the asset owner for generating less than 1MW at peak times in the network and/or at times of high pool prices in the National Electricity Market was negligible and did not warrant the risk or administration required to implement the standby generation option.

Preliminary discussions were also held with Integral Energy about the possibility of using hired generators. Issues such as siting, fuel storage, cabling and grid connection were raised. A hired generator was not considered the ideal option but could be used to generate during peak periods over one summer. This would give energy efficiency options more time to be implemented and/or would make up for any shortfall in the peak demand reduction achieved through these options.

Residential DSM

Integral Energy, in conjunction with SEDA, had previously undertaken an interruptible residential air conditioning trial with 90 residents in western Sydney. Although this was successful in delivering a demand reduction, the trial raised a range of other issues that needed to be addressed before this option could be a reliable, market accepted solution for peak demand reduction over multiple years and with larger numbers of participants.

Further, as the demand peak in Castle Hill dropped off at close of business around 5pm, it was considered that interrupting residential air-conditioners might not be very effective in reducing the early afternoon component of the peak.

Castle Hill has a high penetration of domestic swimming pools. Therefore, a basic investigation into shifting pool pump loads (approximately 1kVA each) to outside peak times was undertaken, including interviews with local pool equipment suppliers and a limited survey of pool owners.

Overall it was considered to be not financially viable to undertake residential DSM initiatives in the Castle Hill Project, given the budget of $187/kVA and that the commercial DSM initiatives looked more promising for the size, length and timing of peak reduction required.

RESULTS

Residential Customers Participating	Commercial and Small Industrial Customers Participating		Agricultural Customers Participating	Large Industrial Customers Participatin g	Additional Generation Installed
	6				
Peak Load	**Peak Load Reduction**	**Duration of Peak Load Reduction**	**Overall Load Reduction**	**Energy Savings**	**Greenhouse Emissions Reduction**
33 MW	1.5 MVA	4 hours	0.9 MVA	3,800 MWh	3,874.4 tC02-e

Fifty-four possible DSM projects were identified with an estimated total load reduction of 5.2 MVA. To achieve the required 1.35 MVA peak load reduction, the top 20 projects were selected. Most of the peak demand reduction projects identified involved lighting, heating, ventilation and air-conditioning (HVAC) or optimisation of building management control systems.

By June 2005, six project partners had been signed up and a total of 900 kVA peak load reduction had been achieved. The project was on track to achieve the target 1.35 MVA reduction by November 2005.

Based on projects with funding approved and currently underway as at June 2005, the following results were expected:

- 1,350 kVA of peak demand reduction will be in place by summer 2005/06 at an average cost of $187/kVA;
- around $370,000 in annual energy savings to businesses;
- over $1 million worth of investment in sustainable energy equipment and expertise.

HOW LOAD REDUCTION WAS MEASURED

HOW GREENHOUSE EMISSIONS REDUCTION WAS CALCULATED

The example calculation of the emissions reduction achieved by the Castle Hill Demand Management Program was carried out for the 12 months between October 2008 and September 2009. We assumed that the DSM measures implemented in the Castle Towers Shopping Centre operated over a 10 hour period from 8 am to 6 pm every day. We also assumed that the load reduction from these measures was 1.35 MVA.

The calculation of emissions reductions was based on the Marginal Historical Emissions method, modified to work with the available data. Historical data were obtained of the electrical energy (MWh) sent out daily by each major power plant located in the New South Wales region of the Australian National Electricity Market (NEM). The NEM-Review program was used to tabulate the energy sent out data in each of the 48 daily half hour trading periods in the NEM during the 12 months between October 2008 and September 2009.

Visual inspection of the table of generation output data was used to identify the marginal power plant each day for the period between 8 am and 6 pm. The table showed which power plants had varying generation output during the selected time period. Ignoring must-run power plants, the plant with the most varied output was determined to be the marginal plant. Most power plants had steady generation output over the time period selected. Only plants with varying output would be backed off in response to load reductions resulting from the operation of the Castle Hill Demand Management Program.

When the marginal power plant changed during the selected time period, the marginal plant was deemed to be the plant that was on the margin for the longest proportion of the period.

The electrical energy (MWh) displaced by the Castle Hill Demand Management Program was calculated by multiplying the load reduction of 1.35 MVA by 10.0, representing the 10 hours between 8 am and 6 pm. The product of this calculation was then multiplied by the emissions factor (tCO2-e/MWh) for the marginal power plant to give the daily emissions reductions achieved by the program.

TIMING OF LOAD/EMISSIONS REDUCTION

We assumed that the DSM measures implemented in the Castle Towers Shopping Centre operated over a 10 hour period from 8 am to 6 pm every day.

AVOIDED COSTS

ACTUAL PROJECT COSTS

Integral Energy's costs were AUD200,000 to June 2005 and were expected to be AUD300,000 in total by the end of the project. The average budgeted project cost was AUD187/kVA.

PROJECT COST FROM THE SOCIETAL PERSPECTIVE

ASSESSMENT OF OVERALL PROJECT EFFECTIVENESS

PROJECT INFORMATION RESOURCES

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Sources

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Department of Energy Utilities and Sustainability (2005). "Castle Hill Demand Management Project: Case Study". Sydney, DEUS.

Personal communication, Frank Bucca, Integral Energy.

DSM-ES01 EFFICIENT STREET LIGHTING IN ALCALÁ DE HENARES

Last updated	3 November 2010
Location of Project	Alcalá de Henares, 35 km northeast of the city of Madrid, Spain
Year Project Implemented	2002
Year Project Completed	2002
Name of Project Proponent	The town council of Alcalá de Henares
Name of Project Implementor	The town council of Alcalá de Henares
Type of Project Implementor	Local government (municipality)
Purpose of Project	Implementing town council policy
Project Objective	Reducing overall load
Project Target	Network element (eg a specific line or substation)
DSM Measure(s) Used	Energy efficiency
Specific Technology Used	High pressure sodium (HPS) lamps
Market Segments Addressed	Local government (town council)

REGULATORY REGIME

There were no legal or regulatory requirements fro the town council to undertake this project.

DRIVERS FOR PROJECT

The town council of Alcala de Henares opted for efficient street lighting to optimize energy consumption.

DESCRIPTION OF PROJECT

The existing Vapor Mercury Color Corrected (VMCC) lamps were replaced by High Pressure Sodium (HPS) lamps which are more efficient and emit within a narrower visible spectrum, reducing light pollution,

The project involved:

- replacing 845 luminaires with new luminaires which are more efficient because they are able to optimize the direction of the beam;
- adapting 612 existing luminaires to operate with the new type of lamps.

RESULTS

Residential Customers Participating	Commercial and Small Industrial Customers Participating		Agricultural Customers Participating	Large Industrial Customers Participating	Additional Generation Installed
	1				
Peak Load	**Peak Load Reduction**	**Duration of Peak Load Reduction**	**Overall Load Reduction**	**Energy Savings**	**Greenhouse Emissions Reduction**
				1,279 MWh	448 tC02-e

The project achieved energy savings of 1,279 MWh per year which corresponds to a reduction of approximately 20%. Cost savings are EUR 65,982 per year.

HOW LOAD REDUCTION WAS MEASURED

HOW GREENHOUSE EMISSIONS REDUCTION WAS CALCULATED

The emission reduction achieved by the project was calculated by multiplying the energy savings by the average grid emissions factor.

TIMING OF LOAD/EMISSIONS REDUCTION

AVOIDED COSTS

ACTUAL PROJECT COSTS

Alcalá de Henares town council: EUR 383,404

PROJECT COST FROM THE SOCIETAL PERSPECTIVE

ASSESSMENT OF OVERALL PROJECT EFFECTIVENESS

PROJECT INFORMATION RESOURCES

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Sources

DSM-ES02 GAD ACTIVE DEMAND SIDE MANAGEMENT

Last updated	3 November 2010
Location of Project	Throughout Spain
Year Project Implemented	2007
Year Project Completed	2010
Name of Project Proponent	CDTI (Centre for the Development of Industrial Technology under the Ministry of Science and Innovation)
Name of Project Implementor	Consortium of 13 companies led by Iberdrola, including the company Red Eléctrica de España
Type of Project Implementor	Electricity retailer / supplier Electricity distribution (wires) business Electricity transmission (wires) business
Purpose of Project	Deferring augmentation of the electricity network Providing network operational services
Project Objective	Minimising outages Increasing operating reserve Reducing peak loads Assisting electricity end users to be more energy efficient
Project Target	Whole electricity network
DSM Measure(s) Used	Demand response Load shifting Pricing initiatives Smart metering
Specific Technology Used	Intelligent devices that assist in optimising electricity consumption
Market Segments Addressed	Residential electricity end users Commercial and small industrial electricity end users Electrical goods manufacturers

REGULATORY REGIME

Spanish Law 54/1997 initiated the process to achieve the liberalisation of the electricity market in Spain.

Following this liberalisation effort, Spain implemented Law 17/2007, which was intended to adapt the Spanish electricity sector to European Union Directive 2003/54/EC, that required increased contestability of customers in the electricity market, ie customers could choose their electricity supplier from a range of electricity retailers.

The Twenty-Fourth Additional Provision of the Law 17/2007 specified the timetable to abolish fixed tariffs from the electricity market and establish negotiable bilateral contracts between customers and electricity suppliers:

- from 1 July 2008, high voltage tariffs were eliminated;

- Order ITC/3801/2008 established electricity tariffs from 1 January 2009 onwards;
- from 1 July 2009, the integrated tariff system was abolished and a tariff of last resort was established for non-contract customers;
- from 1 January 2010, only customers with low voltage supply could purchase electricity under the tariff of last resort;
- from 2011, only consumers whose contracted demand is less than 50kW will be eligible for the tariff of last resort.

DRIVERS FOR PROJECT

The objective of the GAD project is to carry out research and development of solutions to optimize the electrical consumption of low and medium voltage consumers and therefore reduce the cost associated with such consumption, while at the same time meeting users' needs with the same quality of supply.

This project, set up by Iberdrola to solve the problem of managing residential demand, will place Spain at the forefront of world development in this field. The project will also help reduce the environmental impact of electricity infrastructures, because it reduces the requirement for new generation and transmission network capacity and optimizes the integration of renewable sources in distributed generation.

DESCRIPTION OF PROJECT

This project is investigating the use of intelligent devices to assist in optimising end-use electricity consumption, thereby enabling shaping of the load curve and reduction in demand growth.

The project will enable standardisation of various consumption patterns and will provide useful information to end-users and suppliers of domestic electrical appliances. This information will enable end-users to make decisions about how they use electricity on the basis of price, electricity source, environmental impact, comfort etc. Suppliers of electrical appliances will be able to position their products at the most appropriate consumption level, based on end-users preferences.

The active participation of end-users and electrical appliance manufacturers in mechanisms to manage energy consumption and demand, together with the real time availability of energy generation costs - including environmental costs - will contribute to increased awareness by end-users. Consequently users will be able to modify their patterns of energy consumption and move towards energy sustainability.

RESULTS

Residential Customers Participating	Commercial and Small Industrial Customers Participating		Agricultural Customers Participating	Large Industrial Customers Participatin g	Additional Generation Installed
	200				
Peak Load	**Peak Load Reduction**	**Duration of Peak Load Reduction**	**Overall Load Reduction**	**Energy Savings**	**Greenhouse Emissions Reduction**
				6,000 MWh	2,500 tC02-e

HOW LOAD REDUCTION WAS MEASURED

HOW GREENHOUSE EMISSIONS REDUCTION WAS CALCULATED

The emissions reduction that is likely to be achieved by this project was estimated by multiplying the expected maximum energy shifts from peak to valley in the load curve by the average grid emissions factor.

TIMING OF LOAD/EMISSIONS REDUCTION

AVOIDED COSTS

ACTUAL PROJECT COSTS

Expected investment over 4 years: EUR 26.9 million

PROJECT COST FROM THE SOCIETAL PERSPECTIVE

ASSESSMENT OF OVERALL PROJECT EFFECTIVENESS

PROJECT INFORMATION RESOURCES

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Sources

http://www.gadproject.com

http://gad.ite.es/index.php

DSM-ES03 HOURLY DEMAND TARIFF

Last updated	3 November 2010
Location of Project	Throughout Spain
Year Project Implemented	1995
Year Project Completed	2007 (updated)
Name of Project Proponent	Red Eléctrica de España (REE)
Name of Project Implementor	Red Eléctrica de España (REE)
Type of Project Implementor	Electricity transmission (wires) business
Purpose of Project	Providing network operational services
Project Objective	Reducing peak loads
Project Target	Whole electricity network
DSM Measure(s) Used	Pricing initiatives
Specific Technology Used	Not applicable
Market Segments Addressed	Large industrial electricity end users

REGULATORY REGIME

Spanish Law 54/1997 initiated the process to achieve the liberalisation of the electricity market in Spain.

Following this liberalisation effort, Spain implemented Law 17/2007, which was intended to adapt the Spanish electricity sector to European Union Directive 2003/54/EC, that required increased contestability of customers in the electricity market, ie customers could choose their electricity supplier from a range of electricity retailers.

The Twenty-Fourth Additional Provision of the Law 17/2007 specified the timetable to abolish fixed tariffs from the electricity market and establish negotiable bilateral contracts between customers and electricity suppliers:

- from 1 July 2008, high voltage tariffs were eliminated;
- Order ITC/3801/2008 established electricity tariffs from 1 January 2009 onwards;
- from 1 July 2009, the integrated tariff system was abolished and a tariff of last resort was established for non-contract customers;
- from 1 January 2010, only customers with low voltage supply could purchase electricity under the tariff of last resort;
- from 2011, only consumers whose contracted demand is less than 50kW will be eligible for the tariff of last resort.

DRIVERS FOR PROJECT

The Hourly Demand Tariff consists of seven different rates for each of the seven time of use periods into which the 8760 hours in a year are divided. Red Eléctrica de España has the right to determine the hours of operation of Period 1. That period correspond to peak hours and is the most expensive period of the year.

The aim of this measure is to dissuade customers from using electricity during peak hours by increasing the demand and energy cost components of their electricity bills.

DESCRIPTION OF PROJECT

The Hourly Demand Tariff is applicable to five different kind of customers and is mandatory for low voltage customers.

The Hourly Demand Tariff has four components:

- a demand component calculated as the customer's maximum demand in each time of use period multiplied by the rate for that period;
- an energy component calculated as the energy consumed in a time of use period multiplied by the rate for that period;
- an interruptibility discount; and
- if applicable, a reactive power discount.

The time of use rates for the Hourly Demand Tariff are based on dividing the 365 days of the year into four different types (see Table 1, page 62) and the 8760 hours in a year into seven time of use periods (see Table 2, page 62). For each period, there is a contracted demand level and a different rate for each of the demand and energy components of the tariff. Rates for each period are reviewed every year.

The Hourly Demand Tariff rates do not vary with the voltage level of the customer's connection nor with the customer's contracted demand level. The loads of all customers on the Hourly Demand Tariff are interruptible.

To be eligible for the Hourly Power Tariff, customers have to comply with the following requirements:

1. The customer's contracted demand level must be greater than 20MW during a minimum of one time of use period.
2. The customer's contracted demand level must be greater than 5MW for all seven time of use periods.
3. The customer's contracted demand level during a time of use period must be greater than that in the preceding period:

   P7>P6>P5>P4>P3>P2>P1.
4. The customer's premises must be equipped with adequate measurement and control systems.

Table 1. Time of Use Day Types for Hourly Demand Tariff	
Day Type	**Definition**
Type A	Monday to Friday working days during high season (considered to be peak days)
Type B	Monday to Friday working days during medium season
Type C	Monday to Friday working days during low season, except in August
Type D	Saturdays, Sundays, holidays and August

Table 2. Time of Use Periods for Hourly Demand Tariff	
Period	**Duration**
1	13 hours per day between 8 am and midnight on 23 Type A days per year determined by Red Eléctrica de España (REE). These Period 1 days have to be announced by at least the Friday of the week before. Up to 5 of these days per year may be announced by REE the day before.
2	From 4 pm to 10 pm (6 hours per day) on the Type A days not included in Period 1.
3	From 8 am to 4 pm and from 10 pm to midnight (10 hours a day) on the Type A days included in Period 2. Also includes the remaining 3 hours per day between 8 am and midnight on the Type A days included in Period 1.
4	From 4 pm to 10 pm (6 hours a day) on Type B days.
5	From 8 am to 4 pm and from 10 pm to midnight (10 hours a day) on Type B days.
6	From 8 am to midnight (16 hours a day) on Type C days.
7	The rest of the hours which have not been included in any other period.

RESULTS

Residential Customers Participating	Commercial and Small Industrial Customers Participating		Agricultural Customers Participating	Large Industrial Customers Participatin g	Additional Generation Installed
Peak Load	**Peak Load Reduction**	**Duration of Peak Load Reduction**	**Overall Load Reduction**	**Energy Savings**	**Greenhouse Emissions Reduction**
44,876 MW	1,000 MW (hypothetical)				317 tC02-e

It is possible to guesstimate the amount of energy saved by Hourly Demand Tariff customers under some specific changes in consumption patterns:

- 50% change in the time of use of dishwashers and washing machines;
- 15% decrease in energy consumption for lighting;
- decrease in energy consumption for room heating: 10% improvement in insulation and an additional 15% by reduction the maximum temperature.

Given these assumptions, it may be possible to reduce peak load by 1000MW, as shown in Figure 1.

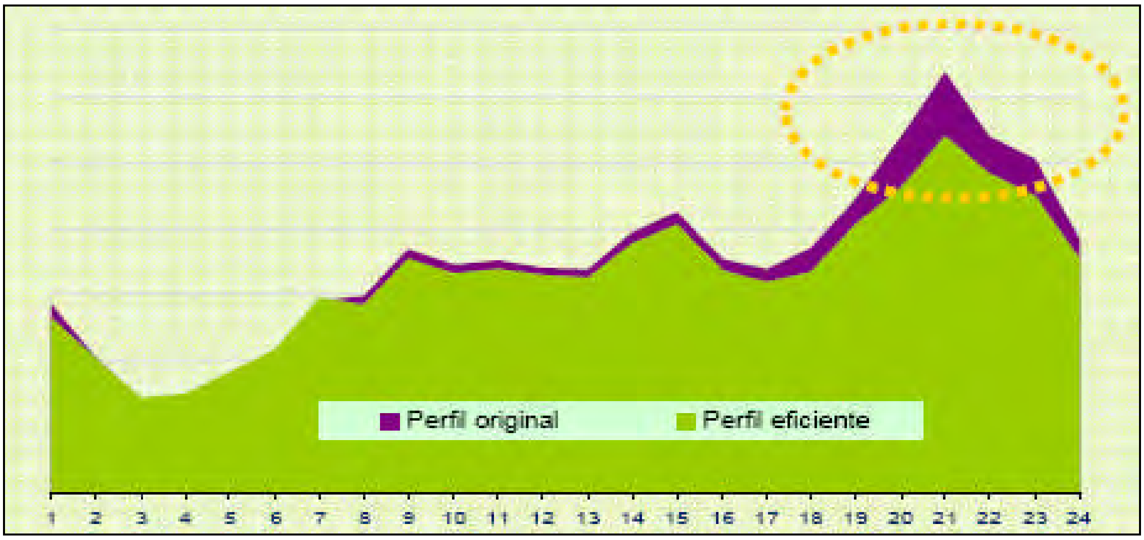

Figure 1. Hypothetical Peak Load Reduction from the Hourly Demand Tariff

HOW LOAD REDUCTION WAS MEASURED

HOW GREENHOUSE EMISSIONS REDUCTION WAS CALCULATED

The possible reduction in greenhouse gas emissions from the Hourly Demand Tariff was estimated by multiplying the hypothetical peak load reduction by the average grid emissions factor during peak hours (0.317 tCO2-e/MW). Peak hours in Spain are between 11.30 and 3.30 pm and between 7.30 pm and 11.30 pm seven days a week.

TIMING OF LOAD/EMISSIONS REDUCTION

Between 11.30 and 3.30 pm and between 7.30 pm and 11.30 pm seven days a week.

AVOIDED COSTS

ACTUAL PROJECT COSTS

PROJECT COST FROM THE SOCIETAL PERSPECTIVE

ASSESSMENT OF OVERALL PROJECT EFFECTIVENESS

PROJECT INFORMATION RESOURCES

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Sources

DSM-ES04 LOAD INTERRUPTION CONTRACT

Last updated	3 November 2010
Location of Project	Throughout Spain
Year Project Implemented	1983
Year Project Completed	2008 (updated)
Name of Project Proponent	Red Eléctrica de España, S.A. (REE)
Name of Project Implementor	Red Eléctrica de España, S.A. (REE)
Type of Project Implementor	Electricity transmission (wires) business
Purpose of Project	Providing network operational services
Project Objective	Minimising outages Increasing operating reserve Reducing peak loads
Project Target	Whole electricity network
DSM Measure(s) Used	Pricing initiatives
Specific Technology Used	Not applicable
Market Segments Addressed	Large industrial electricity end users

REGULATORY REGIME

Spanish Law 54/1997 initiated the process to achieve the liberalisation of the electricity market in Spain.

Following this liberalisation effort, Spain implemented Law 17/2007, which was intended to adapt the Spanish electricity sector to European Union Directive 2003/54/EC, that required increased contestability of customers in the electricity market, ie customers could choose their electricity supplier from a range of electricity retailers.

The Twenty-Fourth Additional Provision of the Law 17/2007 specified the timetable to abolish fixed tariffs from the electricity market and establish negotiable bilateral contracts between customers and electricity suppliers:

- from 1 July 2008, high voltage tariffs were eliminated;
- Order ITC/3801/2008 established electricity tariffs from 1 January 2009 onwards;
- from 1 July 2009, the integrated tariff system was abolished and a tariff of last resort was established for non-contract customers;
- from 1 January 2010, only customers with low voltage supply could purchase electricity under the tariff of last resort;
- from 2011, only consumers whose contracted demand is less than 50kW will be eligible for the tariff of last resort.

DRIVERS FOR PROJECT

The Load Interruption Contract was conceived to provide a demand-side mechanism for large industrial customers. However, until now, it has only been applied as an operational service.

DESCRIPTION OF PROJECT

The Load Interruption Contract is an agreement through which large customers receive a discount on their electricity bills in return for being available to reduce their consumption on request from the System Operator.

The transmission system operator (REE) is responsible for issuing, controlling and supervising all interruption orders. Customers participating in the Load Interruption Contract will must submit to REE monthly schedules for hourly energy demand and maintenance planning.

Only customers with a specific high voltage tariff contract or with an Hourly Power Tariff contract can participate in a Load Interruption Contract. They include iron, steel and other metal industries, cement and chemical industries, airports, etc.

Customers participating in the Load Interruption Contract will must submit to REE monthly schedules for hourly energy demand and maintenance planning.

There are five types of interruptions possible under the Load Interruption Contract depending on the interruption duration and the warning time:

- **Type 1.** Maximum interruption time: 12 hours Minimum warning time: 2 hours
- **Type 2.** Maximum interruption time: 8 hours Minimum warning time: 2 hours
- **Type 3.** Maximum interruption time: 3 hours Minimum warning time: 1 hour
- **Type 4.** Maximum interruption time: 2 hours Minimum warning time: 5 minutes
- **Type 5.** Maximum interruption time: 1 hour Minimum warning time: 0 minutes

Under the Load Interruption Contract, the maximum number of interruptions that can be requested by the System Operator are as follows:

- 1 per day (12 hours maximum per day)
- 5 per week (60 hours per week)
- 120 hours per month
- 240 hours per year.

Customers are permitted to refuse up to three interruption orders per year. If they have more than three refusals, customers are compelled to return the discount already invoiced which can comprise a large amount of money.

The Load Interruption Contract includes the following provisions:

- Tariff: Hourly Power Tariff or High Voltage General Power Tariff;
- Billing mode;
- Contracted demand level for each period in MW (Pc);
- Maximum demand level during interruption in MW (Pmaxi);
- Interruptible load offered in MW (Pof); this is the difference between the contracted demand level for each period (Pc) and the maximum demand level during the interruption (Pmaxi);
- Hourly discrimination mode;
- Interruption types chosen;

- Following year energy consumption forecast;
- Discount: this is an annual discount expressed as a percentage of the total electricity bill invoiced monthly, and is proportional to the base consumption and the interruptible load offered. If customers were not provided with a discount, they would probably select another kind of tariff.

RESULTS

Residential Customers Participating	Commercial and Small Industrial Customers Participating		Agricultural Customers Participating	Large Industrial Customers Participatin g	Additional Generation Installed
				164	
Peak Load	**Peak Load Reduction**	**Duration of Peak Load Reduction**	**Overall Load Reduction**	**Energy Savings**	**Greenhouse Emissions Reduction**
45,000 MW	2,300 MW				6,300 tC02-e per annum (maximum)

Responses from contracted customers are not assured as they are permitted to refuse up to three interruption orders per year. Another factor which reduces the confidence level is the possibility of failure of the communication system. However, high volume industrial consumers are highly reliable when they are requested to interrupt load by the System Operator.

HOW LOAD REDUCTION WAS MEASURED

HOW GREENHOUSE EMISSIONS REDUCTION WAS CALCULATED

The maximum reduction in greenhouse gas emissions from the Load Interruption Contract was estimated by multiplying the maximum energy shifts from peak to valley in the load curve by the difference between the average grid emissions factor during peak hours and during off-peak hours.

TIMING OF LOAD/EMISSIONS REDUCTION

AVOIDED COSTS

ACTUAL PROJECT COSTS

The main cost to Red Eléctrica de España is the discounts on electricity bills. In 2009, the REE budget for bill discounts for Load Interruption Contracts was about EUR 750 million.

PROJECT COST FROM THE SOCIETAL PERSPECTIVE

ASSESSMENT OF OVERALL PROJECT EFFECTIVENESS

The Load Interruption Contract has proved to be very effective. High volume industrial consumers are highly reliable when they are requested to interrupt load by the System Operator.

PROJECT INFORMATION RESOURCES

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Sources

http://www.ree.es/operacion/servicio_interrumpibilidad.asp

DSM-ES05 THE OPTIGES PROJECT

Last updated	3 November 2010
Location of Project	Spain
Year Project Implemented	2006
Year Project Completed	2009
Name of Project Proponent	ENDESA
Name of Project Implementor	Tecnalía Energía
Type of Project Implementor	Electricity retailer / supplier Electricity distribution (wires) business
Purpose of Project	Providing network operational services
Project Objective	Minimising outages Increasing operating reserve Reducing peak loads
Project Target	Whole electricity network
DSM Measure(s) Used	Demand response Load shifting Smart metering
Specific Technology Used	
Market Segments Addressed	Commercial and small industrial electricity end users

REGULATORY REGIME

Spanish Law 54/1997 initiated the process to achieve the liberalisation of the electricity market in Spain.

Following this liberalisation effort, Spain implemented Law 17/2007, which was intended to adapt the Spanish electricity sector to European Union Directive 2003/54/EC, that required increased contestability of customers in the electricity market, ie customers could choose their electricity supplier from a range of electricity retailers.

The Twenty-Fourth Additional Provision of the Law 17/2007 specified the timetable to abolish fixed tariffs from the electricity market and establish negotiable bilateral contracts between customers and electricity suppliers:

- from 1 July 2008, high voltage tariffs were eliminated;
- Order ITC/3801/2008 established electricity tariffs from 1 January 2009 onwards;
- from 1 July 2009, the integrated tariff system was abolished and a tariff of last resort was established for non-contract customers;
- from 1 January 2010, only customers with low voltage supply could purchase electricity under the tariff of last resort;
- from 2011, only consumers whose contracted demand is less than 50kW will be eligible for the tariff of last resort.

DRIVERS FOR PROJECT

The main objective of the OPTIGES project is to establish the technical and financial viability of demand response in small and medium enterprises in Spain.

Additional possible benefits of the project include:

- short term reduction of the investment requirement for transmission, distribution and generation infrastructure;
- minimisation of transmission and distribution losses; and
- increase in the amount of renewable resources that can be integrated in the network.

DESCRIPTION OF PROJECT

A full load control architecture is being developed and different pilot tests are being specified to investigate various issues, including: improvements in network management, reduction of peak consumption, minimization of energy costs, optimisation of investment in transmission and distribution, and optimization of resource consumption.

The project also includes the development and demonstration of the software and hardware infrastructure necessary for the practical implementation of some of demand response technologies.

The project is being implemented in two main phases:

- development of a generic cost-benefit analysis methodology and application of the methodology to various options for implementing demand response in various sectors and key segments of the small and medium enterprise sector;
- execution of a series of pilot demand response projects in collaboration with customers, taking into accounts best practices and success stories. The objective of this phase is to observe real cases and to confirm the methodology previously developed.

RESULTS

Residential Customers Participating	Commercial and Small Industrial Customers Participating		Agricultural Customers Participating	Large Industrial Customers Participatin g	Additional Generation Installed
Peak Load	**Peak Load Reduction**	**Duration of Peak Load Reduction**	**Overall Load Reduction**	**Energy Savings**	**Greenhouse Emissions Reduction**
					7.8 tC02-e

The generic cost-benefit analysis methodology has been developed and used to assess the impact of performing a demand response program over 30 events, with a duration of four hours (taking as a base year 2006)

Results show that if the interruptions are executed during peak price periods, an electricity supplier could potentially increase its revenue by EUR 5,888 per megawatt of load reduction.

HOW LOAD REDUCTION WAS MEASURED

HOW GREENHOUSE EMISSIONS REDUCTION WAS CALCULATED

The emissions reduction that is likely to be achieved by this project was estimated by multiplying the expected maximum energy shifts from peak to valley in the load curve by the average grid emission factor.

TIMING OF LOAD/EMISSIONS REDUCTION

AVOIDED COSTS

If 30 demand response events had been implemented during peak load periods in 2006, the following benefits were estimated by the cost-benefit analysis methodology:

- potentially EUR 572,000 per reduced megawatt could be saved from the reduced requirement for generation and transmission system infrastructure;
- potentially EUR 2789 per reduced megawatt could be saved from the annual reduction in transmission and distribution system losses.

ACTUAL PROJECT COSTS

The total cost of the project was EUR 500,000.

PROJECT COST FROM THE SOCIETAL PERSPECTIVE

ASSESSMENT OF OVERALL PROJECT EFFECTIVENESS

PROJECT INFORMATION RESOURCES

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Sources

I. Cobelo, J.E. Rodriguez, M. Boyra, J. Anduaga, and A. Castellanos (2008). "Economical and technical viability of demand response in the Spanish power system: the "OPTIGES" project". CIRED Seminar 2008: SmartGrids for Distribution. Frankfurt, 23 - 24 June 2008. Paper 0039. Available at: http://dx.doi.org/10.1049/ic:20080453

DSM-ES06 TRASLUZ BIOCLIMATIC OFFICE BUILDING

Last updated	3 November 2010
Location of Project	Calle Golfo de Salónica, nº 73, Madrid, Spain
Year Project Implemented	2004
Year Project Completed	2005
Name of Project Proponent	Subsidised by the General Directorate of Industry and Mines of the Community of Madrid
Name of Project Implementor	Hoteles e Inmuebles, S.A. (HOINSA), Emilio Miguel Mitre y Asociados, S.L. (EMMA) and Gestión Técnica de Montajes y Construcciones S.A. (GTM)
Type of Project Implementor	Electricity end user
Purpose of Project	Reducing electricity consumption
Project Objective	Reducing overall load Assisting electricity end users to be more energy efficient Assisting electricity end users to reduce greenhouse emissions
Project Target	Network element (eg a specific line or substation)
DSM Measure(s) Used	Energy efficiency
Specific Technology Used	
Market Segments Addressed	Commercial and small industrial electricity end users

REGULATORY REGIME

In Europe, the legislative framework on energy efficiency in buildings is based on Directive 2002/91/EC of the European Parliament.

In Spain, legislation on energy efficiency in buildings has been modified to adapt it to the European legislation. These modifications can be found in:

- Technical Building Code (CTE);
- Regulation of Thermal Installations in Buildings (RITE);
- Royal Decree on energy certification of buildings, RD 47/2007, for new buildings.

The Spanish government is developing a new Royal Decree to regulate energy certification for existing buildings.

DRIVERS FOR PROJECT

The development of the Trasluz bioclimatic office building had two main objectives:

- to meet the quality and cost requirements of the market for office buildings: and
- to utilise renewable energy to supply a large proportion of energy consumption in the building, thereby reducing consumption of conventional energy.

DESCRIPTION OF PROJECT

The Trasluz building is shown in Figure 1. The building has a gross floor area of 13,762 square metres and a total of 11 floors.

Figure 1. The Trasluz Building

Relevant building features include:

- use of night purge ventilation by incorporating concrete alveolar slabs that become ducts for the air conditioning;
- use of natural light from an atrium and large window facade;
- controlled lighting in the common areas using automated motion detectors, photocells and scheduled programming;
- use of solar energy: 20 kWp photovoltaic power plant comprising 168 PV modules for electricity production, 64 vacuum-type solar collector for domestic hot water and space heating in winter, absorption cooling and passive solar design;
- high solar control: automatic mobile blinds on the east and west facades and fixed blinds on the south to avoid solar load in summer and to avoid glare problems;
- high level of thermal insulation on the building envelope which comprises a system of wood panels covered with slate;
- use of rainwater;
- use of eco-materials and the structure and finishing materials can be easily separated for recycling.

RESULTS

Residential Customers Participating	Commercial and Small Industrial Customers Participating		Agricultural Customers Participating	Large Industrial Customers Participatin g	Additional Generation Installed
Peak Load	**Peak Load Reduction**	**Duration of Peak Load Reduction**	**Overall Load Reduction**	**Energy Savings**	**Greenhouse Emissions Reduction**
				475 MWh per annum	52 tC02-e per annum

The Trasluz building was designed and constructed so that it will consume 40% less energy than a conventional building, achieved through energy efficiency and on-site generation of electricity. In June 2005, the photovoltaic power plant generated approximately 10% of the energy consumption in the building.

HOW LOAD REDUCTION WAS MEASURED

HOW GREENHOUSE EMISSIONS REDUCTION WAS CALCULATED

The emissions reduction achieved by the project was calculated by multiplying the maximum energy savings by the average grid emissions factor.

TIMING OF LOAD/EMISSIONS REDUCTION

AVOIDED COSTS

ACTUAL PROJECT COSTS

The total construction cost for the Trasluz building was EUR 8.3 million.

PROJECT COST FROM THE SOCIETAL PERSPECTIVE

ASSESSMENT OF OVERALL PROJECT EFFECTIVENESS

PROJECT INFORMATION RESOURCES

Contacts

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Sources

DSM-FR01 DAYLIGHT SAVING TIME IN FRANCE

Last updated	3 November 2010
Location of Project	Throughout France
Year Project Implemented	1975
Year Project Completed	Ongoing
Name of Project Proponent	Government of France
Name of Project Implementor	Government of France
Type of Project Implementor	State or federal government agency
Purpose of Project	Reducing electricity consumption after the 1973 oil price shock Deferring augmentation of the electricity network
Project Objective	Reducing peak loads Reducing overall load
Project Target	Whole electricity network
DSM Measure(s) Used	Moving clocks forward by one hour in Spring and back again in Autumn
Specific Technology Used	
Market Segments Addressed	All energy consumers

REGULATORY REGIME

Daylight saving time was introduced in France in 1975 following the oil crisis of 1973 with the objective of saving energy by reducing the requirement for lighting. The purpose of daylight saving time is to align as much as possible business and private activities with the hours of daylight so as to reduce the requirement for artificial lighting.

Daylight saving time has now been harmonised across the European Union. Directive 2000/84/CE of the European Parliament dated January 19th, 2001 and published in the Official Journal of the European Communities number L31 of February 2nd, 2001 specifies the method of application of daylight saving in the European Union commencing in the year 2002. The provisions of this Directive were implemented in France by the Decree of April 3rd, 2001, published in the Journal Officiel de la Republique Francaise of April 6th, 2001.

Table 1 shows the dates set by the European Commission to define the start and end of daylight saving time in the European Union.

Table 1. Dates for Daylight Saving Time Set by the European Commission

Year	**Start of Daylight Saving Time** (At 2 o'clock in the morning it will be 3 am)	**End of Daylight Saving Time** (At 3 o'clock in the morning it will be 2 am)
2008	March 30th	October 26th
2009	March 29th	October 25th
2010	March 28th	October 31st
2011	March 27th	October 30th

DRIVERS FOR PROJECT

The original objective for introducing daylight saving time in 1975 was to save energy by reducing the requirement for lighting. More recently, studies have shown that daylight saving time also contributes to reducing greenhouse gas emissions.

DESCRIPTION OF PROJECT

In 2006, ADEME, the French Government's Agency for Environment and Energy Management, commissioned a study of the impact of daylight saving time in France on energy consumption. This study investigated savings in electricity consumption for lighting in residential and commercial sector buildings, and it also clarified probable effects on energy consumption for space heating and air-conditioning.

In 2008, ADEME commissioned a further study. This new study:

- updated the results concerning the impacts of daylight saving time on energy consumption for lighting, space heating and air-conditioning; and
- estimated the resulting reductions in greenhouse gas emissions.

RESULTS

Residential Customers Participating	Commercial and Small Industrial Customers Participating		Agricultural Customers Participating	Large Industrial Customers Participating	Additional Generation Installed
Peak Load	**Peak Load Reduction**	**Duration of Peak Load Reduction**	**Overall Load Reduction**	**Energy Savings**	**Greenhouse Emissions Reduction**
				440,000 MWh	44,000 tC02-e

Figure 1 (page 79) shows the impact of daylight saving time in France on the national load curve in the summer of 2008. The effect of the reduced requirement for lighting in the evening is clearly visible, but the effect of an increased requirement for lighting in the morning is less obvious.

Figure 2 (page 79) shows the impact of daylight saving time in France on electricity consumption for lighting in 2009, disaggregated by commercial sub-sector and by the various areas in a dwelling in the residential sector.

The study commissioned by ADEME concluded that in 2009, daylight saving time in France resulted in a reduction in energy consumption for lighting of about 440 GWh, and the corresponding reduction in greenhouse gas emissions was about 44,000 tCO2-e.

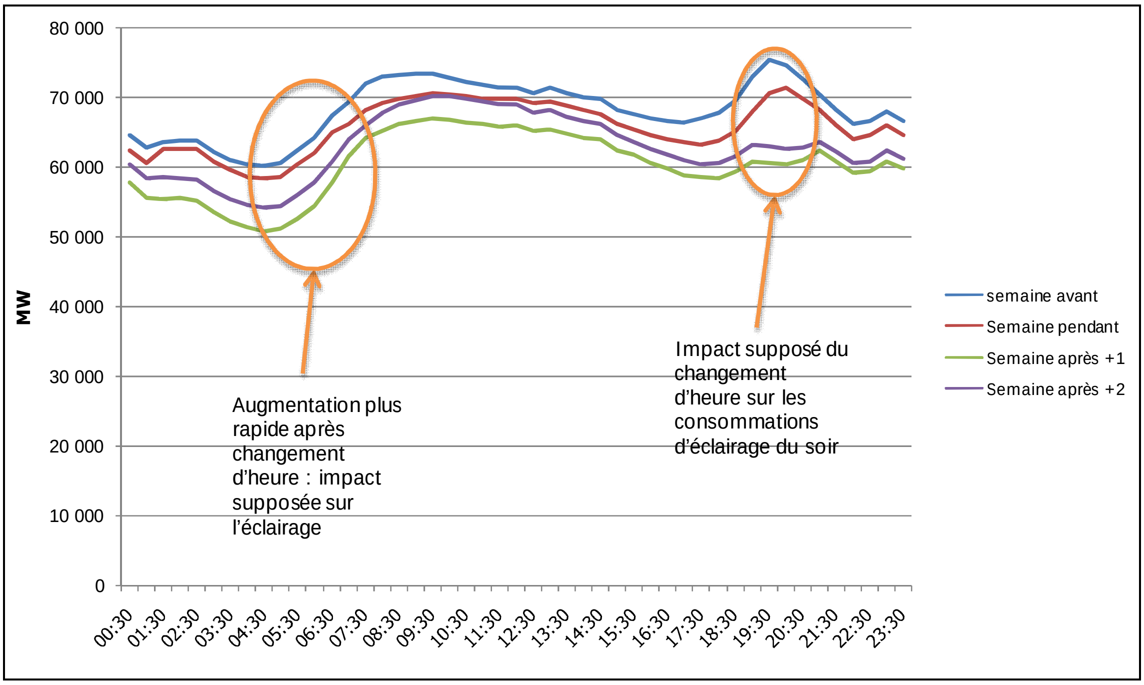

Figure 1. Impact of Daylight Saving Time in France on the National Load Curve, Summer 2008

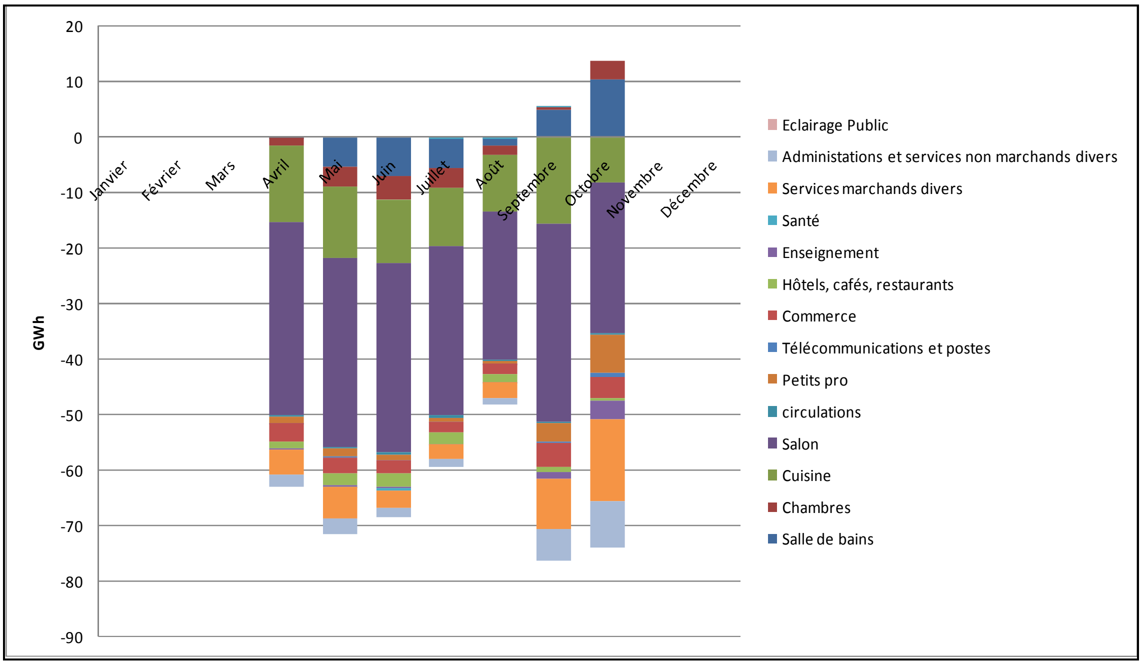

Figure 2. Impact of Daylight Saving Time in France on Electricity Consumption for Lighting, 2009

HOW LOAD REDUCTION WAS MEASURED

HOW GREENHOUSE EMISSIONS REDUCTION WAS CALCULATED

The reduction in energy consumption for lighting resulting from daylight saving time in France was estimated using a complex "bottom-up" simulation model of the typical hours of usage for lighting, disaggregated by commercial sub-sector and by areas within dwellings in the residential sector.

To estimate the corresponding reduction in greenhouse gas emissions, the energy saved was multiplied by the average grid emissions factor.

TIMING OF LOAD/EMISSIONS REDUCTION

AVOIDED COSTS

ACTUAL PROJECT COSTS

PROJECT COST FROM THE SOCIETAL PERSPECTIVE

ASSESSMENT OF OVERALL PROJECT EFFECTIVENESS

PROJECT INFORMATION RESOURCES

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DSM-FR02 TEMPO ELECTRICITY TARIFF

Last updated	3 November 2010
Location of Project	Throughout France
Year Project Implemented	1993
Year Project Completed	Ongoing
Name of Project Proponent	Electricité de France (EDF)
Name of Project Implementor	EDF and Réseau de Transport d'Electricité (RTE)
Type of Project Implementor	Electricity retailer / supplier Electricity distribution (wires) business Electricity transmission (wires) business
Purpose of Project	Deferring augmentation of the electricity network
Project Objective	Reducing peak loads
Project Target	Whole electricity network
DSM Measure(s) Used	Pricing initiatives
Specific Technology Used	
Market Segments Addressed	Residential electricity end users Commercial and small industrial electricity end users

REGULATORY REGIME

European Union Directive 2003/54/EC required increased contestability of customers in the electricity market, ie customers could choose their electricity supplier from a range of electricity retailers. In France, customers contestability, was introduced in July 2004 for small business customers and in 2007 for residential customers.

DRIVERS FOR PROJECT

Since the 1960s, EDF has been moving towards real-time pricing of electricity linked to marginal costs of supply. Consequently, electricity customers in France have been motivated to reduce their consumption when the generation costs are high and during congestion on the electricity network.

Tempo was the most sophisticated tariff for mass market customers the previous situation where EDF had a monopoly in the generation and retail supply of electricity in France.

The Tempo tariff enables smoothing of both the annual and daily electricity load curves, therefore reducing marginal generation and network costs.

DESCRIPTION OF PROJECT

In France, electricity bills for residential and small business customers include a standing charge determined by the level of maximum demand (in kVA) nominated by the customer (*puissance souscrite*), and an energy usage charge based on the type of tariff chosen by the customer (*type d'abonnement*).

There are three types of electricity contract from which residential and small business customers can choose:

Option Base

This is the simplest of the three contract types with the lowest standing charge and a flat rate for electricity usage all the time throughout the day and year. It is more suitable for lower usage, smaller homes and holiday homes with only occasional usage.

Option Heures Creuses (Option HC)

This is a two-part time-of-use tariff with normal (*heures pleines*) and off-peak (*heures creuses*) rates. The standing charge is slightly higher than that of Option Base, but this is offset against a lower off-peak rate for part of the day. The off-peak period is from 10 pm until 6 am each night and, in some regions, also at midday.

Option HC is usually used in conjunction with a water heater operated by ripple control so that the heating element is switched on only during off-peak periods.

Option HC suits the majority of houses used full time where heating is non-electric.

Option Tempo

This is a quite complicated charging system with six rates of electricity pricing based upon the actual weather on particular days and on hours of use.

Under Option Tempo, each day of the year is colour coded. There are three colours, blue (*jours bleus*), white (*jours blancs*) and red (*jours rouges*) which correspond to low, medium and high electricity prices.

The colour of each day is determined mostly by EDF based on the forecast of electricity demand for that day - the level of demand is mainly influenced by the weather. RTE, the French transmission network operator (formerly a division of EDF), also has the ability to determine the day colour if there is significant congestion on the electricity network.

In addition to a colour, each day also has normal and off-peak periods based on Option HC outlined above, with 10pm until 6am being the off-peak period.

The rules for the Option Tempo are as follows:

- the Tempo year starts on 1st September;
- the Tempo day starts at 6 am;
- the number of days per year of each colour is fixed - there are 300 blue days, 43 white days and 22 red days;
- Sunday is always a blue day;
- red days cannot fall on a holiday, weekend or more than five weekdays in a row.

On blue days, the electricity price is by far the lowest - during the off-peak period on a blue day the price is extremely low.

On white days, the price is higher than under Option Base or Option HC.

On red days, the price is very high to encourage lower electricity usage - the normal rate on red days is nine times that of the off-peak rate on blue days. Red days are usually the coldest days in winter.

From 15 August 2010, the prices per kilowatt-hour for electricity purchased under Option Tempo are as follows (see Figure 1):

- Blue days off-peak: 5.72 euro cents
- Blue days normal: 7.22 euro cents
- White days off-peak: 9.01 euro cents
- White days normal: 11.09 euro cents
- Red days off-peak: 18.48 euro cents
- Red days normal: 51.75 euro cents

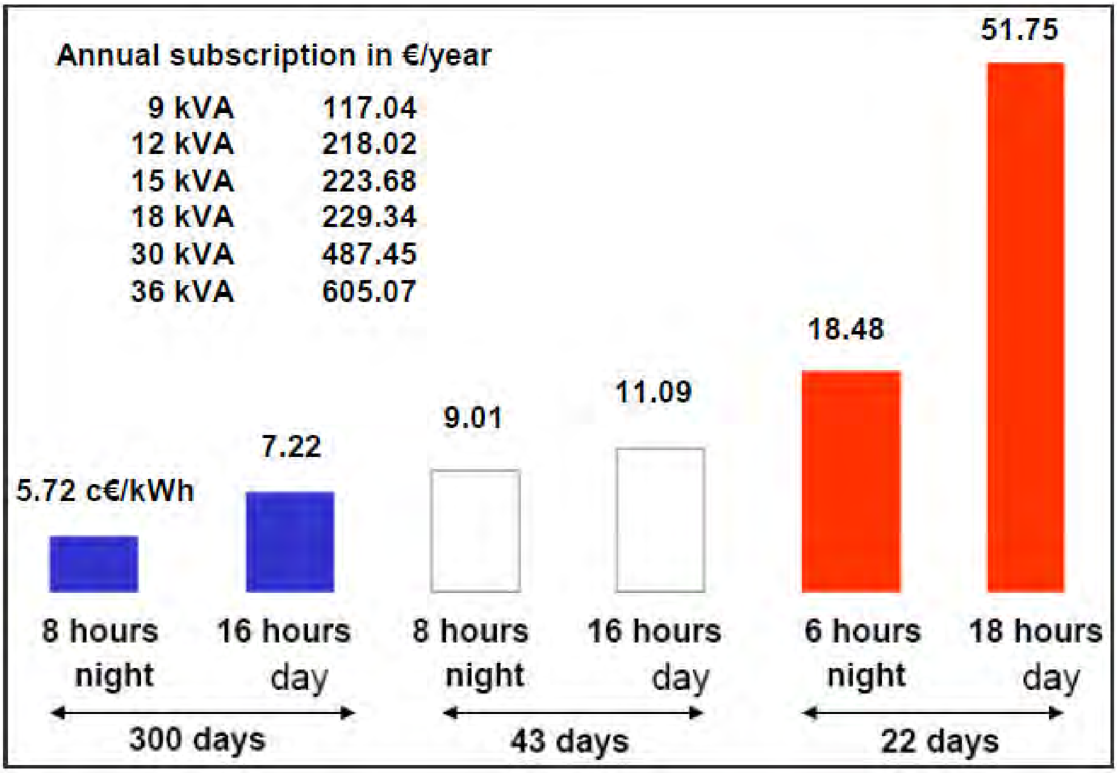

Figure 1. Tempo Tariff Rates from 18 August 2010

There are four different versions of Option Tempo, depending on the metering, communications and load control equipment installed at the customer's premises:

- standard Tempo (the customer has only an electronic interval meter);
- dual energy Tempo (the customer's space-heating boiler can be switched from one energy source to another);
- thermostat tempo (the customer has load control equipment which is able to adjust space heating and water heating loads according to the electricity price);
- comfort Tempo (the customer has a sophisticated energy controller).

Customers who choose Option Tempo are informed each night about the colour for the next day. At 8 pm a signal is sent down powerlines using a ripple control system. Most Tempo customers have a display unit that plugs into any power socket and picks up the signal. The display unit shows the day colour with lights, both for the current day and (from 8pm) for the next day. An (optional) beep informs the consumer if the following day will be a red day. The display unit also shows whether or not the current electricity price is at the off-peak rate.

For older systems without a display unit the information is available over the telephone or via the internet.

Customers can adjust their electricity consumption manually by switching off appliances, adjusting thermostat settings, etc. Some customers who have the necessary communications and load control equipment are able to select load control programs which enable automatic connection and disconnection of separate water-heating and space-heating circuits.

Option Tempo is for high use households, such as very large houses, and those with electric heating and full time occupation, and for small business customers.

RESULTS

Residential Customers Participating	Commercial and Small Industrial Customers Participating		Agricultural Customers Participating	Large Industrial Customers Participatin g	Additional Generation Installed
350,000	100,000				
Peak Load	**Peak Load Reduction**	**Duration of Peak Load Reduction**	**Overall Load Reduction**	**Energy Savings**	**Greenhouse Emissions Reduction**
	450 MW				

Compared with blue days, the Tempo tariff has led to a reduction in electricity consumption of 15% on white days and 45% on red days, on average 1 kW per customer (see Figure 2, page).

Tempo customers have saved 10% on average on their electricity bill and 90% of the customers are satisfied with the tariff. However, customers do not appreciate red days occurring consecutively.

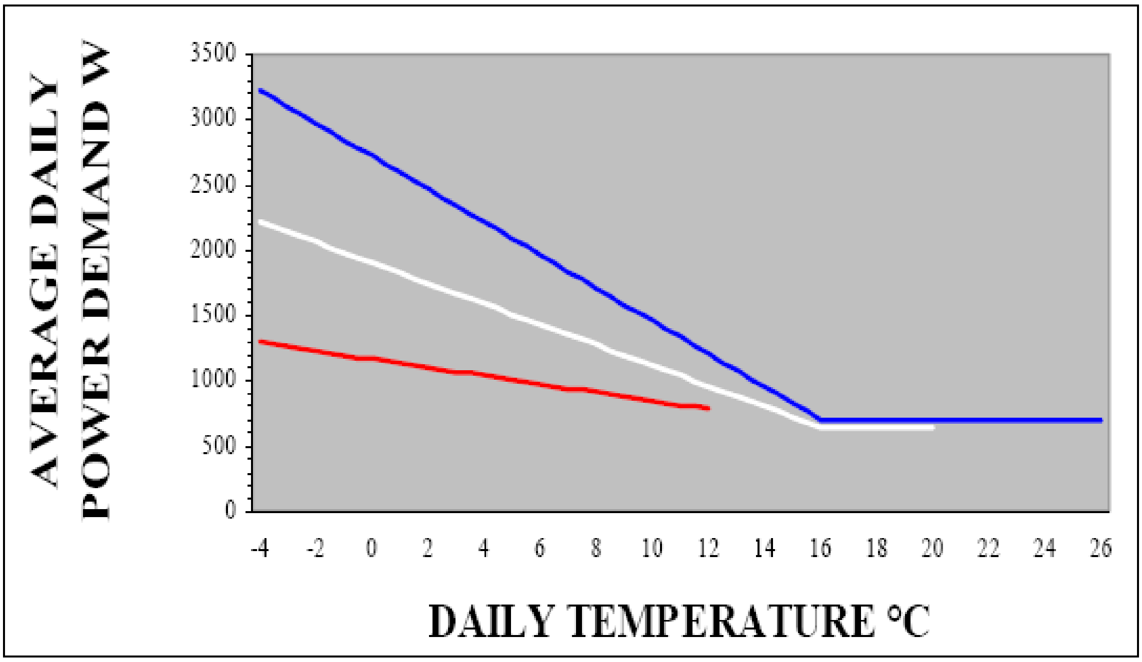

Figure 2. Tempo Customer Power Demand vs Outdoor Temperature

HOW LOAD REDUCTION WAS MEASURED

HOW GREENHOUSE EMISSIONS REDUCTION WAS CALCULATED

TIMING OF LOAD/EMISSIONS REDUCTION

AVOIDED COSTS

ACTUAL PROJECT COSTS

PROJECT COST FROM THE SOCIETAL PERSPECTIVE

ASSESSMENT OF OVERALL PROJECT EFFECTIVENESS

While the Tempo tariff has been successful, less than 20% of electricity customers in France have chosen Option Tempo. Tempo customers have very particular customer profiles and are interested in managing their energy use. They are prepared to constrain their lifestyles to make comparatively small financial savings relative to their incomes.

The Tempo tariff was designed specifically for the situation where EDF is a monopolistic generator and retail supplier of electricity. However, it is not adapted to an open market situation.

In the French open electricity market:

- the network use of system charge does not vary between seasons; and
- the value of peak load reduction is not reflected in spot prices for energy which are less volatile than the marginal costs of supply.

If EDF needs to manage its global load curve in an open electricity market, it will probably have to develop other types of dynamic pricing for mass market customers. The feedback from Tempo customers will be very useful in developing new customer which include electricity supply and services.

In July 2009, EDF discontinued the Tempo tariff for new customers and for customers who are on the tariff at their current residence and then move house.

PROJECT INFORMATION RESOURCES

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DSM-IN01 SEPARATION OF AGRICULTURAL FEEDERS FOR LOAD CONTROL, GUJARAT

Last updated	3 November 2010
Location of Project	Uttar Gujarat, India
Year Project Implemented	2005/06
Year Project Completed	2006/07
Name of Project Proponent	Government of Gujarat
Name of Project Implementor	Uttar Gujarat Vij Company Limited (UGVCL)
Type of Project Implementor	Electricity retailer / supplier Electricity distribution (wires) business
Purpose of Project	Separation of agricultural feeders for load control and to supply 24 hour power supply to all consumers
Project Objective	Minimising outages Reducing peak loads Reducing overall load
Project Target	Whole electricity network
DSM Measure(s) Used	Load shifting
Specific Technology Used	Building new electricity lines to enable separation of agricultural feeders from lines serving non-agricultural customers
Market Segments Addressed	Agricultural electricity end users

REGULATORY REGIME

Uttar Gujarat Vij Company Limited (UGVCL) is a government-owned electricity distributor and retailer. UGVCL started functioning in April 2005 and assumed responsibility for the distribution and retail supply of electricity to northern parts of the State of Gujarat, with a network spread over 50,000 kilometres serving a customer base of more than 2.4 million.

In 2003, the Government of Gujarat announced a scheme called "Jyotigram Yojana" (JGY) to provide continuous three phase power supply to rural areas of the State to improve the quality of life of the rural population. Under the JGY scheme, power is supplied for 24 hours to domestic, commercial, industrial consumers and eight hours to agricultural category consumers.

To receive the benefits of JGY, a village Panchayat (local government body) pays a registration fee of INR1000 and up to 30% of the estimated cost of building any augmentation or expansion required to the electricity network, with a maximum payment of INR25,000. The balance of the cost is paid by the Gujarat Government.

DRIVERS FOR PROJECT

UGVCL was facing power shortages during the morning peak hours and was not able to supply quality power to all customer categories resulting in load shedding, which was affecting the growth of the rural economy.

Maximum and minimum demand on the UGVCL system during FY 2005/06 was 1770 MW (morning hours) and 1100 MW (night hours) respectively, creating a peak and a dip in the daily load curve. This also led to the shortage of peaking capacity during the morning hours. The annual load profile for the UGVCL network for the financial year 2005/06 is presented in Figure 1.

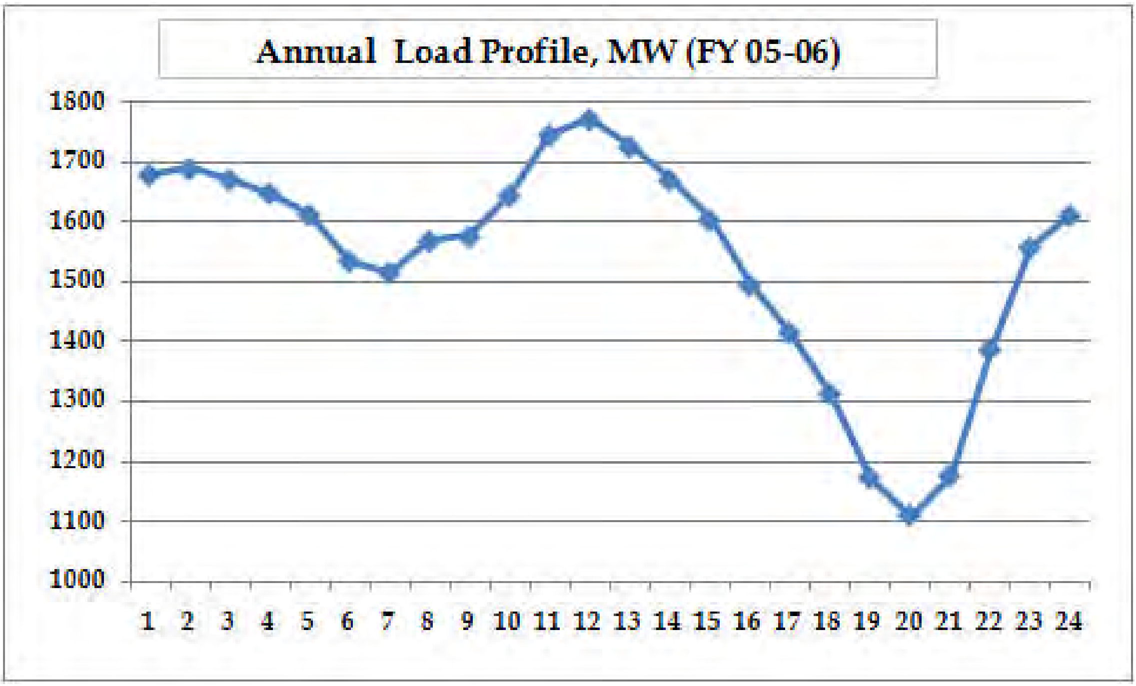

Figure 1. Annual Load Profile of UGVCL for Financial Year 2005/06

The demand from each customer category is different in nature and occurs at different periods and for different intervals during the day. Since capacity addition is a very costly and time consuming process, management of end-user loads was thought to be an appropriate DSM measure to minimize peak demand on the utility infrastructure and achieve better utilization of power plant capacity.

Generally, agricultural loads (mainly pumping water for irrigation), and residential, commercial and industrial loads in towns and villages are all connected to the same rural feeders. This project separated the agricultural pumping load (which does not require a 24 hour supply) from the other types of load. This enabled electricity distributors to implement direct load control of agricultural pumps by establishing schedules specifying the times during the day when each agricultural feeder would be energised. The main objective of implementing this direct load control program was to flatten the load curve to provide sufficient network capacity for the morning and evening peaks.

Water pumping load in the agricultural sector in India is important for several reasons. Agricultural pump sets are often supplied by long rural lines which are costly to build and maintain and have large line losses. The electricity supply to pumps is often unmetered and electricity is effectively supplied free of charge. In these cases, electricity distributors have to bear the supply cost and there is no incentive for agricultural customers to use electricity efficiently.

DESCRIPTION OF PROJECT

In the “Jyotigram Yojana" scheme, the Government decided to separate agriculture pump set connections from the domestic light and fan (DLF) connections by constructing separate 11 KV feeders to supply the pump sets.

To separate the agricultural feeders, UGVCL erected the following new lines with a total expenditure of INR 2,980 million:

High voltage lines: 15,461.49 km

Low voltage lines: 2,043.90 km

New transformers: 2,088

UGVCL divided all agricultural feeders into different groups and started rearranging the power supply schedule in order to obtain the optimum load curve throughout the day. UGVCL also constantly observed the impact of these activities on the load curve. Based on the analysis, UGVCL made necessary changes in the number of agricultural feeder groups as well as the power supply schedule. UGVCL has increased the number of groups from 16 to 31 during the period October 2006 to March 2009. Changes made by UGVCL in the number of groups since October 2006 are shown in Figure 2.

Sr No	No of AG feeder Groups	Period	Name of AG feeder Groups
1	16	April'06 to Sept''06	A11-12/B11-12/C11/D11/K11-12/L11-12/M11-12/N11-12/M/N
2	30	1.10.06 to 07.07.07	A11-12/B11-12/C11-12-13/D11-12-13/K11-12-13-14-15/L11-12-13-14-15/M11-12/N11-12/M/N/P11-12/Q11-12
3	28	08.07.07 to 04.10.08	A11-12/B11-12/C11-12-13/D11-12-13/K11-12-13-14-15/L11-12-13-14-15/M11-12/N11-12/ P11-12/Q11-12
4	31	05.10.08 to 23.05.09	A11-12/B11-12/C11-12-13/D11-12-13/K11-12-13-14-15-16/L11-12-13-14-15-16/M11-12-13/N11-12/ P11-12/Q11-12

Figure 2. Changes in Agricultural Feeder Groups, April 2006 to May 2009

The resulting reduction in overall load on the UGVCL network enabled a continuous 24 hour supply to be provided to domestic, commercial and industrial customers connected to the non-agricultural feeders.

RESULTS

<table>
<tr><th>Residential Customers Participating</th><th colspan="2">Commercial and Small Industrial Customers Participating</th><th>Agricultural Customers Participating</th><th>Large Industrial Customers Participatin g</th><th>Additional Generation Installed</th></tr>
<tr><td>1,504,935</td><td colspan="2">189,352</td><td>205,289</td><td>26,396</td><td></td></tr>
<tr><th>Peak Load</th><th>Peak Load Reduction</th><th>Duration of Peak Load Reduction</th><th>Overall Load Reduction</th><th>Energy Savings</th><th>Greenhouse Emissions Reduction</th></tr>
<tr><td>1,770 MW</td><td>266 MW</td><td>4 hours</td><td></td><td>1,521 GWh</td><td>632,290 tC02-e</td></tr>
</table>

The impact of the "Jyotigram Yojna" scheme on the UGVCL load curve from the base year 2005/06 to 2008/09 is shown in Figure 3. Erection of separate high and low voltage lines and rearrangement of the power supply schedule for agricultural feeders resulted in narrowing the gap between the maximum and minimum demand and flattening the load curve throughout the day.

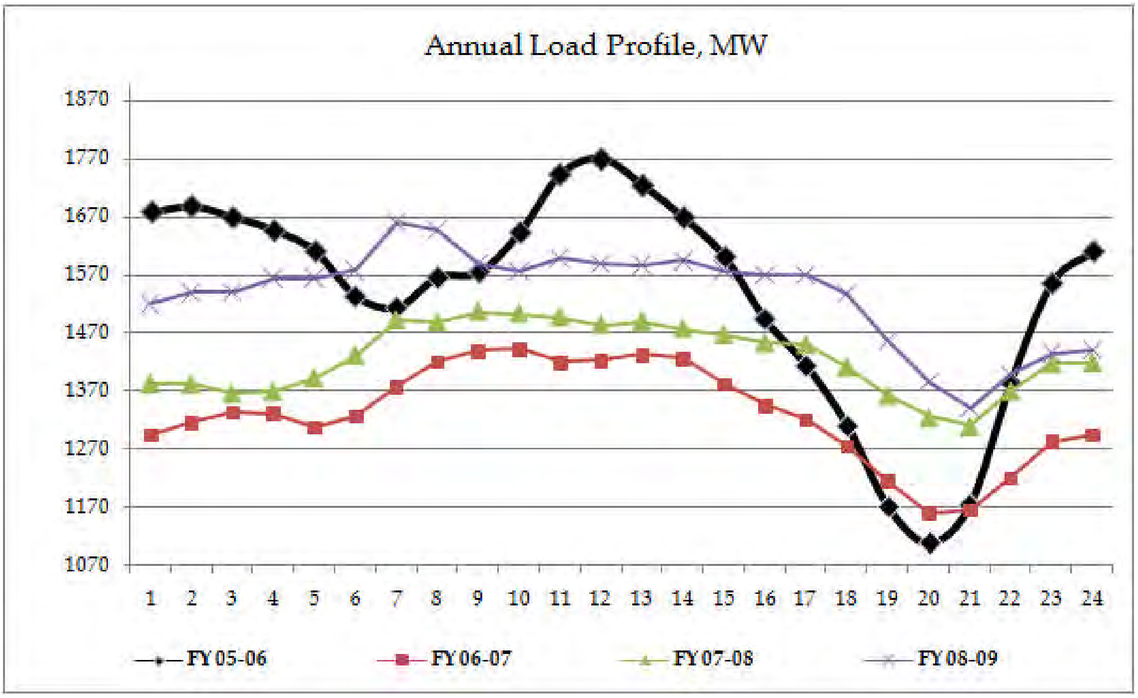

Figure 3. Changes in the UGVCL Load Curve from the Base Year 2005/06 to 2008/09

Major achievements of the project included:

- maximum and minimum demand of UGVCL during base year (FY 2005/06) were 1770 MW and 1100 MW respectively, a major difference of 670 MW;
- despite a growth of 21.48% in sales from 8,852 GWh in FY 2005/06 to 10,754 GWh in FY 2008/09, the difference between the peak and minimum demand has reduced significantly compared to the base year; the recorded differences between the maximum and minimum demand during FY 2006/07, FY 2007/08 and FY 2008/09 were 283 MW, 197 MW and 319 MW respectively;
- the load factor at the interface between the transmission system and UGVCL's distribution system was 86.67% during the base year (FY 2005/06); this increased to 92.29%, 94.73% and 92.54% during FY 2006/07, FY 2007/08 and FY 2008/09 respectively;
- the separation of agricultural feeders, grouping into various groups and rearrangement of the power supply schedule has successfully resulted in flattening the load curve of UGVCL and avoided investment in generation, transmission and distribution infrastructure.

Figure 4 (page 92) shows the calculation of generation capacity avoided by the JGY scheme and the consequent reduction in greenhouse gas emissions.

HOW LOAD REDUCTION WAS MEASURED

HOW GREENHOUSE EMISSIONS REDUCTION WAS CALCULATED

The methodology first calculated the average avoided generation capacity, taking into account the improvement in the load factor due to the separation of agricultural feeders. The average reduction in greenhouse gas emissions was then calculated using the average grid emission factor of the Western Grid (i.e. 0.82 kg of CO_2 per kWh) issued by Central Electricity Authority.

TIMING OF LOAD/EMISSIONS REDUCTION

AVOIDED COSTS

UGVCL would have had to plan for the additional generation capacity to serve the increase in the number of consumers and their energy consumption compared to the base year. However, separation of agricultural feeders and rearrangement of power supply schedule has resulted in the improved load factor and reduction in investment requirement for generation, transmission and distribution infrastructure.

ACTUAL PROJECT COSTS

INR 2,980 million paid by UGVCL

Sr. No.	Description	Units	FY 2005-06	FY 2006-07	FY 2007-08	FY 2008-09
1	Average Maximum Demand	MW	1772	1443	1508	1661
2	Average Demand	MW	1537	1332	1429	1537
3	Load Factor at T<>D interface		0.867307504	0.922994734	0.947311486	0.925459238
4	Total Energy Sales	MU	8852	9590	10245	10754
5	Distribution Losses	%	22.95	15.82	17.31	16
6	Energy Requirement at T<>D level	MU	11488.64374	11392.25469	12389.64808	12802.38095
7	Average Demand at T<>D level	MW	1311.489011	1300.485695	1414.343388	1461.459013
8	Peak Demand considering the base year load factor (assuming project would have not implemented)	MW	1512.138434	1499.451682	1630.728873	1685.052886
9	Peak Demand considering modified load factor	MW	1512.138434	1408.984957	1493.007749	1579.171672
10	Avoided Generation Capacity addition at T<>D level	MW	0	90.46672424	137.721124	105.881214
11	Transmission Losses including pooled losses	%	0	5.03	4.79	5.62
12	Avoided Generatin Capacity	MW	0	95.25821232	144.6498519	112.1860712
13	Average avoided generation capacity	MW	117.3647118			
13	Equivalent reduction in energy requirement considering 75% PLF	MWh	771086.1565			
14	Average Emission Reduction Factor	tCO2/MWH	0.82			
15	Average Emission Reduction	tCO2	632290.6484			

Figure 4. Calculation of Avoided Generation Capacity and Consequent Emissions Reduction

PROJECT COST FROM THE SOCIETAL PERSPECTIVE

ASSESSMENT OF OVERALL PROJECT EFFECTIVENESS

By implementing the Gujarat Government's "Jyotigram Yojana" scheme, UGVCL is able to provide quality power supply to all residential, commercial and industrial consumers in rural areas for 24 hours. The improvement in standard of living of villagers is remarkable and satisfying. Also, separation of agricultural feeders, grouping into various groups and rearrangement of the power supply schedule has successfully resulted in to the flattening the load curve of UGVCL, improved load factor and avoided investment requirement for generation, transmission and distribution infrastructure.

PROJECT INFORMATION RESOURCES

Contacts

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Sources

DSM-IN02 MODEL FOR MITIGATING LOAD SHEDDING IN PUNE URBAN CIRCLE

Last updated	3 November 2010
Location of Project	Pune, Maharashtra, India
Year Project Implemented	2007
Year Project Completed	Continuing
Name of Project Proponent	Confederation of Indian Industry (CII)
Name of Project Implementor	Maharashtra State Electricity Distribution Company Limited (MSEDCL)
Type of Project Implementor	Electricity retailer / supplier Electricity distribution (wires) business
Purpose of Project	Deferring augmentation of the electricity network
Project Objective	Minimising outages Reducing peak loads
Project Target	Network element (eg a specific line or substation)
DSM Measure(s) Used	Distributed generation
Specific Technology Used	Standby generators - in India standby generators are known as "captive power plants" and the owners of the generators are termed "captive power providers" (CPPs)
Market Segments Addressed	Commercial and small industrial electricity end users Large industrial electricity end user

REGULATORY REGIME

In June 2005, the former Maharashtra State Electricity Board (MSEB) was unbundled into three separate companies responsible for electricity generation, transmission and distribution, plus a holding company. Maharashtra State Electricity Distribution Company Limited (MSEDCL) is responsible for distribution and retailing of electricity in most of the State of Maharashtra with a consumer base of more than 17.6 million and sales of 50,041 GWh in financial year 2008/09. In the Mumbai region, MSEDCL and two private companies are responsible for distribution and retailing.

The distributed generation model for mitigating load shedding in the Pune urban circle was developed by MSEDCL in consultation with the Confederation of Indian Industry (CII). CII proposed to utilise surplus power available from Captive Power Producers (CPPs) during peak hours and make available the grid power for supply to other consumers in the Pune urban circle.

The regulatory process for implementation of the CII Pune model took almost a year from the introduction of the proposal to release of the first order for implementation. Further deliberations continued for another year.

Following are the main events in this regulatory process:

- in its Order dated 3rd August 2005, Maharashtra Electricity Regulatory Commission (MERC) laid down the principles and protocol for load shedding, and directed MSEDCL to examine the CII proposal for utilising surplus captive power in Pune and revert to MERC with a detailed pilot scheme in consultation with CII;

- on 25th October 2005, CII submitted its detailed proposal to MERC for the utilisation of dormant captive power available from some of its members to mitigate load shedding in Pune Urban Circle;
- on 16th Nov 2005. MSEDCL submitted its observations on the proposal submitted by CII;
- on 4th November 2005, MERC issued a Public Notice making the CII proposal available along with MSEDCL's observations on the proposal, inviting written comments and suggestions from the public, and advertising the date of a Public Hearing;
- the Public Hearing was conducted at Pune on December 12, 2005. Approximately 30 individuals/organizations participated in this public process. During the hearing, MERC asked MSEDCL to provide clarifications on certain economic aspects and directed MSEDCL to submit revised economics of the proposal;
- MERC finalized the policy for purchase of power from fossil fuel-based CPPs and issued an Order on January 25, 2006. In this Order, MERC directed MSEDCL to make all the operational arrangements including integration of CPPs with the grid, installation of export-import meters, etc. It also directed CII to submit the details of variable cost computations for each of the CPPs, including heat rate, fuel used, calorific value of fuel, cost of fuel, etc;
- on 10th February 2006, CII submitted the variable/increment cost details that would be incurred by CPPs when they run their generator sets for captive consumption;
- MERC analysed the details submitted by CII and approved the normative fuel efficiency and the variable cost of generation for additional power provided by captive units. It also allowed recovery through a Fuel Cost Adjustment (FAC) mechanism in case of variation in fuel prices;
- on 5th April 2006, in view of MERC's decision to treat recovery of incremental costs from consumers in the Pune region as a tariff matter, MSEDCL filed a separate Proposal for approval of recovery of additional cost as a reliability charge for mitigating load shedding in Pune Circle;
- MERC decided to hold the Public Hearing in this regard and directed MSEDCL to publish notices inviting written comments and suggestions from the public, and advertising the date of a Public Hearing;
- the Public Hearing was held at Pune on April 15, 2006. Around 130 individuals and organizations participated in this public process. MSEDCL made a presentation at the Public Hearing;
- in its order dated May 16, 2006, MERC approved a reliability charge of INR 0.42 per kilowatt-hour for implementing the CII proposal, to be levied on Pune Urban Circle consumers, excluding domestic consumers consuming up to 300 kilowatt-hours per month;
- on 23 October 2007, MSEDCL submitted a Petition before MERC to allow MSEDCL to recover additional reliability charges from Pune City consumers because of the higher gap between demand and supply that had developed;
- MERC scheduled a Technical Validation Session (TVS) on November 7, 2007, and directed MSEDCL to serve a copy of its Petition to the four consumer representative organisations who are authorised to represent the interest of consumers before MERC;

- during the TVS session, MERC gave its views and suggestions to address the issue of recovery of additional reliability chargers from Pune City consumers and directed MSEDCL to submit a revised proposal;
- on December 31, 2007, MSEDCL submitted a Revised Petition in accordance with MERC's directions during the TVS;
- in its order dated March 31, 2007, MERC issued clarifications on the appointment of a distribution-based franchisee for implementation of the CII model in Pune City.

DRIVERS FOR PROJECT

Maharashtra State witnessed rapid economic growth in the decade to 2005, leading to increased demand for electricity. But the growth in electricity generation capacity in the State did not keep pace with the demand growth.

In 2005/06, Maharashtra State faced a demand/supply gap of 2600 MW to 3500 MW during the peak hours of the day and 2200 MW during non peak hours. This deficit led MSEDCL to resort to load shedding across all the regions of the State. Because the demand/supply gap was expected to prevail for the next five years at least, there was an urgent need to resolve the situation across the entire State

In this context, CII proposed to utilize surplus power available from CPPs during peak hours and make available the grid power for supply to other consumers in the Pune Urban Circle. It was intended that the project could be replicated in other cities across the State based on the performance evaluation and incorporating the learning from the pilot scheme.

DESCRIPTION OF PROJECT

Figure 1 (page) is a map of Pune Urban Circle showing the various commercial divisions and the network infrastructure.

During FY 2005/06, the average load in the Pune Urban Circle was 751 MW, of which sheddable load was 358 MW while non-sheddable load was 393 MW. The average evening peak load during FY 2005/06 was 834 MW, while the average morning peak load was 742 MW. Normal load shedding in Pune was about 1200 MWh/day during FY 2005/06. MSEDCL had implemented several DSM measures and expected to bring down the load shedding in Pune to between 1000 and 1100 MWh/day.

MSEDCL undertook sensitivity analysis and identified three scenarios for Pune with load shedding of: (1) 180 MWh/day; (2) 300 MWh/day; and (3) 540 MWh /day, depending upon the power shortage in the state of Maharashtra. MSEDCL found that with the largest load shedding scenario of 540 MWh/day, the maximum load to be curtailed was approximately 90 MW.

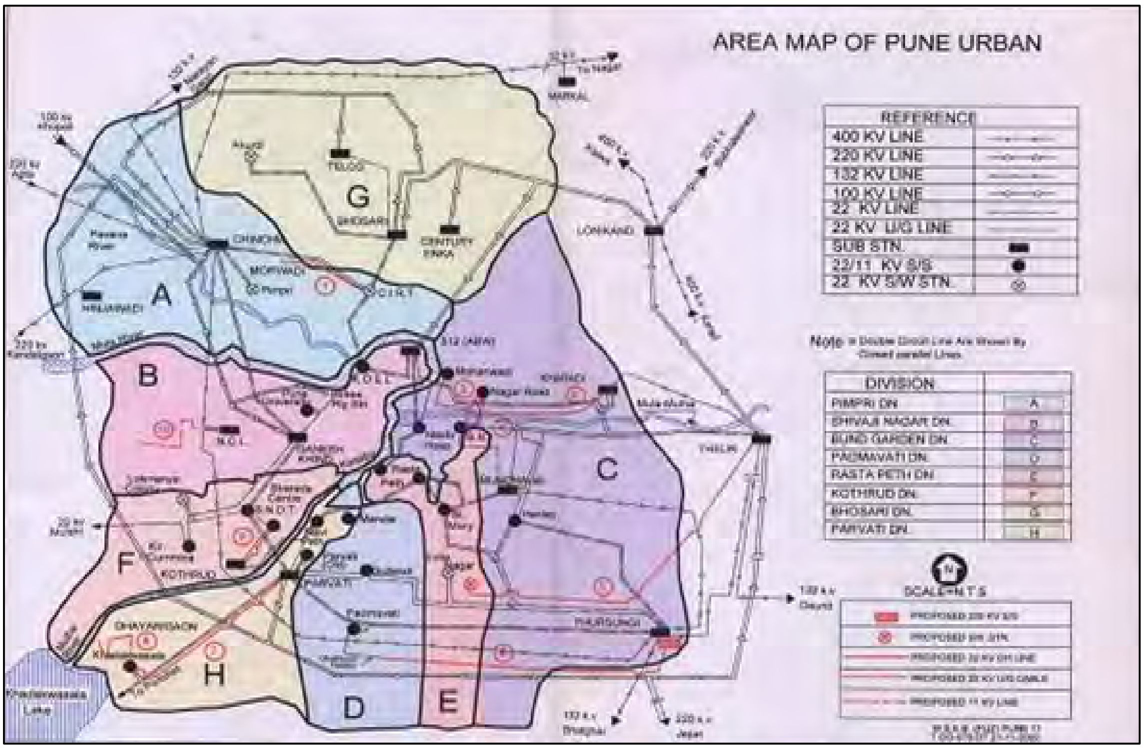

Figure 1. Map of Pune Urban Circle showing Commercial Divisions and Network Infrastructure

CII compiled information on the installed capacity of captive/standby generator sets on the premises of high voltage consumers located in the Rasthapet and Ganeshkhind circles in Pune and found that the total installed capacity was more than 400 MW. CII also found that the top 30 major captive power producers (CPPs) had unutilized capacity in excess of 100 MW which was equivalent to the load curtailment in the largest load shedding scenario.

Based on this information, CII developed a proposal to mitigate load shedding. CII proposed that industries with captive/standby gensets that were drawing power from the MSEDCL grid on a 24 hour basis should reduce their off-take of power from the grid during certain specified peak periods and instead operate their own generators. The additional grid power made available through this strategy could then be diverted by MSEDCL to low voltage customers to mitigate load shedding. This would eliminate the need for load shedding in the Pune Urban Circle.

The CPPs would be reimbursed the incremental cost for electricity they generated on-site during the specified peak periods. Payments to CPPs for the reduction in the quantity of electricity consumed from the grid would comprise the difference between the variable cost of running the on-site generator sets and the applicable MSEDCL peak hour variable tariff. The extra costs incurred by MSEDCL in mitigating load shedding would be recovered by a 'reliability surcharge' on the electricity tariffs for all consumers, including the CPPs, located in the two circles of the Pune urban region.

To determine the tariff increases required, MSEDCL in consultation with CII undertook sensitivity analysis for three different scenario of load shedding, including a detailed analysis of the costs incurred in facilitating generation of additional power by captive units in Pune during the peak periods and making available the grid power for supply to other consumers. MSEDCL had to generate sufficient revenue to cover these costs from the quantities of electricity it transported across the low voltage network. The revenue earned from the two Pune circles had to pay the differential cost of generation by the CPPs and also take care of any cross subsidy (including technical losses and collection efficiency) components and fuel reimbursement charges. The results of this sensitivity analysis comprising the increases in tariffs across all customer categories are shown in Table 1.

Table 1. Impact on Tariffs for Three Different Scenarios

Load Shedding (MWh/day)	Annualised Load Shedding (MWh/year)	Additional Revenue Required (INR)	Tariff Increase for all Customer Classes (INR/kWh)
180	64,800	4.409 million	0.14
300	108,000	7.349 million	0.23
540	194,400	13.229 million	0.41

In implementing this model, MSEDCL established a mini-load dispatch centre to co-ordinate with all the CPPs regarding their output capacities during the specified peak periods. Grid connectivity with a synchronising facility was provided to operate captive/standby generators either in stand-alone mode, island mode or parallel mode. An appropriate protection system was provided to the CPPs so as to safeguard MSEDCL's network against faults, particularly in the case of parallel operation. Export and import meters were installed to monitor the generation and consumption of CPPs to enable the calculation of the payments for incremental costs on an actual basis.

RESULTS

<table>
<tr><th>Residential Customers Participating</th><th colspan="2">Commercial and Small Industrial Customers Participating</th><th>Agricultural Customers Participating</th><th>Large Industrial Customers Participatin g</th><th>Additional Generation Installed</th></tr>
<tr><td></td><td colspan="2">871,149</td><td></td><td>1,365</td><td>100 MW</td></tr>
<tr><th>Peak Load</th><th>Peak Load Reduction</th><th>Duration of Peak Load Reduction</th><th>Overall Load Reduction</th><th>Energy Savings</th><th>Greenhouse Emissions Reduction</th></tr>
<tr><td>834 MW</td><td>100 MW</td><td>3.5 hours</td><td></td><td>20,440 MWh</td><td>16,761 tC02-e</td></tr>
</table>

HOW LOAD REDUCTION WAS MEASURED

HOW GREENHOUSE EMISSIONS REDUCTION WAS CALCULATED

For the calculation of GHG emissions reduction achieved by this project, the average grid emissions factor for the Western Region issued by Central Electricity Authority was used (0.82 kg of CO2 per kWh). Captive power plants supply power at the consumer's site and thereby avoid transmission and distribution losses. Hence the quantum of energy saved was increased by the average 15% losses in the Rasthapet and Ganeshkhind circles of Pune.

TIMING OF LOAD/EMISSIONS REDUCTION

AVOIDED COSTS

The MSEDCL model to mitigate load shedding in the Pune Urban Circle helped the utility avoid not only load shedding by bridging the demand supply gap during peak hours but also investment in transmission and distribution infrastructure.

ACTUAL PROJECT COSTS

Extra costs incurred comprised the difference between the variable cost of running the on-site generator sets and the applicable MSEDCL peak hour variable tariff. These extra costs incurred by MSEDCL in mitigating load shedding were recovered by a 'reliability surcharge' on the electricity tariffs for all consumers, including the CPPs, located in the two circles of the Pune urban region. This additional charge worked out to be INR 0.42 per kilowatt-hour.

PROJECT COST FROM THE SOCIETAL PERSPECTIVE

ASSESSMENT OF OVERALL PROJECT EFFECTIVENESS

This project was very effective in managing demand and preventing load shedding. This is a relatively expensive option but flexible enough to deploy in a range of situations. Implementation of this project avoided investment in transmission and distribution networks, improved the quality and reliability of the supply and resulted in reduced greenhouse gas emissions. Similar projects can also be implemented by other distribution utilities which are facing acute power shortages and consequently are implementing load shedding.

PROJECT INFORMATION RESOURCES

Contacts

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Sources

DSM-IN03 PILOT AGRICULTURAL DEMAND SIDE MANAGEMENT PROJECT AT SOLAPUR, MAHARASHTRA

Last updated	4 November 2010
Location of Project	Solapur, Maharashtra, India
Year Project Implemented	2011 (proposed)
Year Project Completed	
Name of Project Proponent	Bureau of Energy Efficiency, Ministry of Power, Government of India
Name of Project Implementor	Maharashtra Electricity Distribution Company Limited (MSEDCL) and energy services companies
Type of Project Implementor	Electricity retailer / supplier Electricity distribution (wires) business ESCO/Energy management company
Purpose of Project	Implementing government policy
Project Objective	Reducing overall load Assisting electricity end users to be more energy efficient Assisting electricity end users to reduce greenhouse emissions
Project Target	Network region
DSM Measure(s) Used	Energy efficiency
Specific Technology Used	Replacing existing inefficient agricultural pump sets with 4/5 star rated energy efficient pump sets
Market Segments Addressed	Agricultural electricity end users

REGULATORY REGIME

In June 2005, the former Maharashtra State Electricity Board (MSEB) was unbundled into three separate companies responsible for electricity generation, transmission and distribution, plus a holding company. Maharashtra State Electricity Distribution Company Limited (MSEDCL) is responsible for distribution and retailing of electricity in most of the State of Maharashtra with a consumer base of more than 17.6 million and sales of 50,041 GWh in financial year 2008/09. In the Mumbai region, MSEDCL and two private companies are responsible for distribution and retailing.

The State regulator, Maharashtra Electricity Regulatory Commission (MERC) has expressed its commitment to energy efficiency, energy conservation and DSM and has established a positive regulatory framework for energy efficiency and DSM initiatives.

In 2005, MERC's Tariff Regulations treated energy conservation and energy efficiency measures as a 'supply' source and stipulated that long term power procurement plans prepared by distribution licensees should include proposals for implementing energy conservation and energy efficiency measures.

To avoid power shortages and minimize costly power purchases, MERC directed the distribution licensees to carry out energy conservation and load management initiatives for all power-intensive consumers on both a short-term and long-term basis.

MERC has implemented several tariff-based measures, such as a time of day tariff, to encourage consumers to reduce their electricity demand during certain times of the day. In particular, MERC levies a Load Management Charges on consumers who do not restrict their consumption within a stipulated limit, and provides a Load Management Rebate to consumers who restrict their consumption below the stipulated limit. MERC directed all the distribution utilities to use the net amount collected from these measures as a Load Management Fund for promotion and implementation of energy efficiency, energy conservation and demand side management measures.

In addition, to ensure that consumers are not burdened with a high cost of power procurement, MERC in its Multi Year Tariff Order of April/May 2007, directed distribution utilities in Mumbai city to use DSM measures to reduce by two per cent their high-cost power purchases.

MERC has allowed the distribution licensees in the State to recover all costs incurred by them on any DSM-related activity, including planning, designing, implementing, monitoring and evaluating DSM programmes. These costs are added to the electricity distributors' annual revenue requirements to enable their funding through increases in electricity prices.

The Bureau of Energy Efficiency has initiated a national level Agricultural Demand Side Management Programme to capture untapped potential in the agricultural sector. Based on the directives given by MERC, MSEDCL decided to participate in this DSM programme.

DRIVERS FOR PROJECT

Water pumping load in the agricultural sector in India is important for several reasons. Agricultural pump sets are often supplied by long rural lines which are costly to build and maintain and have large line losses. The electricity supply to pumps is often unmetered and electricity is effectively supplied free of charge. In these cases, electricity distributors have to bear the supply cost and there is no incentive for agricultural customers to use electricity efficiently.

Power consumption in the agriculture sector in India increased from 4,470 GWh during 1970/71 accounting for 10.21% of total power consumption, to 99,023 GWh during 2006/07, accounting for 21.7% of the total consumption. This high growth rate is a result of aggressive rural electrification coupled with a policy of pricing electricity to farmers at below cost. Given the low or no cost of power, farmers use inefficient pumps for irrigation pumping. The excessive use of electricity in agriculture leads to a high subsidy burden on Indian States, estimated at about INR 4,000 billion.

In financial year 2008/09, Maharashtra State experienced power shortages of 21.4% in energy and 23.7% in peak demand. To meet the power shortage, Maharashtra State Electricity Distribution Company Limited (MSEDCL) relied upon short term external power purchases, which are high cost. Consequently, MSEDCL was required to comply with the MERC Order to reduce two per cent of high-cost power purchases by implementing DSM measures.

Agricultural DSM provides opportunities for reducing the overall power consumption, improving efficiencies of ground water extraction and reducing the subsidy burden on the States without sacrificing the service obligation to this sector.

DESCRIPTION OF PROJECT

The Bureau of Energy Efficiency initiated the Agricultural Demand Side Management Programme (Ag DSM) with the objective of creating an appropriate framework for market-based interventions in the agricultural pumping sector, particularly by establishing a favourable policy environment to promote Public Private Partnerships (PPPs) as a mechanism to implement projects. Because of the large demand/supply gap prevalent in the State of Maharashtra, the first pilot Ag DSM programme was launched at Mangalwedha subdivision of Solapur Circle in Maharashtra.

This pilot Ag DSM project covers 2221 agricultural pumps connected on four feeders (Bramhapuri, Nandeshwar, Borale and Bhose) in Mangalwedha subdivision. These four feeders are segregated agricultural feeders supplying power to 11 villages. The major load on the feeders is irrigation pumping; a very small proportion of the load is contributed by household consumers living on the farms.

First Phase

In the first phase of the project, the Detailed Project Report (DPR) was prepared after an exhaustive site survey including a detailed energy audit for each pump set connected to the project feeder lines. During the energy audit, detailed information about all the agricultural consumers such as details about pumps (number, type, make, age and ratings), water requirements/consumption, status of meter installation, number of harvesting cycles, cropping pattern, underground water level in different seasons, power supply pattern and socio-economic conditions etc. was collected and analyzed.

Because of the energy shortage in the State, agricultural consumers are supplied with power only for eight hours each day and the availability of the supply also varies for different periods of day. Hourly demand data indicating the variation in supply hours for these four feeders on 12 November 2008 is shown in Figure 1 (page 104). Hourly demand for all the four feeders varies continuously throughout the day, mainly due to variation in the number of pumps and their operating hours as well as variation in power supply availability.

In addition to daily demand variation, there is also variation over seasons, as shown in Figure 2 (page 104). Power consumption on the feeders decreases during the rainy season (June to September) and increases during the summer months (March to May). The main reason for increased power consumption during summer is the lowering of the ground water level. Power consumption of the Bramhapuri feeder is comparatively high because of sugarcane cultivation in the area served by the feeder.

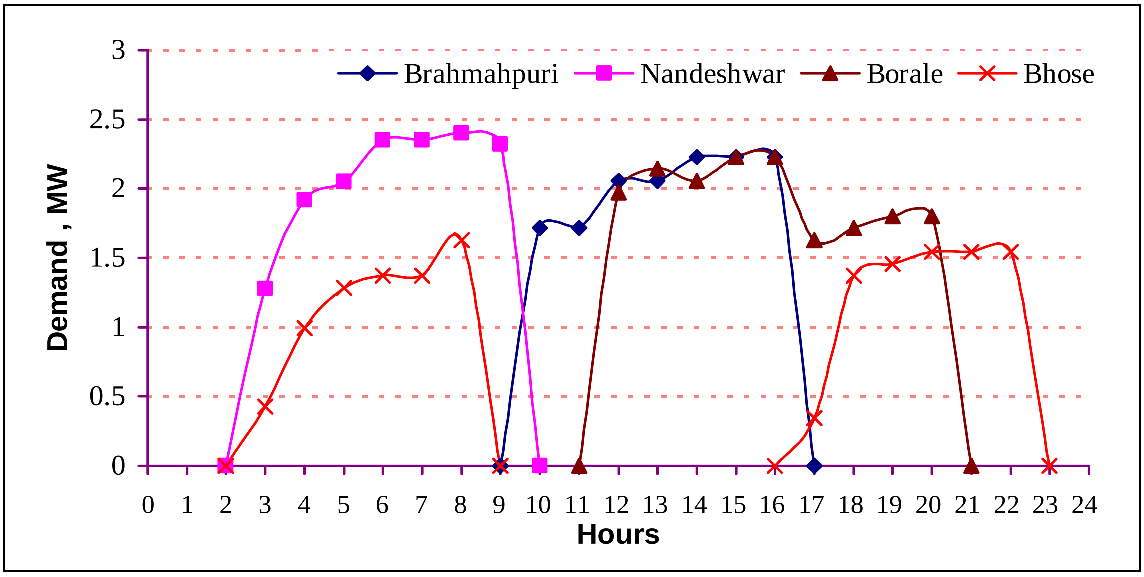

Figure 1. Hourly Demand on the Pilot Project Feeder Lines, 12 November 2008

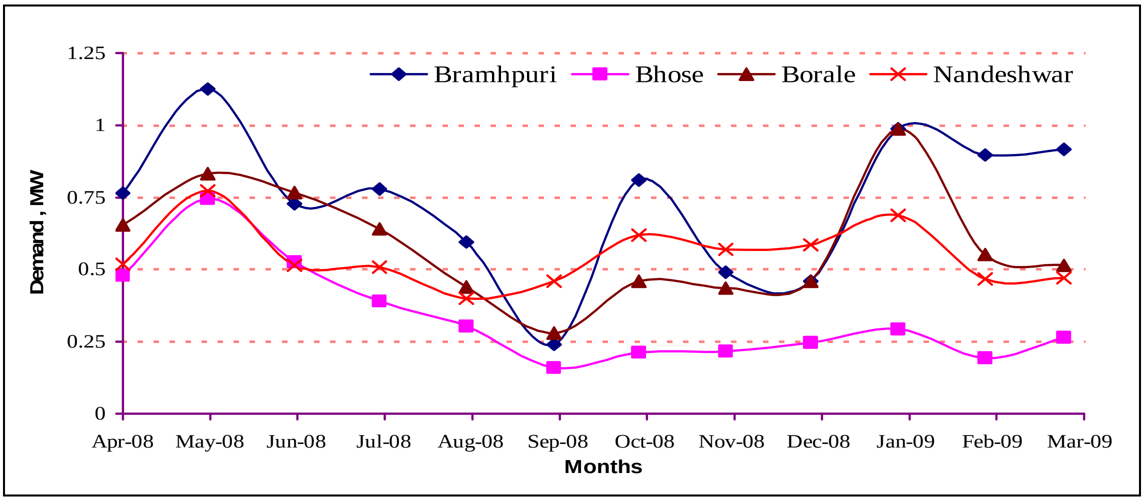

Figure 2. Monthly Demand on the Pilot Project Feeder Lines, April 2008 to March 2009

Data collected during the site survey enabled calculation of the average operating efficiency of each pump set. From a total of 2221 pumps connected to the project feeders, 1670 pumps were tested on site. The overall weighted average operating efficiency based on the nameplate ratings for all the pump sets was found to be only 28%.

To improve the operating efficiency, replacement of existing pumps with new energy efficient pump sets was recommended. Appropriate energy efficient pump sets were selected by analysing head and flow data for each pump set, together with the site water level variation and changes in cropping patterns. The overall weighted average operating efficiency of new energy efficient pump sets is expected to be 48.9%.

Second Phase

The second phase of the project involves implementing the replacement of existing pumps through an ESCO-based business model. MSEDCL had collected approximately INR 400 million through the Load Management Charge and had maintained this amount as a separate Load Management Fund, as directed by MERC. With approval from MERC, MSEDCL could utilize this Fund for implementation of Ag DSM.

After taking into account other possible financing options, three different ESCO-based business models were developed and categorized as "DISCOM Mode", "ESCO Mode" and "HYBRID Mode", as described below:

- in the DISCOM Mode, MSEDCL utilizes a part of the Load Management Fund for replacement of old inefficient pumps with new higher efficiency pump sets and outsources repair and maintenance of pumps and certain aspects of project works to a project contractor;
- in the ESCO Mode, an ESCO under contract with MSEDCL finances and implements the project; the ESCO would borrow the project debt and repay it from project revenues;
- in the HYBRID Mode, an ESCO provides part of project funds through debt and equity and signs a contract with MSEDCL, where part of the project fund would be contributed by MSEDCL through the Load Management Fund.

MSEDCL and BEE are in the process of engaging ESCOs to implement the proposed pilot Ag DSM project.

RESULTS

Residential Customers Participating	Commercial and Small Industrial Customers Participating		Agricultural Customers Participating	Large Industrial Customers Participatin g	Additional Generation Installed
			2,221		
Peak Load	**Peak Load Reduction**	**Duration of Peak Load Reduction**	**Overall Load Reduction**	**Energy Savings**	**Greenhouse Emissions Reduction**
4.8 MW	1.9 MW			6,100 MWh	4,941 tC02-e

The total energy consumption of the 2221 existing pump sets was calculated as 15.6 GWh per annum. On average a pump set operates for 1,642 hours during the year; consequently, implementation of the proposed pilot project will reduce energy consumption by 9.4 GWh, resulting in annual energy savings of 6.1 GWh.

The total demand of the existing pump sets has been estimated as 9.5 MW; installing efficient pump sets should reduce this to 5.8 MW. However due to variation in the supply availability periods the actual reduction in peak demand is estimated as 1.9 MW at an assumed diversity factor of 50%.

Implementation of the proposed project will also result in a reduction in greenhouse gas emissions of 4,941 tCO2-e per annum.

HOW LOAD REDUCTION WAS MEASURED

HOW GREENHOUSE EMISSIONS REDUCTION WAS CALCULATED

For the calculation of GHG emissions reduction achieved by this project, the average grid emissions factor for the Western Region issued by Central Electricity Authority was used (0.82 kg of CO2 per kWh). The reduction in energy consumption that would result from the implementation of the proposed pilot DSM project was estimated and this figure was then multiplied by the average grid emissions factor.

TIMING OF LOAD/EMISSIONS REDUCTION

AVOIDED COSTS

To be calculated after implementation of of the project.

ACTUAL PROJECT COSTS

Capital Cost

The total project capital cost estimate for the Ag DSM Pilot Project is INR 43.3 million. Different cost parameters are shown in Table 1.

Table 1. Estimated Capital Costs of the Pilot Project

Item	Cost in INR millions
Cost of Energy Efficient Pump Sets	40.18
Cost of dismantling existing pump set and installing EEPS	0.98
Cost of replacing foot valves for monoblock and flexible coupling pump sets	0.72
Replacement of GI pipes and fittings	1.18
Cost for Efficiency testing and demonstration - pre and Post installation	0.22
Total Project Cost	43.28
Total Project Cost Including R&M Cost for 4 years	57.57

Repair and Maintenance Cost

The annual repair and maintenance cost (post warranty period) for all the 2221 pumps is around INR 3.6 million. To continue the savings, repair and maintenance should be provided for four years (after a warranty period of one year). The total R&M cost for four years after warranty is INR 14.3 million. This cost could be funded either from the Load Management Fund or from the annual revenue generation through energy savings.

Financial Savings to MSEDCL

Agricultural consumers are supplied at a subsidised metered tariff of INR 1.10 per kWh whereas the average power tariff is INR 3.62 per kWh. Hence, MSEDCL is benefited by a reduction in agricultural energy consumption. In addition, revenue is effectively collected from only 18% of agricultural consumers in Mangalvedha subdivision. This leads to additional financial losses to MSEDCL which could be avoided by reduced consumption.

PROJECT COST FROM THE SOCIETAL PERSPECTIVE

ASSESSMENT OF OVERALL PROJECT EFFECTIVENESS

DISCOM Mode

The saved energy could be sold to other consumers at an average rate of INR 3.62 per kWh (FY 2008 Actual). The net annual energy saving for MSEDCL is 6.1 GWh which equates to a financial saving of INR 13.8 million with an investment of INR 43.3 million, showing a simple payback period of 3 years. The Internal Rate of Return (IRR) for a project cycle of 10 years is 33.5 %. If R&M for 4 years is provided through the Load Management Fund, the total investment required to implement the project is INR 58 million and the IRR of the project improves to 38.9%.

ESCO Mode

If the project is implemented through the ESCO mode, the energy savings would be shared between the ESCO and MSEDCL. Assuming 95% of the proposed energy savings are shared with the ESCO for 10 years, the IRR of the project is 19.21% for a project cycle of 10 years (a simple payback period of five years).

HYBRID Mode

For implementation of the project through the HYBRID Mode, where the ESCO invests 33% of the total capital cost and retains 55% of net savings, the project IRR is 27.27% for the ESCO and 12.83% for MSEDCL over a project cycle of five years (a simple payback period of four years).

Overall

The project is techno-economically viable and the detailed financial analysis provides attractive returns within a reasonable payback period. All the technical risks have been discussed and mitigated. The energy savings are assured considering that almost 75% of the pumps have been actually tested and efficiency levels verified. This evidence should give MSEDCL enough confidence to implement this Ag DSM pilot project on its own.

Alternatively, utilizing the Load Management Fund for part of the capital cost of the project with the balance of the investment provided by an ESCO is the simplest structure, and an appropriate business model for implementing the Ag DSM pilot project. The project provides attractive returns within a payback period of five years for project implementation through the HYBRID Mode. Therefore, the project is likely to have several ESCO's interested in participating in its implementation.

The overall benefits of this type of project to DISCOMs such as MSEDCL, farmers and the State Government are shown in Figure 3.

DISCOMs

- Reduction in technical and commercial loss levels
- Increase in revenue realisation by sale of saved energy to other consumers
- Increase in reliability and power supply quality
- Supply to more number of consumers without investment in additional infrastructure
- Additional CDM benefits could be availed for HVDS and Pump replacement

FARMERS

- Free of cost BEE Star labelled pump set will be provided
- Negligible maintenance cost during the warranty period
- Reduction in monthly energy bills due to 30 % of energy saved
- Power supply with better quality and less time for same water discharge
- Availability of trained local specialists to handle maintenance and repair of energy efficient pump sets

STATE GOVERNMENT

Reduction in subsidy

- Mitigation of Demand Supply Gap
- Sustainable Development
- Reduced Energy Intensity per GDP
- Additional investment in new power plants could be avoided

SOCIETY

- Reduced pollution levels
- Reduced energy Density for agricultural purpose

Figure 3. Overall Benefits of the Pilot Project

PROJECT INFORMATION RESOURCES

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Sources

DSM-IN04 EFFICIENT LIGHTING PROGRAMME, MUMBAI

Last updated	4 November 2010
Location of Project	Reliance Infrastructure supply area, Mumbai, India
Year Project Implemented	2006/07
Year Project Completed	2006/07
Name of Project Proponent	Reliance Infrastructure Limited (previously known as Reliance Energy Limited)
Name of Project Implementor	Reliance Infrastructure Limited (RInfra)
Type of Project Implementor	Electricity retailer / supplier Electricity distribution (wires) business
Purpose of Project	Deferring augmentation of the electricity network
Project Objective	Reducing peak loads Reducing overall load Assisting electricity end users to be more energy efficient
Project Target	Whole electricity network
DSM Measure(s) Used	Energy efficiency
Specific Technology Used	Compact fluorescent lamps (CFLs)
Market Segments Addressed	Residential electricity end users

REGULATORY REGIME

Reliance Infrastructure Limited (RInfra) is an electricity company operating for over 80 years in the field of generation, transmission, distribution and supply of electricity. The electricity distribution area served by RInfra under its license is divided into five divisions, covering an approximate area of 384 square kilometres in the western and eastern suburbs of Mumbai. RInfra serves a population of 9 million and has 2.63 million electricity consumers.

The State regulator, Maharashtra Electricity Regulatory Commission (MERC) has expressed its commitment to energy efficiency, energy conservation and DSM and has established a positive regulatory framework for energy efficiency and DSM initiatives.

In 2005, MERC's Tariff Regulations treated energy conservation and energy efficiency measures as a 'supply' source and stipulated that long term power procurement plans prepared by distribution licensees should include proposals for implementing energy conservation and energy efficiency measures.

To avoid power shortages and minimize costly power purchases, MERC directed the distribution licensees to carry out energy conservation and load management initiatives for all power-intensive consumers on both a short-term and long-term basis.

MERC has implemented several tariff-based measures, such as a time of day tariff, to encourage consumers to reduce their electricity demand during certain times of the day. In particular, MERC levies a Load Management Charges on consumers who do not restrict their consumption within a stipulated limit, and provides a Load Management Rebate to consumers who restrict their consumption below the stipulated limit. MERC directed all the distribution utilities to use the net amount collected from these measures as a Load Management Fund for promotion and implementation of energy efficiency, energy conservation and demand side management measures.

In addition, to ensure that consumers are not burdened with a high cost of power procurement, MERC in its Multi Year Tariff Order of April/May 2007, directed distribution utilities in Mumbai city to use DSM measures to reduce by two per cent their high-cost power purchases.

MERC has allowed the distribution licensees in the State to recover all costs incurred by them on any DSM-related activity, including planning, designing, implementing, monitoring and evaluating DSM programmes. These costs are added to the electricity distributors' annual revenue requirements to enable their funding through increases in electricity prices.

Based on the directives given by MERC, RInfra initiated and implemented an efficient lighting programme targeting residential consumers in the city of Mumbai.

DRIVERS FOR PROJECT

In the early 2000s, Maharashtra State was experiencing rapid economic growth leading to increased demand for electricity. But the growth in electricity generation capacity in the State had not kept pace with the demand growth. Consequently, in 2006 load shedding was being carried out for 4 to 10 hours in various parts of Maharashtra.

The city of Mumbai had been spared from load shedding, as the three electricity distributor/retailer licensees supplying the Mumbai region were able to meet their energy requirements through their own generation and by sourcing power from external agencies. However, due to the national shortage of generation capacity in India of 14,000 MW, the availability of additional generation from external sources was uncertain.

In April and May 2006 there was an expected demand/supply gap in the Mumbai region of 250 to 275 MW during peak hours. If the external generation required to bridge this gap was not available, load shedding would have become inevitable in the city of Mumbai and particularly in RInfra's supply area. This scenario was expected to become an annual event, and would become increasingly worse with continuous load growth.

Following the MERC directives on DSM, several initiatives were taken up for strategic energy conservation and peak load reduction. The Mumbai Efficient Lighting Programme was one of these initiatives.

DESCRIPTION OF PROJECT

In 2007/08, RInfra sold 7807 GWh of electricity and met a maximum demand of 1464 MVA. The residential sector constitutes 85% of total consumers serviced by RInfra, contributing 53% of total energy sales. The industrial and commercial sectors constitute only 0.01% of total consumers but contribute 10% of total energy sales.

Figure 1 (page) shows the typical average monthly load profile of RInfra during the period April to September. Figure 1 highlights that demand starts rising from 1000 hours and remains almost constant till 2300 hours, however a sharp reduction in demand occurs after 2300 hours. RInfra carried out load research to understand the contribution of the different consumers to the load curve. This indicated that the primary reason for the peak demand during 1000 hours to 2300 hours was the higher share of residential and commercial consumers in RInfras' overall consumer mix. In order to achieve peak/overall demand reduction, RInfra initiated the Efficient Lighting Programme targeting residential consumers.

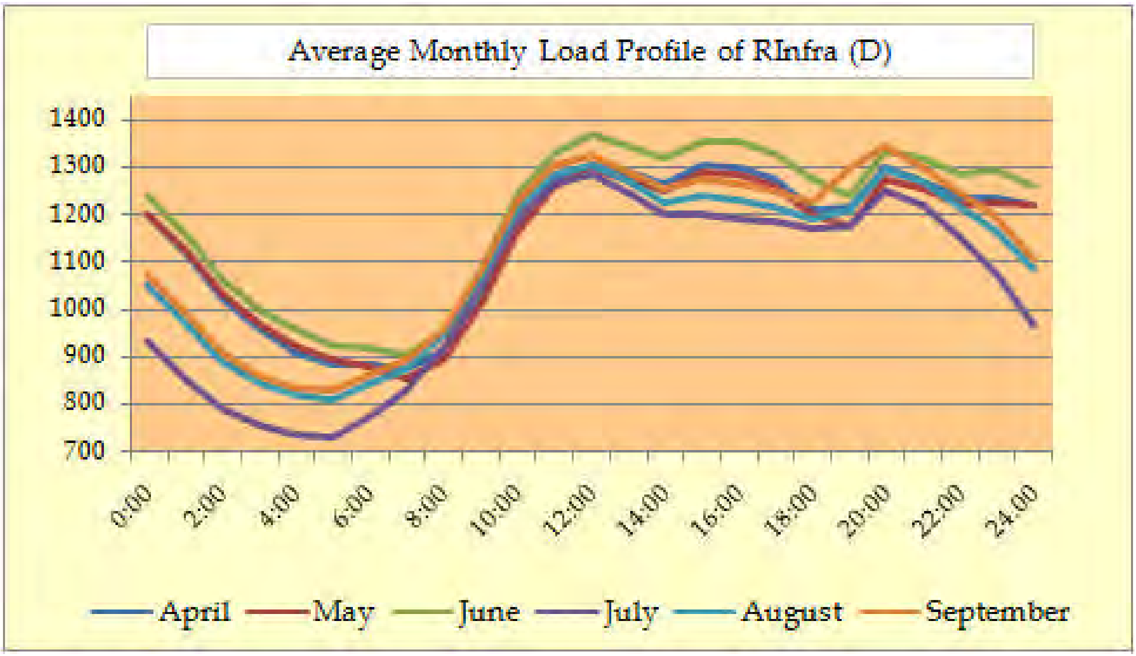

Figure 1. Average Monthly Load Profile of Reliance Infrastructure Ltd

RInfra offered up to three 15 watt CFLs per consumer at a discounted price. RInfra negotiated with M/s. Bajaj Electricals a unit retail price of INR82 for 15 watt CFLs, compared with the market price of INR160. RInfra offered only one model of CFL with a warranty of one year for sale under this program.

RInfra promoted the scheme by providing a coupon mailed with the monthly electricity bills of consumers that could be exchanged for a maximum of three discounted price CFLs (see Figure 2, page 112). The coupon was valid only if the consumer had no outstanding arrears on their electricity bill. To purchase the CFLs, consumers visited one of a number of designated outlets (distributors for M/s. Bajaj Electricals).

The cost of each CFL purchased through this scheme was recovered from consumers through their monthly electricity bills. Payments were made in 11 instalments of INR7 each plus a last instalment of INR5. However, for those who paid nine monthly instalments before due dates, the last three months of instalments amounting to INR19 were waived, thus encouraging consumers to participate in the program.

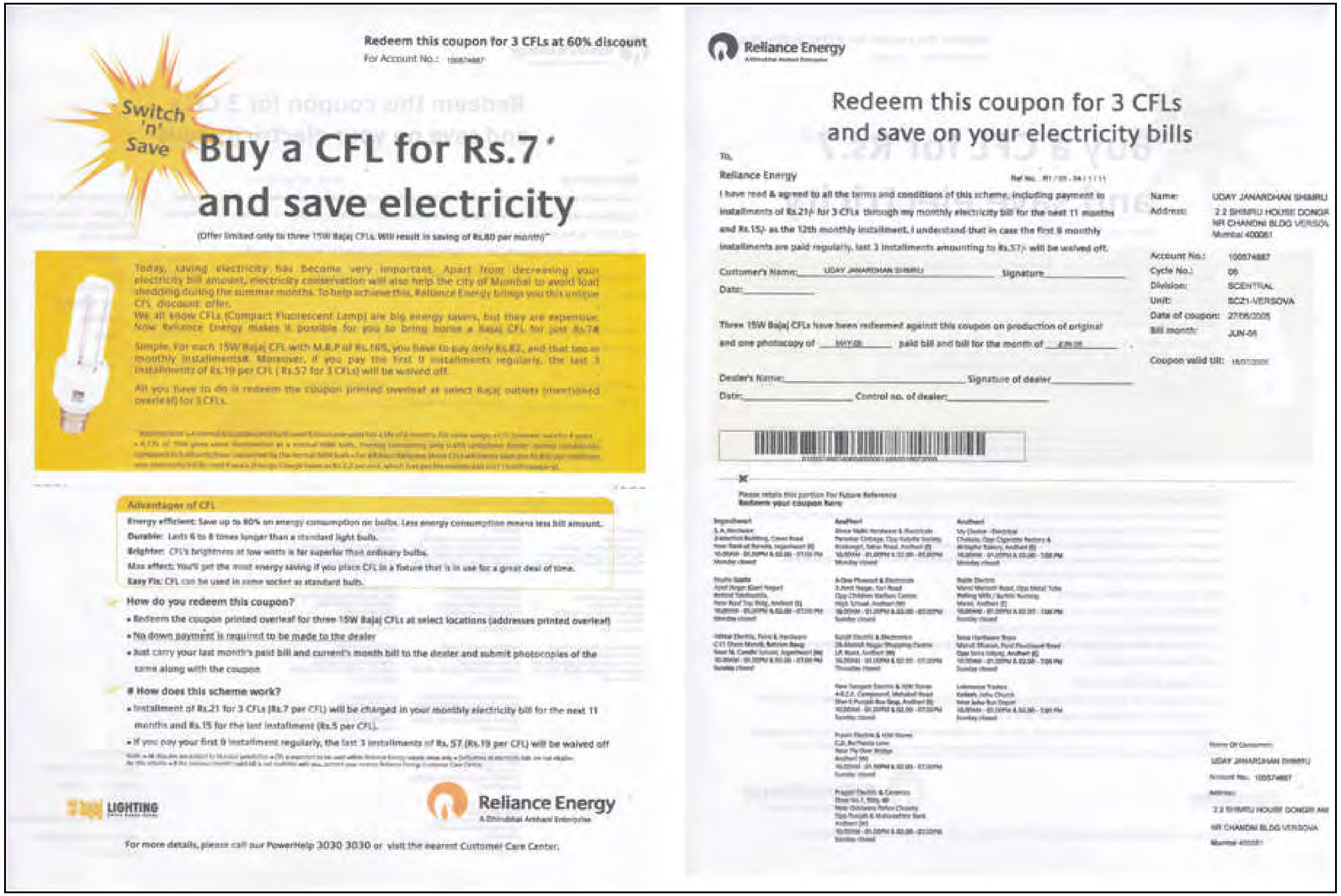

Figure 2. Coupon Mailer Used in the Mumbai Efficient Lighting Programme

RESULTS

Residential Customers Participating	Commercial and Small Industrial Customers Participating		Agricultural Customers Participating	Large Industrial Customers Participatin g	Additional Generation Installed
205,000					
Peak Load	**Peak Load Reduction**	**Duration of Peak Load Reduction**	**Overall Load Reduction**	**Energy Savings**	**Greenhouse Emissions Reduction**
	10 MW	6 hours	12 MW	21,000 MWh	168,000 tC02-e

HOW LOAD REDUCTION WAS MEASURED

In order to assess the impact of the CFL scheme, RInfra appointed Drishti Strategic Research Services to conduct a study to analyze how effectively CFLs purchased under this scheme were utilised by RInfra's customers. Savings were calculated from the difference between participating consumers' measured annual consumption, pre- and post-replacement.

HOW GREENHOUSE EMISSIONS REDUCTION WAS CALCULATED

The energy and demand savings achieved from CFL scheme were estimated on the basis of findings of the survey and were estimated at 21,000 MWh and 10 MW respectively. These benefits were recurring over the life of CFLs.

For the calculation of GHG emissions reduction achieved by the efficient lighting program, the average grid emissions factor for the Western Region issued by Central Electricity Authority was used (0.82 kg of CO2 per kWh). The energy savings (MWh) were multiplied by the grid emission factor (tCO2-e/MWh) to give the estimated reduction in emissions.

TIMING OF LOAD/EMISSIONS REDUCTION

AVOIDED COSTS

ACTUAL PROJECT COSTS

Reliance Infrastructure Limited: INR 11.7 Million

Consumers: INR 38.9 Million

PROJECT COST FROM THE SOCIETAL PERSPECTIVE

ASSESSMENT OF OVERALL PROJECT EFFECTIVENESS

The project was successful in achieving peak/overall demand reduction. The project also achieved a soft target of spreading awareness about energy efficient CFL technology in place of incandescent bulbs. This awareness is likely to affect consumers' future purchases.

PROJECT INFORMATION RESOURCES

Contacts

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Sources

DSM-IN05 STREET LIGHT REPLACEMENT PROGRAMME, MUMBAI

Last updated	4 November 2010
Location of Project	Reliance Infrastructure supply area, Mumbai, India
Year Project Implemented	2008
Year Project Completed	2008
Name of Project Proponent	Reliance Infrastructure Limited (previously known as Reliance Energy Limited)
Name of Project Implementor	Reliance Infrastructure Limited (RInfra)
Type of Project Implementor	Electricity retailer / supplier Electricity distribution (wires) business
Purpose of Project	Deferring augmentation of the electricity network
Project Objective	Reducing peak loads Reducing overall load
Project Target	Whole electricity network
DSM Measure(s) Used	Energy efficiency
Specific Technology Used	High pressure sodium vapour lamps
Market Segments Addressed	Urban local government bodies

REGULATORY REGIME

Reliance Infrastructure Limited (RInfra) is an electricity company operating for over 80 years in the field of generation, transmission, distribution and supply of electricity. The electricity distribution area served by RInfra under its license is divided into five divisions, covering an approximate area of 384 square kilometres in the western and eastern suburbs of Mumbai. RInfra serves a population of 9 million and has 2.63 million electricity consumers.

The State regulator, Maharashtra Electricity Regulatory Commission (MERC) has expressed its commitment to energy efficiency, energy conservation and DSM and has established a positive regulatory framework for energy efficiency and DSM initiatives.

In 2005, MERC's Tariff Regulations treated energy conservation and energy efficiency measures as a 'supply' source and stipulated that long term power procurement plans prepared by distribution licensees should include proposals for implementing energy conservation and energy efficiency measures.

To avoid power shortages and minimize costly power purchases, MERC directed the distribution licensees to carry out energy conservation and load management initiatives for all power-intensive consumers on both a short-term and long-term basis.

MERC has implemented several tariff-based measures, such as a time of day tariff, to encourage consumers to reduce their electricity demand during certain times of the day. In particular, MERC levies a Load Management Charges on consumers who do not restrict their consumption within a stipulated limit, and provides a Load Management Rebate to consumers who restrict their consumption below the stipulated limit. MERC directed all the distribution utilities to use the net amount collected from these measures as a Load Management Fund for promotion and implementation of energy efficiency, energy conservation and demand side management measures.

In addition, to ensure that consumers are not burdened with a high cost of power procurement, MERC in its Multi Year Tariff Order of April/May 2007, directed distribution utilities in Mumbai city to use DSM measures to reduce by two per cent their high-cost power purchases.

MERC has allowed the distribution licensees in the State to recover all costs incurred by them on any DSM-related activity, including planning, designing, implementing, monitoring and evaluating DSM programmes. These costs are added to the electricity distributors' annual revenue requirements to enable their funding through increases in electricity prices.

Based on the directives given by MERC, RInfra initiated and implemented street lighting efficiency improvement programme targeting two urban local government bodies in its distribution area in the city of Mumbai.

DRIVERS FOR PROJECT

In the early 2000s, Maharashtra State was experiencing rapid economic growth leading to increased demand for electricity. But the growth in electricity generation capacity in the State had not kept pace with the demand growth. Consequently, in 2006 load shedding was being carried out for 4 to 10 hours in various parts of Maharashtra.

The city of Mumbai had been spared from load shedding, as the three electricity distributor/retailer licensees supplying the Mumbai region were able to meet their energy requirements through their own generation and by sourcing power from external agencies. However, due to the national shortage of generation capacity in India of 14,000 MW, the availability of additional generation from external sources was uncertain.

In April and May 2006 there was an expected demand/supply gap in the Mumbai region of 250 to 275 MW during peak hours. If the external generation required to bridge this gap was not available, load shedding would have become inevitable in the city of Mumbai and particularly in RInfra’s supply area. This scenario was expected to become an annual event, and would become increasingly worse with continuous load growth.

Following the MERC directives on DSM, several initiatives were taken up for strategic energy conservation and peak load reduction. The Mumbai Street Light Replacement Programme was one of these initiatives.

DESCRIPTION OF PROJECT

RInfra supplies electricity to two urban local government bodies (ULBs) located in its distribution area, the Municipal Corporation of Greater Mumbai (MCGM) and Mira Bhyandar Corporation (MBMC). The ULBs provide water and services such as street lighting, sewage treatment, etc to the urban residents but in all areas under their jurisdiction. Usage of energy for providing these services is one of the major costs for these ULBs. Also, usage of street lighting contributes to the evening peak demand for electricity.

At present, street lighting in these two ULBs is provided using High Pressure Mercury Vapour (HPMV) lamps. It is possible to replace the existing HPMV lamps with energy efficient High Pressure Sodium Vapour (HPSV) lamps while maintaining the existing lux level on the roadway. Replacement of HPMV lamps with HPSV lamps leads to substantial energy savings and reduction in peak load.

In 2008, RInfra initiated and implemented a DSM program which involved replacement of existing HPMV lamps with HPSV lamps used for street lighting in the MCGM and MBMC areas. Figure 1 shows the existing installation of HPMV lamps and their wattage prior to the implementation of the DSM program.

Division	Number of HPMV Lamps (80W)	Number of HPMV Lamps (125 W)
North	5509	5286
Central	3221	3183
South Central	1917	2670
South	2153	4008
East	5234	3378
Total	**18,034**	**18,525**

Figure 1. Numbers of HPMV Lamps Installed Prior to the Implementation of the Mumbai Street Lamp Replacement Programme

The DSM program replaced 36,559 HPMV lamps of 80 and 125 watts with 70 watt HPSV lamps. The energy savings achieved through replacement of HPMV lamps with HPSV lamps are shown in Figure 2 (page).

Description	Unit	Baseline	Project
Lamp Technology		HPMV	HPSV
Type 1 - Replacement of 80 W HPMV with 70 W HPSV Lamp			
Rating of Lamp	Watts	80	70
Rating of Ballast	Watts	13	15
Total Ratings	Watts	93	85
Number of Lamps	No.	18,034	18,034
Operating Hours / Day	No.	11	11
Annual Operating Hours	Hrs	4,015	4,015
Annual energy requirement	MWh	6,733.81	6,154.55
Type 2 - Replacement of 125 W HPMV with 70 W HPSV Lamp			
Rating of Lamp	Watts	125	70
Rating of Ballast	Watts	17	15
Total Ratings	Watts	142	85
Number of Lamps	No.	18,525	18,525
Operating Hours / Day	No.	11	11
Annual Operating Hours	Hrs	4,015	4,015
Annual energy requirement	MWh	10,561.66	6,322.12
Annual energy requirement	MWh	17,295.46	12,476.67
Average technical Grid losses	Number	0.10	0.10
Actual Electricity Consumption	MWh	19,217.18	13,862.97
Total Savings (Annual)	**MWh**		**5,354.21**

Figure 2. Energy Savings Achieved in the Mumbai Street Lamp Replacement Programme

RESULTS

Residential Customers Participating	Commercial and Small Industrial Customers Participating		Agricultural Customers Participating	Large Industrial Customers Participatin g	Additional Generation Installed
Peak Load	**Peak Load Reduction**	**Duration of Peak Load Reduction**	**Overall Load Reduction**	**Energy Savings**	**Greenhouse Emissions Reduction**
4.79 MW	1.33 MW	4 hours		5,354 MWh	4,283 tC02-e

HOW LOAD REDUCTION WAS MEASURED

To estimate the load reduction, RInfra measured the actual energy consumption of the feeders where replacement of the lighting fixtures was carried out. This was compared with the average energy consumption during six months immediately before implementation of the DSM project.

HOW GREENHOUSE EMISSIONS REDUCTION WAS CALCULATED

The energy and peak demand savings achieved from replacement of inefficient HPMV lamps with HPSV lamps is 5,354 MWh and 1.33 MW respectively.

For the calculation of GHG emissions reduction achieved by the efficient lighting program, the average grid emissions factor for the Western Region issued by Central Electricity Authority was used (0.82 kg of CO2 per kWh). The energy savings (MWh) were multiplied by the grid emission factor (tCO2-e/MWh) to give the estimated reduction in emissions.

TIMING OF LOAD/EMISSIONS REDUCTION

Between the hours of 6.30 pm and 6.30 am seven days per week/

AVOIDED COSTS

ACTUAL PROJECT COSTS

Reliance Infrastructure Limited: INR 54.8 million

PROJECT COST FROM THE SOCIETAL PERSPECTIVE

ASSESSMENT OF OVERALL PROJECT EFFECTIVENESS

PROJECT INFORMATION RESOURCES

Contacts

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Sources

EMR-AU01 VICTORIAN ENERGY EFFICIENCY TARGET PHASE 1

Last updated	4 November 2010
Location of Project	State of Victoria, Australia
Year Project Implemented	2009
Year Project Completed	Continuing
Name of Project Proponent	Victorian Department of Primary Industries
Name of Project Implementor	Essential Services Commission, Victoria
Type of Project Implementor	State or federal government agency
Purpose of Project	Implementing government policy
Project Objective	Assisting electricity end users to reduce greenhouse emissions Assisting (in the first instance) residential energy consumers to reduce their energy bills
Project Target	Whole electricity network
DSM Measure(s) Used	Energy efficiency Fuel substitution
Specific Technology Used	See below
Market Segments Addressed	Residential electricity end users

REGULATORY REGIME

The platform of energy and greenhouse policies of the Victorian State Government elected in November 2006 included a commitment to introduce:

"… a [Victorian Energy Efficiency Target (VEET)] scheme that will require energy retailers to help families cut their power bills through measures such as providing energy efficient light globes, insulation and efficient shower roses…VEET will be a market based scheme and … will place an obligation on energy retailers to meet specific energy conservation targets."

Following detailed consultation and analysis, the Government introduced a VEET Bill into Parliament on 31 October 2007. After a brief debate in both houses, the bill was supported by all parties, and the Victorian Energy Efficiency Target Act (VEET Act) received the Royal Assent on 11 December 2007.

The objects of the Act, as stated in Section 4, are to:

- reduce GHG emissions;
- encourage the efficient use of electricity and gas; and
- encourage investment, employment and technology development in industries that supply goods and services which reduce the use of electricity and gas by consumers.

The Act establishes the VEET scheme and also establishes most of the salient design elements of the scheme. The Act:

- establishes the commencement of the scheme (1 January 2009) and its conclusion date (31 December 2029);
- establishes an annual target, in tonnes of CO2-e;

- creates a legal liability for energy retailers (both electricity and gas) with more than 5,000 Victorian customers, to meet a share of this annual target, based on their proportional share of the electricity and gas markets (see ministerial orders below);
- specifies that certificates will be the means for determining whether a party has acquitted their liability;
- specifies that certificates will be produced by businesses accredited by the scheme administrator (the Essential Services Commission, or ESC) to produce certificates;
- indicates (section 75) that remaining details will be determined through Regulations to be made under the heads of power established by the Act;
- indicates that these Regulations will be limited to a three-year duration, thereby establishing three-yearly scheme phases.

The Victorian Energy Efficiency Target Regulations 2008 were made on 11 December 2008. This followed consultation on the exposure draft of the proposed Regulations and subsequent response to submissions received. As dictated by the Act, the Victorian Energy Efficiency Target Regulations have the following objectives:

- to prescribe activities carried out in residential premises that result in reduction of GHG emissions that would not otherwise have occurred if the activities were not undertaken;
- to prescribe the shortfall penalty rate; and
- to prescribe the method and variables to calculate the carbon dioxide equivalent of greenhouse gases to be reduced by a prescribed activity.

The Essential Services Commission Guidelines specify the form and nature of information disclosure. These guidelines address, among other things, information required to:

- achieve accreditation as a certificate creator;
- seek registration of certificates; and
- comply with audits.

Ministerial Orders are instruments made by the Minister, and published in the Victorian Government Gazette, to address:

- the GHG reduction rate; and
- the application of discount abatement factors.

The GHG reduction rate determines the liability for relevant entities (energy retailers). The liability at any point in time for a relevant electricity or gas retailer will be a function of their wholesale acquisition of energy, in MWh or GJ, multiplied by the greenhouse reduction rate. The GHG reduction rate must be published by no later than 31 May of the year to which it applies.

Discount abatement factors are determinations by the Minister that the abatement value (in certificates) attributed to a given activity in the regulations should be discounted, in some or all instances, to take account of circumstances unforseen at the time the regulations were made. These could include a shorter operating life for a given product, or evidence of consumer behaviour which compromises performance of a product (for example, deinstallation of air sealing). Discount abatement factors will be published as required.

Figure 1 presents a schematic diagram of the regulatory regime for the VEET scheme.

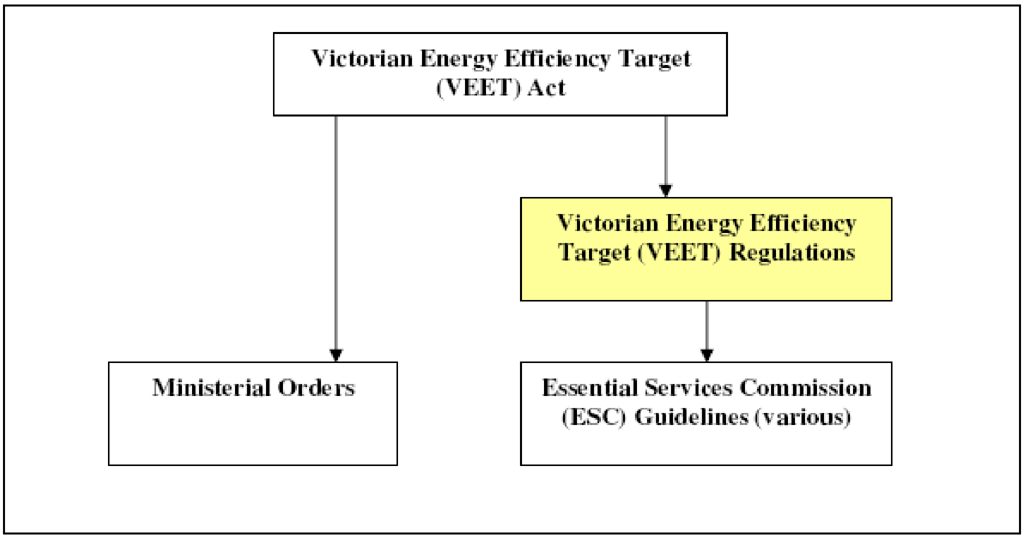

Figure 1. Legal Structure of the VEET Scheme

DRIVERS FOR PROJECT

The VEET scheme is intended to play an important role in achieving the Victorian Government's target of reducing greenhouse gas emissions from households by 10 per cent by 2010, and Victoria's overall emissions to 60 per cent by 2050.

DESCRIPTION OF PROJECT

The VEET scheme, which commenced on 1 January 2009, aims to encourage the uptake of energy efficient technology, initially in the residential sector.

The scheme is focussed on commercially available energy efficiency or fuel switching technologies which reduce greenhouse emissions in the residential sector, including weatherisation measures (insulation / air sealing / double glazing), low energy lighting, low flow shower roses, high efficiency heating appliances, low emissions water heating, and high efficiency refrigerators. This list may be updated from time to time.

The VEET scheme is a 'White Certificate' scheme. It operates by imposing a legal liability on large electricity and gas retailers in Victoria (known as "relevant entities") to contribute to energy efficiency measures by acquiring and surrendering Victorian energy efficiency certificates (VEECs). A penalty will be imposed on entities that fail to surrender sufficient VEECs to meet their liability.

Under the VEET scheme, accredited persons are eligible to create VEECs for prescribed activities undertaken at residential premises. Each VEEC created represents one tonne of carbon dioxide equivalent (CO2-e) abated by a prescribed activity. In the first phase of the scheme all VEECs are deemed, that is, the prescribed activities are allocated a number of VEECs equivalent to their estimated lifetime greenhouse abatement at time of installation.

The VEET Act provides for the VEET scheme to operate in three-year phases, with new scheme targets and prescribed activities set for each phase. The first phase of the VEET scheme will operate from 1 January 2009 to 31 December 2011, and is focussed on activities in the residential sector.

Section 30 of the VEET Act provides for the setting of scheme targets over three-year periods. For the first three years of the scheme (2009-2011), the target is to surrender in each year a total of VEECs equivalent to 2.7 million tonnes of lifetime CO2-e abatement. This three-year target is expected to lead to a reduction in lifetime greenhouse gas emissions by a total of 8.1 million tonnes.

Figure 2 presents a schematic diagram of how the VEET Scheme operates.

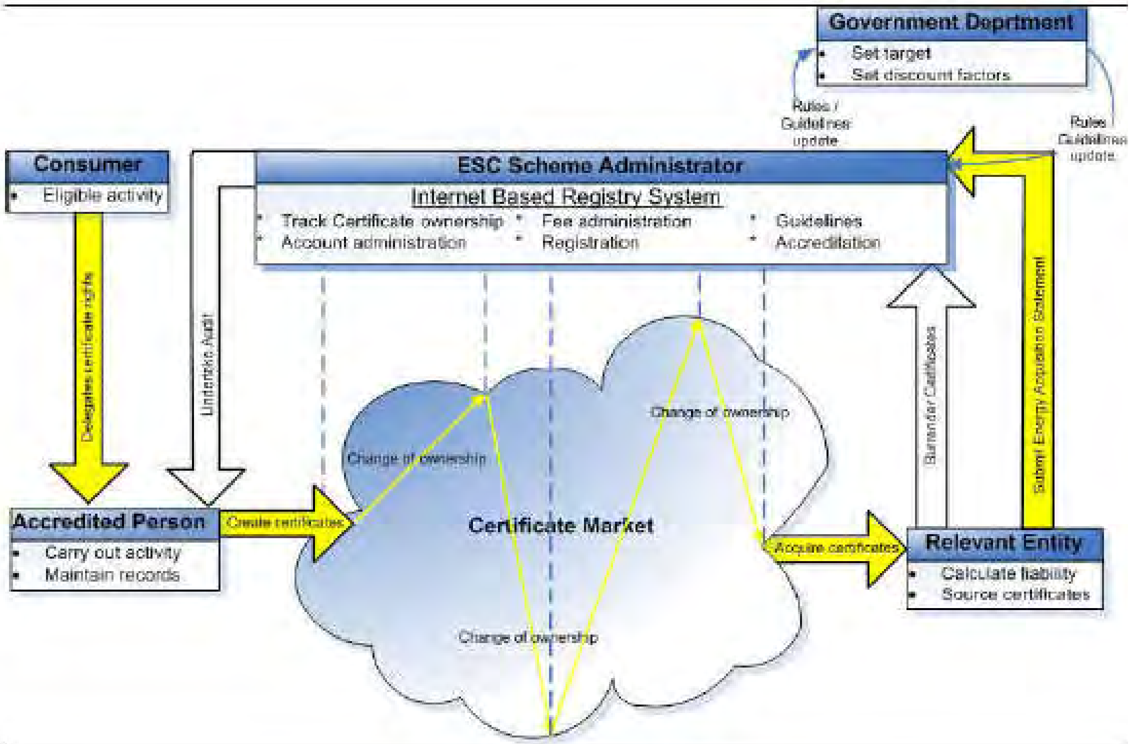

Figure 2. Operation of the VEET Scheme

RESULTS

<table>
<tr><th>Residential Customers Participating</th><th colspan="2">Commercial and Small Industrial Customers Participating</th><th>Agricultural Customers Participating</th><th>Large Industrial Customers Participatin g</th><th>Additional Generation Installed</th></tr>
<tr><td>Potentially all Victorian residential energy consumers</td><td colspan="2"></td><td></td><td></td><td></td></tr>
<tr><th>Peak Load</th><th>Peak Load Reduction</th><th>Duration of Peak Load Reduction</th><th>Overall Load Reduction</th><th>Energy Savings</th><th>Greenhouse Emissions Reduction</th></tr>
<tr><td></td><td></td><td></td><td></td><td>Estimated savings in 2011:
Electricity - 654,000 MWh/yr
Gas - 1,254 TJ/yr</td><td>Estimated savings:
0.192 Mt/yr in 2009
0.675 Mt/yr in 2011
8.1 Mt of lifetime abatement from Phase 1 (2009 to 2011)</td></tr>
</table>

The scheme only commenced in January 2009. At the time of writing in April 2009, the scheme is still in an early stage and the only "results" available are the key outputs from the program, being the number of accredited persons and participating businesses, and the number of certificates registered.

HOW LOAD REDUCTION WAS MEASURED

HOW GREENHOUSE EMISSIONS REDUCTION WAS CALCULATED

1. A range of likely energy efficiency measures were identified, and average energy savings (electricity, gas, wood) were estimated for each measure.
2. Estimates of capital cost, administration cost, the likely incentive required to induce consumer response, and the likely consumer uptake were used to develop a cost curve (based on estimated certificate price) for the energy efficiency measures. This was used to establish the annual greenhouse abatement (trade off between likely certificate price and abatement which could be achieved), and to estimate the annual electricity and gas savings which would be achieved by implementing the abatement target. Estimates of the marginal greenhouse coefficient for electricity and the average greenhouse coefficient for other fuels was used as the basis of estimating the likely greenhouse abatement.

3. The annual electricity saving data from the cost curve was fed into a model of the electricity system (National Electricity Market), and used to estimate the annual greenhouse abatement from electricity savings, as well as the likely impact on wholesale and retail electricity prices and generator revenue. Greenhouse savings from gas savings were calculated directly from the gas saving estimates derived during the development of the cost curve.

TIMING OF LOAD/EMISSIONS REDUCTION

AVOIDED COSTS

ACTUAL PROJECT COSTS

PROJECT COST FROM THE SOCIETAL PERSPECTIVE

ASSESSMENT OF OVERALL PROJECT EFFECTIVENESS

The project has just commenced. It is likely to require at least one full year of implementation before effectiveness can be assessed.

PROJECT INFORMATION RESOURCES

Contacts

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Sustainabilty Victoria
– development of initial cost curves for modelling VEET scenarios
– development of algorithms to determine number of eligible certificates
Ian McNicol <ian.mcnicol@sustainability.vic.gov.au>

Sources

The Victorian Energy Efficiency Target Act (VEET Act):
http://www.legislation.vic.gov.au/Domino/Web_Notes/LDMS/PubStatbook.nsf/f932b66241ecf1b7ca256e92000e23be/1474BEF614D8AEB0CA2573AE00156D7C/$FILE/07-070a.pdf

The Victorian Energy Efficiency Target Regulations:
http://www.dpi.vic.gov.au/dpi/dpinenergy.nsf/LinkView/557AD927677CBF7BCA25751C008310054CAC723B1D538D66CA25740C000D2004/$file/Final VEET Regulations 2008.pdf

The Essential Services Commission Guidelines:
http://www.esc.vic.gov.au/public/VEET/Victorian+Energy+Efficiency+Target+scheme.htm

Department of Primary Industries Website:
http://www.dpi.vic.gov.au/dpi/dpinenergy.nsf/LinkView/25F3A72717ED1F21CA2572B2001BF39D866B51F390263BA1CA2572B2001634F9
- Initial Discussion Paper
- VEET Act
- Regulatory Impact Statement
- VEET Regulations

Essential Services Commission Website:
http://www.esc.vic.gov.au/public/VEET/Prescribed+Activities.htm
- Administrative Guidelines for scheme participants
- Details of prescribed activities and certificate creation from prescribed activities
- Register of participants, certificates

EMR-AU02 MINIMUM ENERGY PERFORMANCE STANDARDS FOR RESIDENTIAL REFRIGERATORS AND FREEZERS

Last updated	4 November 2010
Location of Project	Australia-wide, but case study will focus on impacts in the State of Victoria
Year Project Implemented	1999
Year Project Completed	Ongoing
Name of Project Proponent	(In Australia) National Equipment Energy Efficiency Committee
Name of Project Implementor	(In Victoria) Energy Safe Victoria
Type of Project Implementor	State or federal government agency
Purpose of Project	Implementing government policy
Project Objective	Assisting electricity end users to reduce greenhouse emissions Increasing the energy efficiency of new refrigerators sold; helping to reduce consumer energy bills
Project Target	Whole electricity network
DSM Measure(s) Used	Energy efficiency
Specific Technology Used	Australian Standards are used to specify energy performance testing methods and minimum energy performance standards (MEPS) for the different classes of residential refrigerators and freezers. Regulations require that only products which comply with the required MEPS levels can be sold.
Market Segments Addressed	Residential electricity end users

REGULATORY REGIME

In Australia, the Equipment Energy Efficiency Committee (the "E3 Committee"), comprising representatives of the Commonwealth, State and Territory Governments, coordinates the national implementation of mandatory minimum energy performance standards (MEPS) and energy labelling.

Regulatory proposals and standards are developed through the E3 Committee in consultation with industry stakeholders. These proposals are required to undergo a Regulation Impact Statement process according to national regulatory guidelines before they can be approved. Regulatory proposals are considered by a number of joint Commonwealth, State and Territory government committees before final approval by the Ministerial Council on Energy (comprising Commonwealth, State and Territory Energy Ministers).

Once approved, the MEPS are put into effect through State and Territory regulations, with most regulations sitting under the relevant electrical safety Act. The required energy performance testing procedures and the minimum energy performance standards are published as Australian Standards, and these are referenced in the relevant regulations.

Mutual Recognition Agreements which operate between Australian States and Territories effectively require that MEPS (levels and timing of their introduction) are nationally uniform. New Zealand joined with Australia in 2002 to form a common Trans-Tasman Program. The Trans-Tasman Mutual Recognition Agreement requires that Australia and New Zealand seek to implement a uniform program.

In Victoria, the relevant regulations are put in place under the Electrical Safety Act 1998. The principal regulations are the Electrical Safety (Equipment Efficiency) Regulations 1999. These regulations have been amended on numerous occasions to establish mandatory minimum energy performance and labelling requirements for additional classes of electrical equipment, following agreement by the Ministerial Council on Energy and its predecessors. The regulations are due to sunset on 28 April 2009. Consequently, new regulations must be made in order to ensure that the standards remain in operation, and this process is currently underway.

DRIVERS FOR PROJECT

The initial driver to introduce MEPS for residential refrigerators and freezers was Australia's National Greenhouse Response Strategy (1992), updated in 1998 as the National Greenhouse Strategy. This led to the creation of a joint Commonwealth, State and Territory government committee in 1992 to reduce greenhouse emissions by driving improvements in the energy efficiency of energy using appliances and equipment through mandatory energy labelling and minimum energy performance standards.

Refrigerators and freezers are the single largest user of electricity in the residential sector in Australia. Analytical work undertaken in the 1990's identified these products as a priority item for regulation, and MEPS were first introduced in October 1999 to complement mandatory energy labelling for refrigerators. These initial MEPS levels were made more stringent in January 2005, following analysis which indicated that further cost-effective greenhouse abatement could be achieved.

DESCRIPTION OF PROJECT

Suppliers/manufacturers of residential refrigerators and freezers are required to have their products tested to the relevant Australian Standards, and then register these products with one of four State Regulators (Victoria, New South Wales, Queensland, South Australia). The products must be registered and meet the required MEPS levels before they can be legally sold.

A nationally coordinated check testing program operates to identify products that do not comply with the MEPS regulations. Non-compliant products are required to be withdrawn from sale, and the suppliers can have a financial penalty imposed under state regulations.

Sales data purchased from the market monitoring company GfK is combined with data from the registration database and used to track trends in the energy efficiency of refrigerators and freezers sold. This data is publicly available in the "Greening Whitegoods" report which is published from time to time.

In Victoria, Energy Safe Victoria has the formal responsibility for the Electrical Safety Act and regulations. Energy Safe Victoria can register regulated appliances and equipment, and is also responsible for compliance and enforcement within Victoria.

RESULTS

Residential Customers Participating	Commercial and Small Industrial Customers Participating		Agricultural Customers Participating	Large Industrial Customers Participatin g	Additional Generation Installed
1,000,000 (half of all households in Victoria)					
Peak Load	**Peak Load Reduction**	**Duration of Peak Load Reduction**	**Overall Load Reduction**	**Energy Savings**	**Greenhouse Emissions Reduction**
	Estimated average of: 2005 - 18.8 MW 2008 - 26.9 MW		Estimated average of: 2005 - 18.8 MW 2008 - 26.9 MW	2005 - 165,000 MWh 2008 - 236,000 MWh	2005 - 283,000 tCO_2-e 2008 - 391,000 tCO_2-e

The implementation of MEPS for residential refrigerators and freezers, coupled with mandatory energy labelling, has led to a significant increase in the energy efficiency of new refrigerators and freezers sold in Australia, and to significant greenhouse abatement. The combined impact of these programs has meant that total energy consumption, and therefore greenhouse emissions from residential refrigeration are now less than when MEPS were introduced in 1999.

Graphs of the average energy consumption of new refrigerators/freezers sold, estimated total energy use for refrigerator/freezers in Australia, and estimated Australia-wide savings are provided in Figures 1 to 4 and Table 1 (pages 131 to 133).

While the data in these Figures are for the Australia-wide impact, the data in the table above are just for the State of Victoria. This simplifies the greenhouse calculations, because the greenhouse coefficients differ between different States (ie regions of the Australian National Electricity Market).

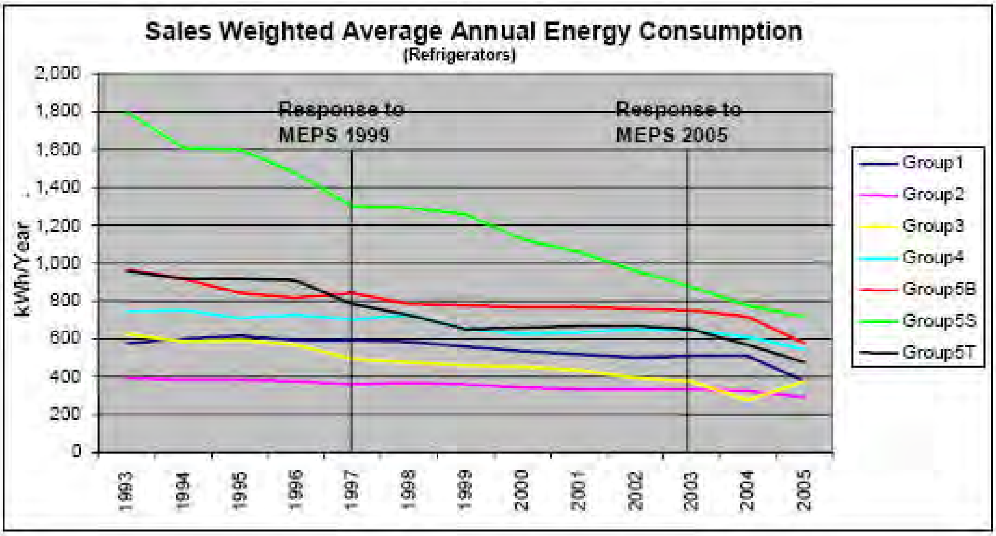

Figure 1. Sales Weighted Average Energy Consumption of Refrigerators by Group

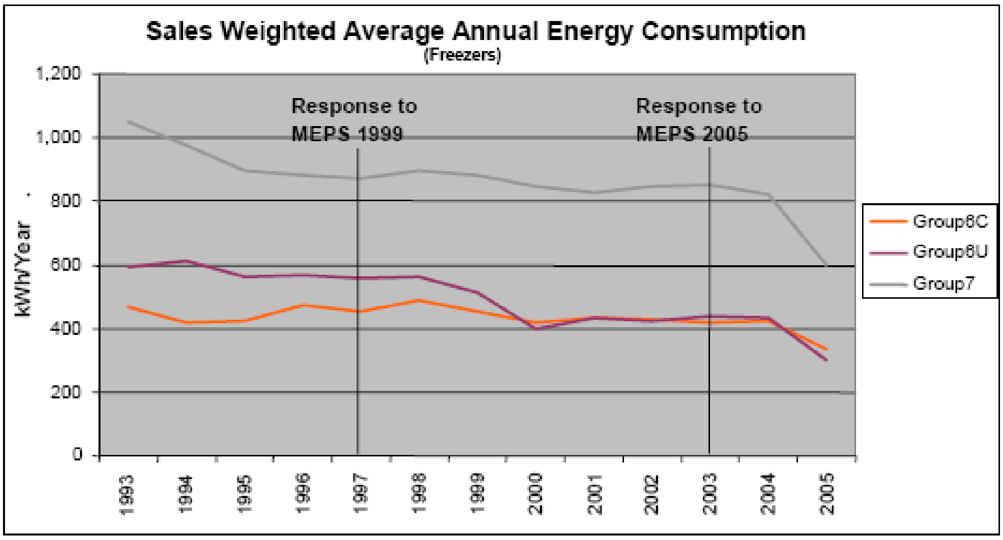

Figure 2. Sales Weighted Average Energy Consumption of Freezers by Group

Table 1. Refrigerator / Freezer Categories Covered by MEPS

Group Title	Description
Group 1	Single door, All Refrigerator, no internal frozen space
Group 2	Single door, All Refrigerator, with an internal ice making sub-compartment
Group 3	Single door, All Refrigerator, with short-term internal frozen food sub-compartment
Group 4	Two door, Cyclic Defrost Refrigerator, with separate freezer section/compartment
Group 5T	Two door, Vertical Refrigerator, Frost Free, with freezer compartment at Top
Group 5B	Two door, Vertical Refrigerator, Frost Free, with freezer compartment at Bottom
Group 5S	Two door, Vertical Refrigerator, Frost Free, with freezer compartment at Side
Group 6C	All freezer – Chest type
Group 6U	All freezer - Vertical cabinet type manual defrost
Group 7	All freezer - Vertical cabinet type frost free

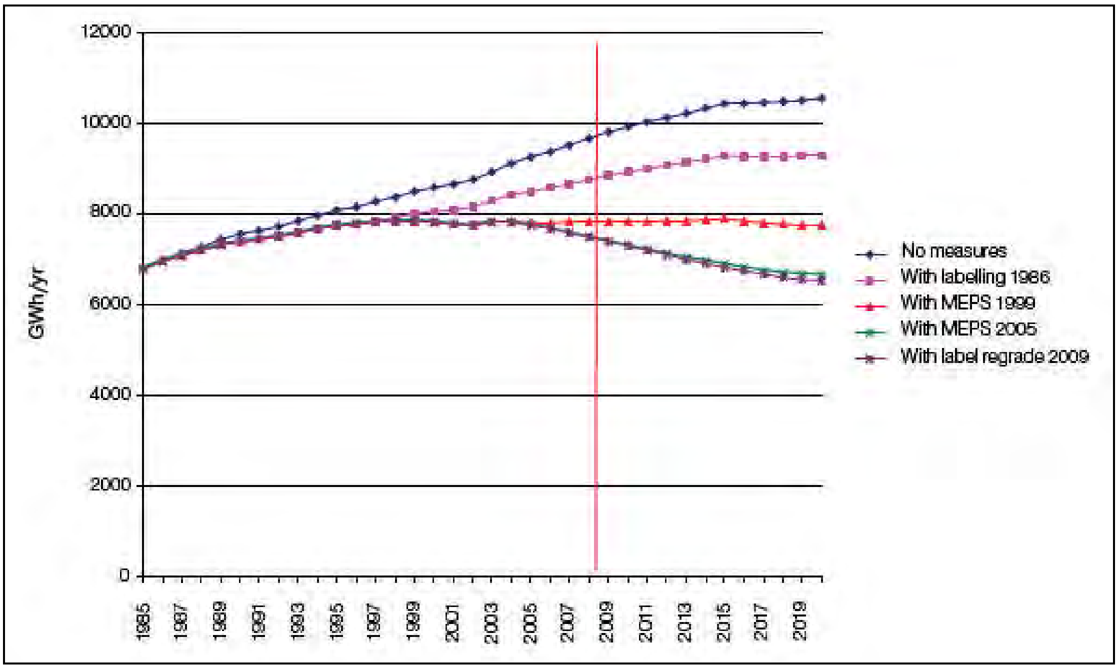

Figure 3. Historical and Projected Energy Use by Refrigerators/Freezers in Australia

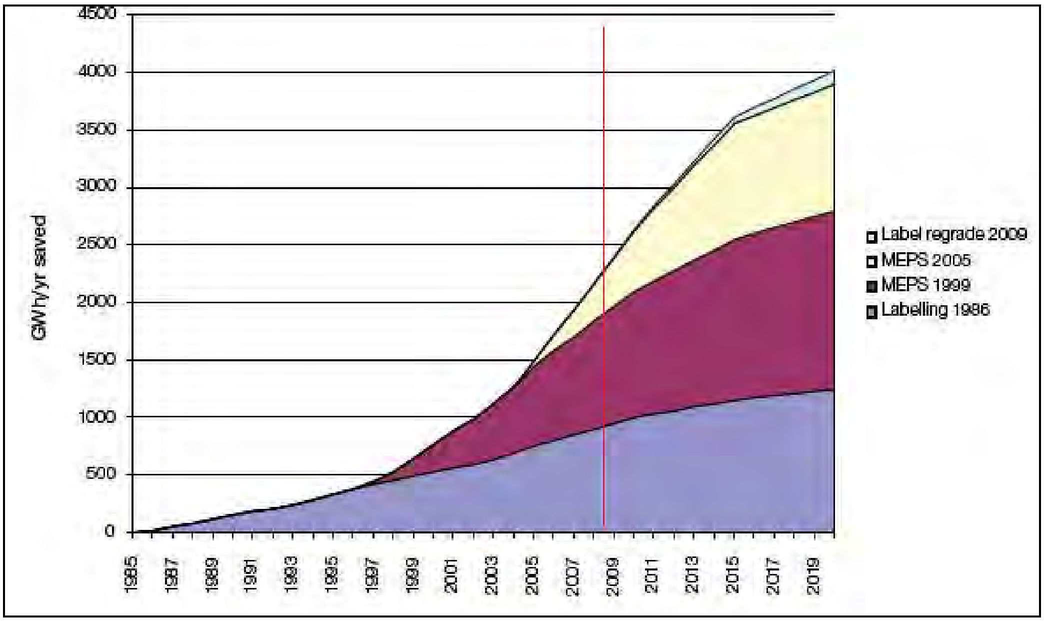

Figure 4. Historical and Projected Energy Savings for Refrigerator/Freezer MEPS and Labelling in Australia

HOW LOAD REDUCTION WAS MEASURED

Simple estimate based on annual energy saving.

HOW GREENHOUSE EMISSIONS REDUCTION WAS CALCULATED

The calculation was based on estimates prepared for the 2009 Projected Impacts report (see Sources below). This report used data from Regulation Impact Statements and the Post-Implementation Evaluation report (also see Sources below).

TIMING OF LOAD/EMISSIONS REDUCTION

Generally 24 hours a day, seven days a week.

AVOIDED COSTS

ACTUAL PROJECT COSTS

PROJECT COST FROM THE SOCIETAL PERSPECTIVE

ASSESSMENT OF OVERALL PROJECT EFFECTIVENESS

MEPS, combined with energy labelling, have been highly effective at reducing the average energy use (and therefore greenhouse emissions) from new refrigerators/freezers sold in Australia. The recent 2009 Projected Impacts report (see Sources below) concluded:

"It is estimated that even in the BAU case, the average energy used in household refrigeration would have declined by about 16%, from about from 1250 kWh/yr per household in 1985 to 1050 kWh/yr per household in 2020. However, accelerated efficiency improvements brought about by energy labelling and two rounds of MEPS will have reduced refrigeration energy requirement per household to about 650 kWh/yr, or 48% less than in 2005. This is about 38% lower than if E3 measures had not been implemented.

"In fact, the rate of increase in energy efficiency has exceeded the rate of increase in population and in household numbers, so total electricity used in household refrigeration has declined. The quantity of cold space per household has remained fairly constant: while the ownership of stand-alone freezers has been falling, the average number of refrigerators per household and their average volume has been increasing. The quality of refrigeration service has also been increasing, in that a growing share of the refrigerators in use are now frost-free, with better temperature control and no need for manual defrost. Therefore the effective increase in energy efficiency has been even greater than indicated."

PROJECT INFORMATION RESOURCES

Contacts

Ian McNicol, Sustainability Victoria
Victorian State Government representative on the E3 Committee
ian.mcnicol@sustainability.vic.gov.au

Sources

Details of the current MEPS levels for refrigerators and freezers in Australia are available at: http://www.energyrating.gov.au/rf2.html

Details of products which have been registered for MEPS in Australia are available from a public access website:
http://www.energyrating.gov.au/appsearch/refrig_srch.asp

Data on trends in the energy efficiency of refrigerators and freezers sold in Australia are available at:
http://www.energyrating.gov.au/library/details200606-greening.html

A major post-implementation evaluation of Australia's MEPS and labelling program for refrigerators and freezers was published in October 2006 and is available at: http://www.energyrating.gov.au/library/details200614-meps-rf-fz.html

2009 Projected impacts report:
http://www.energyrating.gov.au/library/details200901-projected-impacts.html

Refrigerator/Freezer post-implementation evaluation report:
http://www.energyrating.gov.au/library/details200614-meps-rf-fz.html

"Greening Whitegoods 2009" (tracks sales weighted average data):
http://www.energyrating.gov.au/library/details201008-greening.html

EMR-AU03 MINIMUM ENERGY PERFORMANCE STANDARDS FOR SINGLE-PHASE AIR CONDITIONERS

Last updated	4 November 2010
Location of Project	Australia-wide, but case study will focus on impacts in the State of Victoria
Year Project Implemented	2004
Year Project Completed	Ongoing
Name of Project Proponent	(In Australia) National Equipment Energy Efficiency Committee
Name of Project Implementor	(In Victoria) Energy Safe Victoria
Type of Project Implementor	State or federal government agency
Purpose of Project	Implementing government policy
Project Objective	Assisting electricity end users to reduce greenhouse emissions Increasing the energy efficiency of new refrigerators sold; helping to reduce consumer energy bills
Project Target	Whole electricity network
DSM Measure(s) Used	Energy efficiency
Specific Technology Used	Australian Standards are used to specify energy performance testing methods and minimum energy performance standards (MEPS) for single-phase air conditioners for their cooling performance, based on their Energy Efficiency Ratio (EER). Regulations require that only products which comply with the required MEPS levels can be sold.
Market Segments Addressed	Residential electricity end users

REGULATORY REGIME

In Australia, the Equipment Energy Efficiency Committee (the "E3 Committee"), comprising representatives of the Commonwealth, State and Territory Governments, coordinates the national implementation of mandatory minimum energy performance standards (MEPS) and energy labelling.

Regulatory proposals and standards are developed through the E3 Committee in consultation with industry stakeholders. These proposals are required to undergo a Regulation Impact Statement process according to national regulatory guidelines before they can be approved. Regulatory proposals are considered by a number of joint Commonwealth, State and Territory government committees before final approval by the Ministerial Council on Energy (comprising Commonwealth, State and Territory Energy Ministers).

Once approved, the MEPS are put into effect through State and Territory regulations, with most regulations sitting under the relevant electrical safety Act. The required energy performance testing procedures and the minimum energy performance standards are published as Australian Standards, and these are referenced in the relevant regulations.

Mutual Recognition Agreements which operate between Australian States and Territories effectively require that MEPS (levels and timing of their introduction) are nationally uniform. New Zealand joined with Australia in 2002 to form a common Trans-Tasman Program. The Trans-Tasman Mutual Recognition Agreement requires that Australia and New Zealand seek to implement a uniform program.

In Victoria, the relevant regulations are put in place under the Electrical Safety Act 1998. The principal regulations are the Electrical Safety (Equipment Efficiency) Regulations 1999. These regulations have been amended on numerous occasions to establish mandatory minimum energy performance and labelling requirements for additional classes of electrical equipment, following agreement by the Ministerial Council on Energy and its predecessors. The regulations are due to sunset on 28 April 2009. Consequently, new regulations must be made in order to ensure that the standards remain in operation, and this process is currently underway.

DRIVERS FOR PROJECT

The initial driver to introduce MEPS for single-phase air conditioners was Australia's National Greenhouse Response Strategy (1992), updated in 1998 as the National Greenhouse Strategy. This led to the creation of a joint Commonwealth, State and Territory government committee in 1992 to reduce greenhouse emissions by driving improvements in the energy efficiency of energy using appliances and equipment through mandatory energy labelling and minimum energy performance standards.

In Australia, mandatory energy labelling of single-phase air conditioners with cooling capacities up to 7.5 kW was introduced in 1987. The extension of MEPS to single-phase air conditioners was first explored in an E3 Committee report published in December 2001 (see Sources below), and followed the introduction of MEPS for 3-phase packaged air conditioners in 2001.

DESCRIPTION OF PROJECT

Increasing summer electricity demand (driven by a rapid increase in the penetration of single-phase air conditioners in the residential sector) and major blackouts in some states in the early 2000's created the impetus to introduce MEPS for single-phase air conditioners. The widespread use of air conditioners also meant that the introduction of MEPS would result in significant and cost effective greenhouse abatement.

The initial (Phase 1) MEPS for single-phase air conditioners was implemented in October 2004. Continuing concerns about the reliability of electricity supply during summer months after 2004 resulted in more stringent Phase 2 MEPS being introduced in April 2006 for single-phase air conditioners with a cooling output less than 7.5 kW. MEPS levels for single-phase air conditioners with a cooling output greater than 7.5 kW were made more stringent in October 2007.

Suppliers/manufacturers of single-phase air conditioners are required to have their products tested to the relevant Australian Standards, and then register these products with one of four State Regulators (Victoria, New South Wales, Queensland, South Australia). The products must be registered and meet the required MEPS levels before they can be legally sold.

A nationally coordinated check testing program operates to identify products that do not comply with the MEPS regulations. Non-compliant products are required to be withdrawn from sale, and the suppliers can have a financial penalty imposed under state regulations.

RESULTS

Residential Customers Participating	Commercial and Small Industrial Customers Participating		Agricultural Customers Participating	Large Industrial Customers Participatin g	Additional Generation Installed
Peak Load	**Peak Load Reduction**	**Duration of Peak Load Reduction**	**Overall Load Reduction**	**Energy Savings**	**Greenhouse Emissions Reduction**
Estimated Summer peak load of residential air conditioners in Victoria is around 1,400 MW		2 hours		2008 8,700 MWh	2008 11,000 tCO2-e

Data on the sales weighted average energy performance of single-phase air conditioners sold in Australia is provided in Figures 1 and 2 (page 138). These data indicate that the energy efficiency of the average air conditioner sold has increased significantly since 2003, following the introduction of MEPS in 2004, subsequently made more stringent in 2006/2007.

The average Energy Efficiency Ratio of air conditioners has increased from 2.55 to 3.05 (19.6%) and the average Coefficient of Performance has increased from 2.85 to 3.40 (19.3%). A further increase in the stringency of the MEPS is scheduled to be implemented in 2010, and should drive further efficiency improvements.

While the data in the Appendix is for the Australia-wide impact, the data in the table below are just for the State of Victoria. This simplifies the greenhouse calculations, because the greenhouse coefficients differ between different States (ie regions of the Australian National Electricity Market).

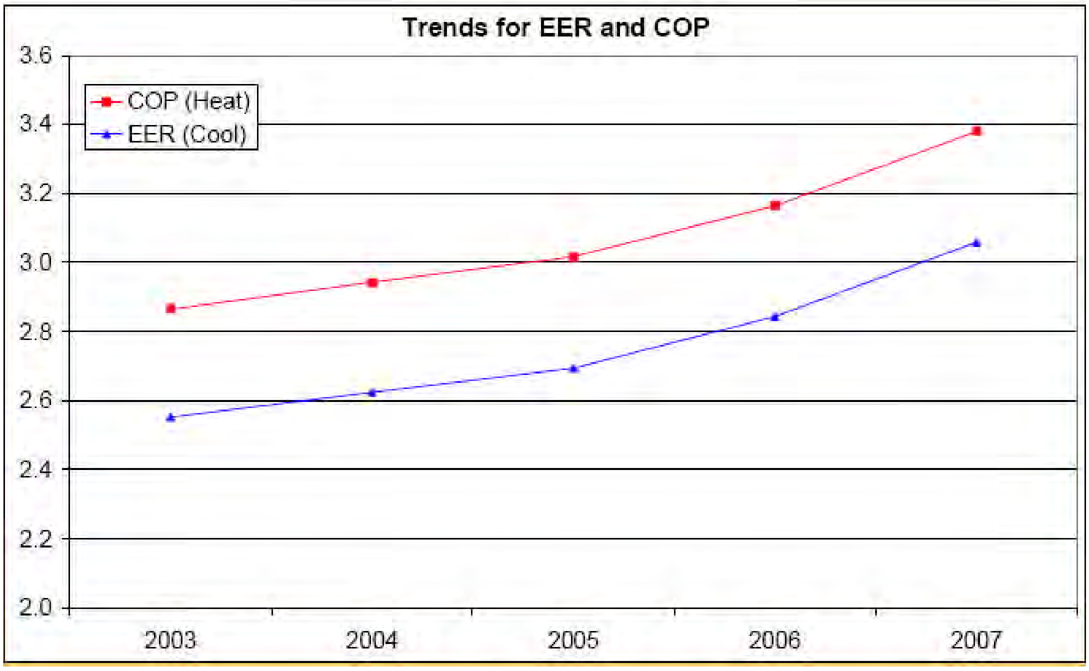

Figure 1. Sales Weighted Average Performance of Single-Phase Air Conditioners

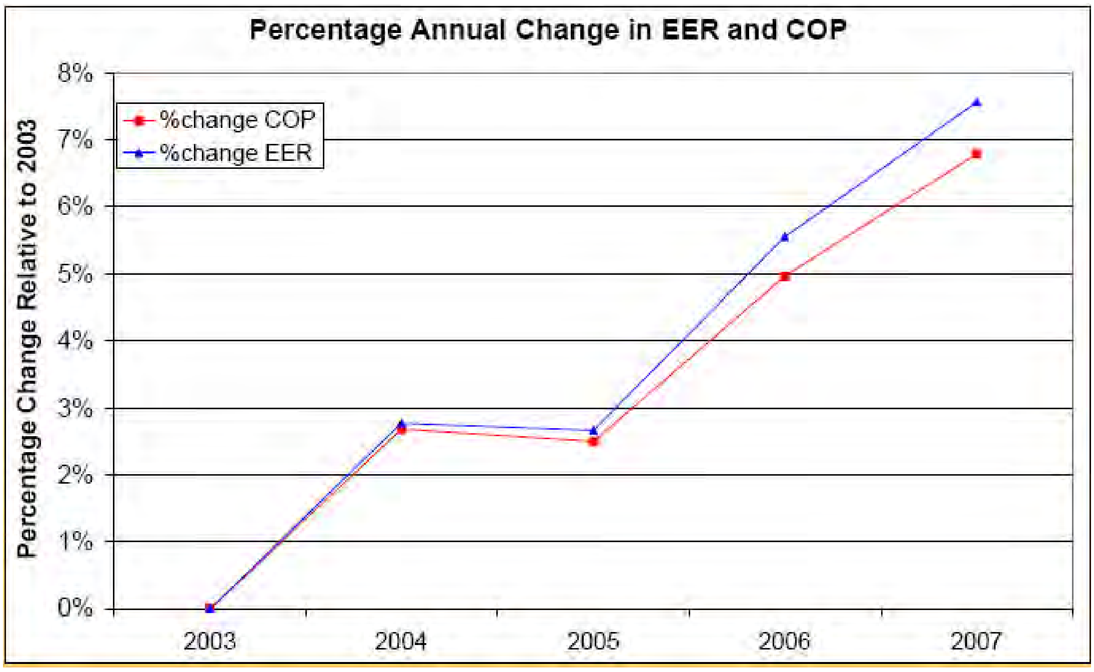

Figure 2. Percentage Annual Change in EER and CoP of Single-Phase Air Conditioners

HOW LOAD REDUCTION WAS MEASURED

HOW GREENHOUSE EMISSIONS REDUCTION WAS CALCULATED

The calculation was based on estimates prepared for the 2009 Projected Impacts report (see Sources below). This report used data from Regulation Impact Statements.

Ultimately the estimate is based on estimated market sales and energy performance data for air conditioners registered for MEPS and energy labelling. Recently actual market sales data has become available, and this can be linked to energy performance data to prepare more robust, sales-weighted average estimates.

The data is used to develop a stock model for air conditioners in the Australian residential sector. The savings (energy) are estimated by comparing a modelled business-as-usual (without MEPS or labelling) scenario with a scenario based on the presence of MEPS and labelling. The energy savings are then multiplied by a time-series of greenhouse coefficients for electricity in Victoria to derive the estimated greenhouse abatement.

TIMING OF LOAD/EMISSIONS REDUCTION

In Victoria air conditioner energy use for heating is significantly greater (about a factor of 10) than cooling energy consumption. This means that the energy/greenhouse savings occur mainly during the winter months (June to August). Any peak load reductions will mainly occur during winter months (7 am to 9 am; 4 pm to 8 pm) and during Summer months on weekdays (3 pm to 5 pm).

AVOIDED COSTS

ACTUAL PROJECT COSTS

PROJECT COST FROM THE SOCIETAL PERSPECTIVE

ASSESSMENT OF OVERALL PROJECT EFFECTIVENESS

Australia is still in the fairly early stages of implementing MEPS for single-phase air conditioners. However, recently prepared sales-weighted average data (see Figure 3, page 140) suggests that the measures are driving a significant improvement in the average efficiency of new air conditioners sold. The 2009 Projected Impacts study (see Sources below) suggests that the 2004/2006/2007 MEPS, combined with even more stringent MEPS expected to be introduced in 2010 will start to achieve significant energy and greenhouse savings over the next decade.

To date, no post-implementation evaluation of Australia's air conditioner MEPS and labelling program has been undertaken, but such a study is expected during 2010.

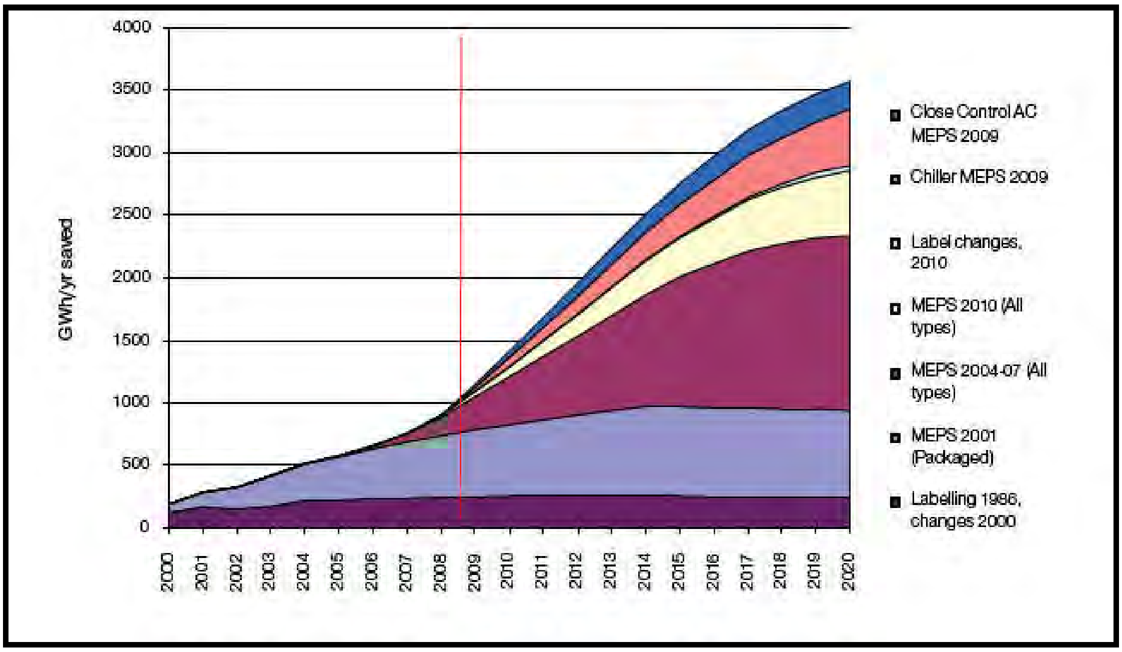

Figure 3. Historical and Projected Impacts of Air Conditioner MEPS and Labelling

Note that estimated savings for single-phase air conditioner MEPS are included under "MEPS 2004-07 (All types)"

PROJECT INFORMATION RESOURCES

Contacts

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Sources

E3 Committee report "The Scope for Application of Minimum Energy Performance Standards to Additional Household Appliances" published in December 2001 is available at: http://www.energyrating.gov.au/library/details200204-additional.html

Details of the MEPS levels for air conditioners in Australia are available at: http://www.energyrating.gov.au/pac1.html

Details of products which have been registered are available from a public access website: http://www.energyrating.gov.au/appsearch/air_srch.asp

2004 MEPS Regulation Impact Statement:
http://www.energyrating.gov.au/library/details200308-risairconditioner.html

2006 MEPS Regulation Impact Statement:
http://www.energyrating.gov.au/library/details200516-acmeps-ris.html

Sales weighted average data:
http://www.energyrating.gov.au/pubs/2009-ac-day1-ryan.pdf

2009 Projected impacts report:
http://www.energyrating.gov.au/library/details200901-projected-impacts.html

EMR-AU04 EARTH HOUR VICTORIA

Last updated	5 November 2010
Location of Project	State of Victoria, Australia
Year Project Implemented	2008
Year Project Completed	Ongoing - annual event
Name of Project Proponent	WWF - Australia
Name of Project Implementor	WWF - Australia
Type of Project Implementor	Environmental group
Purpose of Project	Reducing greenhouse emissions and raising awareness of climate change
Project Objective	Assisting electricity end users to reduce greenhouse emissions Raising awareness of energy/greenhouse savings from lighting and appliance standby power consumption Raising awareness of climate change
Project Target	Whole electricity network
DSM Measure(s) Used	Energy conservation, eg switching off lights and appliances
Specific Technology Used	Switching off non-essential lighting, non-essential appliances at the power point, and any other non-essential equipment for one hour at night
Market Segments Addressed	Residential electricity end users Commercial and small industrial electricity end users

REGULATORY REGIME

This is a voluntary program implemented by an environmental group.

DRIVERS FOR PROJECT

Earth Hour is a worldwide campaign that aims to educate the community about the threats of climate change, informing individuals and businesses about the difference they can make by reducing their emissions at home and in the workplace.

Climate change is seen by WWF to be the most significant threat to life on Earth. Through Earth Hour they want to demonstrate that collectively, simple activities like leaving lights on when you leave a room or leaving appliances on standby are direct and unnecessary contributors to climate change.

DESCRIPTION OF PROJECT

Earth Hour is an Australian initiative that began in Sydney in 2007. Earth Hour started as a joint initiative between WWF-Australia, Fairfax Media and the Leo Burnett advertising agency. The intent is for the event to be adopted by other residents, communities, businesses and governments around the world so they too can help demonstrate that individual action on a mass scale can help change our planet for the better.

Residential and business consumers are encouraged to switch off non-essential lighting, non-essential appliances at the power point, and any other non-essential equipment for one hour at night on a nominated day (usually a Saturday) during the year.

A range of promotional activities is used to raise awareness of Earth Hour and to encourage households and businesses to participate. Information on the campaign and information for participating households and businesses is provided through the website http://www.earthhour.org.

RESULTS

Residential Customers Participating	Commercial and Small Industrial Customers Participating		Agricultural Customers Participating	Large Industrial Customers Participatin g	Additional Generation Installed
Victoria 2008 approx 0.84 million households	Unknown		Unknown	Unknown	
Peak Load	**Peak Load Reduction**	**Duration of Peak Load Reduction**	**Overall Load Reduction**	**Energy Savings**	**Greenhouse Emissions Reduction**
Victoria 2008 5,746 MW at start of Earth Hour	Victoria 2008 299 MW (max)	Victoria 2008 approx 4 hours	Victoria 2008 299 MW (max)	Victoria 2008 estimated 681 MWh	Victoria 2008 estimated 892 tCO2-e

Approximately 2.2 million people and 2,100 businesses took part in Earth Hour during the first year (2007).

In 2008, Earth Hour was held on Saturday 29 March and involved between 50 and 100 million people in 370 cities and towns around the world, including Chicago, Toronto, Copenhagen, Dublin, Atlanta and Bangkok. An independent survey found that in 2008, 58 per cent of people in Australian capital cities joined in by switching off their lights.

Graphs showing the estimated impact of Earth Hour 2008 on Victorian electricity demand are provided in Figures 1 to 3 (pages 143 and 144).

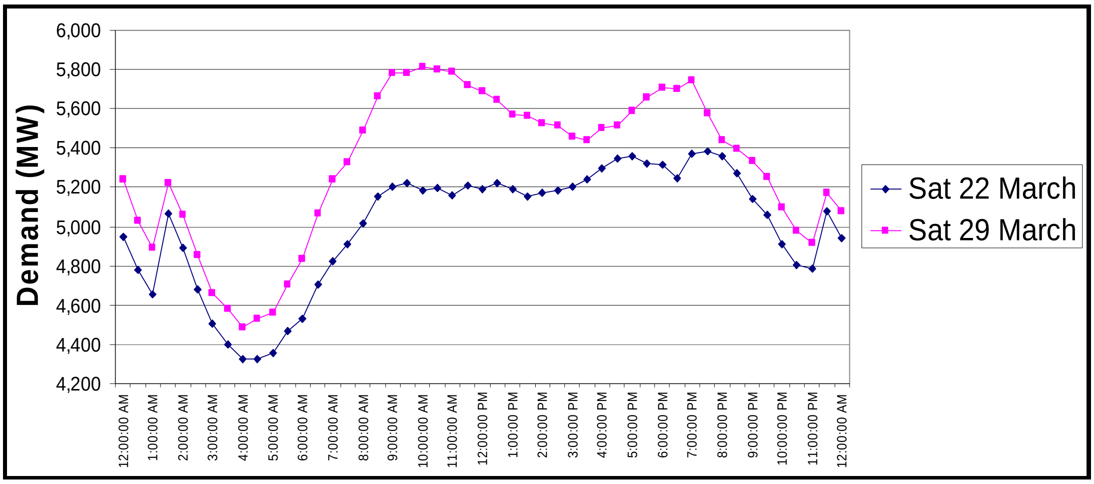

Figure 1. Victorian Electricity Demand, Saturday 22 March vs Saturday 29 March 2008*

** Earth Hour occurred on 29 March between 7 pm and 8 pm*

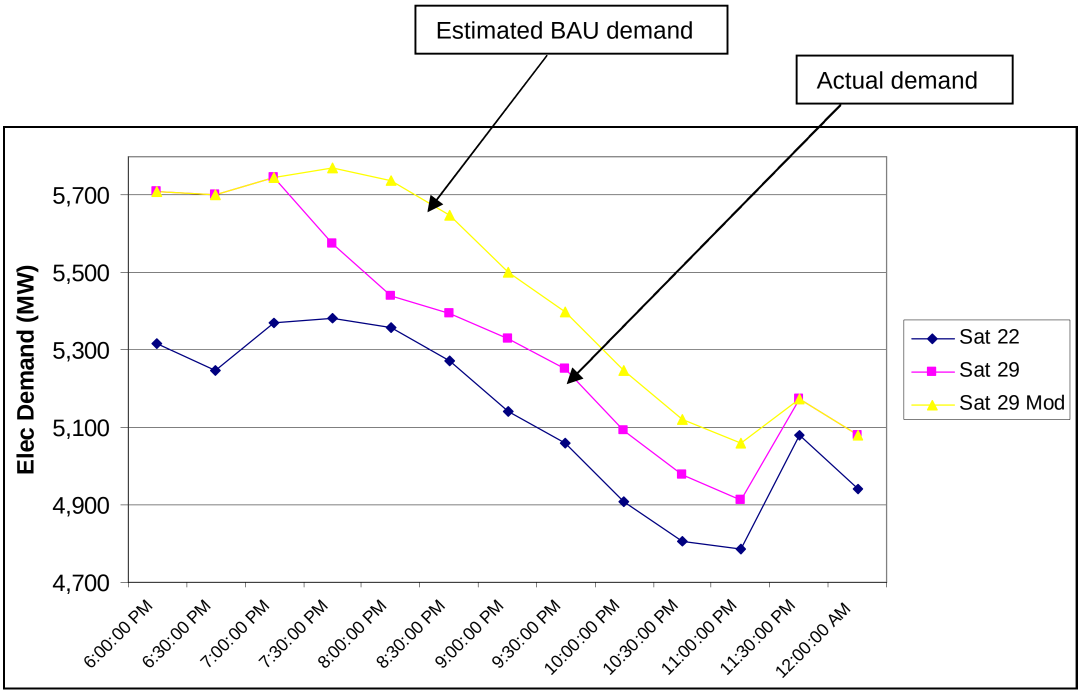

Figure 2. Estimated BAU Demand and Actual Demand during Victorian Earth Hour 2008*

** Estimated BAU demand is based on the shape of the load profile on Saturday 22 March*

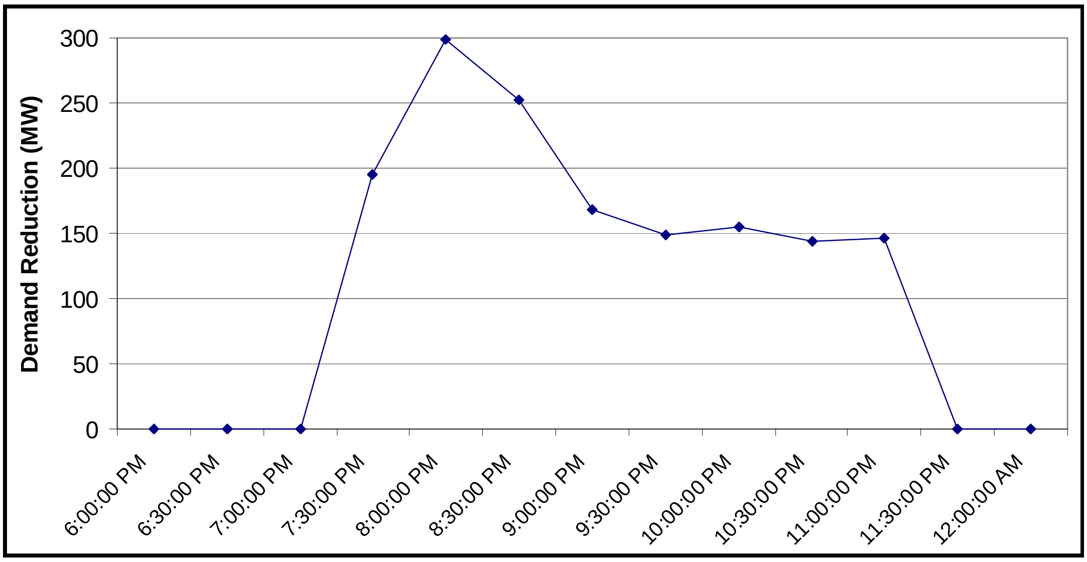

Figure 3. Estimated Demand Reduction from Victorian Earth Hour 2008

HOW LOAD REDUCTION WAS MEASURED

Estimated from Victorian electrical demand data obtained from the NEMMCO website. (See below for details.)

HOW GREENHOUSE EMISSIONS REDUCTION WAS CALCULATED

The first step was to estimate the electrical demand reduction during and after Earth Hour, using load profile data from the Australian Energy Market Operator (AEMO). Demand on Saturday 22 March was compared with demand on Saturday 29 March (Earth Hour day). The shape of the demand curve on 22 March was used to estimate business as usual (BAU) demand without Earth Hour for Saturday 29 March. The demand reduction caused by Earth Hour was estimated as the difference between the BAU demand and the actual demand (see Figure 2, page 143).

The next step was to use the half hourly demand reduction data, convert this into an energy saving, and then multiply by the average greenhouse coefficient for Victoria (1.31 t/MWh). This methodology may overestimate the actual greenhouse savings.

TIMING OF LOAD/EMISSIONS REDUCTION

AVOIDED COSTS

ACTUAL PROJECT COSTS

In general there would have been minimal costs for households participating. Businesses which participated would have had some costs associated with arranging to have lights, etc switched off – although many participating businesses also sought to obtain promotional benefit from participating. The main costs would have been the actual costs of organising the event, much of which seems to have been funded by business sponsors.

PROJECT COST FROM THE SOCIETAL PERSPECTIVE

ASSESSMENT OF OVERALL PROJECT EFFECTIVENESS

Earth Hour has grown from an initial event in Sydney in 2007, to a global event. While the energy and greenhouse savings are relatively modest, these are just the savings for a one-off event which officially lasts for only one hour a year.

Significant additional savings could be achieved where this has an ongoing impact on household behaviour. We are not (currently) aware of any research along these lines. Subsequent Earth Hours will provide an opportunity to compare the impact in 2008 with the impact in later years. Earth Hour eventually aims to reach 1 billion people in more than 1,000 cities.

PROJECT INFORMATION RESOURCES

Contacts

Sources

Earth Hour website
http://www.earthhour.org

AEMO website – Aggregated price and demand data
http://www.aemo.com.au/data/price_demand.html

EMR-AU05 VICTORIAN FIVE STAR HOUSING STANDARD

Last updated	5 November 2010
Location of Project	State of Victoria, Australia
Year Project Implemented	2005
Year Project Completed	Ongoing
Name of Project Proponent	State Government of Victoria
Name of Project Implementor	Building Commission, Victoria
Type of Project Implementor	State or federal government agency
Purpose of Project	Implementing government policy
Project Objective	Assisting electricity end users to reduce greenhouse emissions Assisting gas end users to reduce greenhouse emissions
Project Target	Whole electricity network
DSM Measure(s) Used	Energy efficiency
Specific Technology Used	Regulatory Standard that requires houses to be designed to achieve a five star house energy rating for the building shell (based on specified rating tools). The Standard also requires certain water efficiency measures, and the use of either a rainwater tank connected to a toilet cistern or a solar water heater.
Market Segments Addressed	Residential electricity end users Residential gas end users

REGULATORY REGIME

The Victorian Building Commission and Plumbing Industry Commission are responsible for the legislation which puts in place the Five Star Standard.

The Five Star Standard requires houses to be designed to achieve a five star house energy rating (based on specified rating tools) for the building shell. The Standard also requires certain water efficiency measures, and the use of either a rainwater tank connected to a toilet cistern or a solar water heater.

The designs for new residential dwellings constructed in Victoria must be rated using either the FirstRate5 or AccuRate house energy rating tools, and must achieve a five star rating. The ratings must be carried out by accredited house energy raters, who must complete and pass an accredited training course and be registered.

Proof of achieving a five star rating, and compliance with the water efficiency, rainwater tank / solar water heater components of the Five Star Standard are required as part of the buildings approval process, which is managed by local councils.

Sustainability Victoria maintains the register of accredited house energy raters, and also undertakes an annual audit of the accredited raters.

DRIVERS FOR PROJECT

The Five Star Standard was introduced by the Victorian Government in July 2005 (after a 12 month transition period) to reduce greenhouse emissions from the residential sector.

Prior to the introduction of this standard, Victoria had mandatory insulation requirements (ceilings, walls, floors) for residential dwellings from 1991. However, an analysis of houses built to this standard indicated that they were achieving an house energy rating of only around two stars. A cost-benefit analysis indicated that it was cost effective to build new houses to a Five Star Standard, thereby improving comfort and reducing heating and cooling energy consumption by about 50%.

DESCRIPTION OF PROJECT

Since July 2005, new houses and apartments in Victoria must be built to meet the energy efficiency and water management requirements of the 5 Star Standard. Approximately 35,000 to 40,000 new residential dwellings are constructed in Victoria each year.

The Five Star Standard requires:

- a five star house energy rating for the building shell;
- water efficient taps and fittings; plus
- either a rainwater tank for toilet flushing, or a solar hot water system (applies only to Class 1 dwellings, eg stand alone or semi-detached houses).

The building shell requirements are based on a performance standard which is technology neutral. Any combination of technologies can be used in the house design, as long as it achieves the required rating, based on the modelled annual thermal performance of the building shell.

The house energy rating is based on either the FirstRate 5 or AccuRate house energy rating software. House design and construction details and site details are entered into the rating tool to develop a thermal model of the house, and this is linked to climate data for a typical year for the climate zone in which the house is located. The software calculates the annual energy (MJ/m2) required for heating and cooling to maintain thermal comfort in the home, and this is then used to establish the house energy rating.

For most houses, achieving the 5 Star Standard requires a few simple improvements to the standard design and construction of a home. This may be achieved through a wide range of options, such as increasing the level of insulation, better orientation and exterior shading, better seals and draught-proofing and the use of high performance glazing.

The 5 Star standard is a flexible standard – it is performance-based rather than prescriptive. This means designers and builders can use their creativity on how they meet homeowners' requirements of being cost-effective, functional and aesthetic in designing and constructing 5 Star homes. The combination of energy and water saving features of a 5 Star home work together to ensure a high degree of occupancy comfort and reduced operating costs.

RESULTS

Residential Customers Participating	Commercial and Small Industrial Customers Participating		Agricultural Customers Participating	Large Industrial Customers Participatin g	Additional Generation Installed
Approx 100,000 to date (grows by 35,000 to 40,000 per annum)					
Peak Load	**Peak Load Reduction**	**Duration of Peak Load Reduction**	**Overall Load Reduction**	**Energy Savings**	**Greenhouse Emissions Reduction**
		Summer (3 pm to 5 pm) Winter (7 am to 9 am) and (5pm to 8 pm)		Based on 100,000 houses – 124,000 MWh	Based on reduced electricity use in 100,000 houses – 358,000 tCO2-e

To late 2008, over 100,000 new houses were constructed to the Five Star Standard (equivalent to around 5% of the housing stock). From May 2008, the standard was extended to cover alterations, additions and relocation of existing houses.

Houses built to the 5 Star Standard are estimated to have a heating and cooling energy consumption 50% less than equivalent houses constructed prior to the introduction of the Standard, reducing consumer energy bills by around $200 per year. Around 50% of the Class 1 dwellings being constructed are achieving compliance by installing a solar water heater – installation rates prior to the introduction of the Standard were less than 2%.

Space heating and cooling and water heating account for around two-thirds of the energy used in Victorian homes. Historically both space heating and water heating have been dominated by natural gas, especially in the main metropolitan areas. Electricity is used more extensively for heating and water heating in the country areas of Victoria.

This means that the Five Star Standard has led to significant savings in gas used in new homes, with electricity savings playing a relatively minor role. However since 2000, air conditioner penetration has been rising quite rapidly in Victorian homes (from 43.5% in 1999 to 69.5% in 2008), and the Five Star Standard is playing a role in helping to contain the growth in peak electricity demand.

The average savings per new dwelling constructed are estimated to be:

Electricity – 1.24 MWh/household/year (4.46 GJ/household/yr)

Gas – 27.5 GJ/household/year

Greenhouse gas emissions – 3.58 Tonnes/household/year from electricity and gas savings.

HOW LOAD REDUCTION WAS MEASURED

HOW GREENHOUSE EMISSIONS REDUCTION WAS CALCULATED

Base energy requirement for heating and cooling was estimated from thermal modelling of typical new dwellings constructed in Victoria for the different climate zones in the State. This was combined with data on heating/cooling equipment used in new dwellings, and with data on water heating and other household energy use to estimate overall usage of electricity, gas and other fuels. Houses constructed to the Five Star Standard were compared with houses constructed prior to the introduction of the Standard to estimate the energy savings. The energy savings were then multiplied by average State greenhouse coefficients to estimate the greenhouse emissions reductions.

TIMING OF LOAD/EMISSIONS REDUCTION

The emissions reductions are mainly related to residential heating, and would mainly occur during winter months (June to August) from around 6 am to 11 pm. The other main area of emission reductions would be for water heating – mornings and evenings for gas, and during the night time off peak period (11 pm to 7 am) for electricity. There would also be small emission reductions during summer months (December to February) during the afternoon/evening of hot summer days (about 30 per year above 30 degrees Celsius in Melbourne).

AVOIDED COSTS

ACTUAL PROJECT COSTS

PROJECT COST FROM THE SOCIETAL PERSPECTIVE

ASSESSMENT OF OVERALL PROJECT EFFECTIVENESS

A 2007 study "Options to Reduce Greenhouse Emissions from New Homes in Victoria through the Buildings Approval Process" (see Sources below) drew the following conclusions about the Victorian Five Star Housing Standard.

At the current rate of construction (about 38,000 new dwellings each year) Victoria's residential sector energy emissions are increasing by about 532,000 tonnes (532 kt) of CO2-e per annum from energy use in new housing.

The energy-related emissions of the average new dwelling are nearly 6% higher than the average emissions of existing dwellings. The emissions from the end uses targeted by the 5 Star requirements – heating, cooling and water heating – are significantly lower than in existing dwellings, but these gains appear to be more than outweighed by growth in emissions from lighting (driven by the widespread use on low voltage halogen downlights), which is not targeted by the 5 Star Standard.

A major driver for increasing emissions from lighting, and a restraint on reductions from heating and cooling, is the increasing size of dwellings – the average new dwelling is estimated to have a 30% larger net conditioned floor area than the average existing dwelling.

It is also relevant to compare new dwellings meeting the 5 Star regulations with what would have happened if the 5 Star measures had not been introduced. Without the 5 Star measures, it is estimated that the average thermal performance of new dwellings would have been about 2.5 stars on the AccuRate rating scale, and annual emissions from energy use would have been about 17.6 t CO2-e/yr, or 33% higher than for existing homes. This is because there would have been very little improvement in thermal performance to compensate for the larger size of new dwellings and their increased lighting load. (See Figure 1).

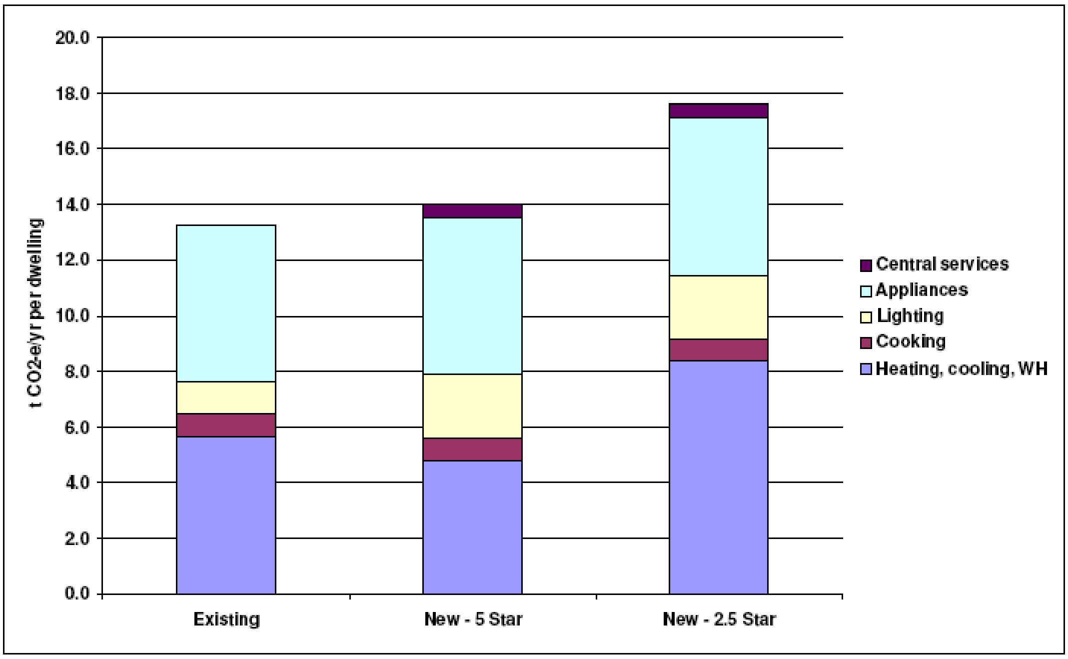

Figure 1. Comparison of Average Annual Greenhouse Emissions from Dwellings in Victoria with Various Star Ratings

The 5 Star regulations have largely compensated for the effects of larger dwellings by lowering the requirement for heating, cooling and water heating (but not lighting), so average emissions are only 6% higher than existing dwellings rather than 33% higher. In other words, the 5 Star measures have meant that average emissions from new dwellings are about 20% less than if the measures had not been implemented. The difference amounts to about 3.6 t CO2-e/year per new dwelling: about 3.1 t CO2-e/year due to the thermal performance impacts and 0.5 t CO2-e/year due to the water efficiency and solar water heater impacts. Without 5 Star, the annual emissions added by each year's cohort of new dwellings would have been about 136 kt CO2-e/yr higher than it is.

PROJECT INFORMATION RESOURCES

Contacts

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Sources

Five Star Standard website:
http://www.makeyourhomegreen.vic.gov.au/www/html/1962-introduction.asp?intLocationID=1960

George Wilkenfeld and Associates with Energy Efficient Strategies (2007). "Options to Reduce Greenhouse Emissions from New Homes in Victoria through the Buildings Approval Process". Melbourne, Department of Sustainability and Environment. Available at:
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EMR-ES01 HYBRID ELECTRIC VEHICLE DEVELOPMENT

Last updated	5 November 2010
Location of Project	Madrid, Spain
Year Project Implemented	2006
Year Project Completed	2008
Name of Project Proponent	Besel
Name of Project Implementor	Boyaca
Type of Project Implementor	Transport company
Purpose of Project	Maintaining the financial viability of the project proponent's business
Project Objective	Assisting electricity end users to reduce greenhouse emissions
Project Target	Whole electricity network
DSM Measure(s) Used	Hybrid electric vehicle
Specific Technology Used	Hybrid electric vehicle
Market Segments Addressed	Goods transport firms

REGULATORY REGIME

The Spanish Ministry of Industry announced in the summer of 2008 the development of 31 measures to improve energy efficiency in the Spanish economy. One of those measures was the development of at least 1 million electric and electric hybrid vehicles by 2014.

DRIVERS FOR PROJECT

This project is a study about the performances of a prototype electric vehicle used for the distribution of goods. The main purpose is to evaluate the energy needs, the greenhouse gas emissions reduction and, generally speaking, the strengths and weaknesses of the considered vehicle. The aim of the project is to find an efficient alternative to the traditional individually-owned transport vehicle.

DESCRIPTION OF PROJECT

The project developed a small hybrid electric vehicle ideal for transporting small loads in urban areas. The vehicle is shown in Figure 1 (page).

The main characteristics of the vehicle are:

- load capacity of more than 500 kg;
- maximum speed of 40 km/h;
- range of more than 60 km per charge.

This is a pilot project intended to promote the use of electric vehicles. To achieve widespread use of this technology the main requirement is the development of vehicle parking spaces with electrical charging facilities.

Figure 1. The Prototype Hybrid Electric Vehicle

RESULTS

Residential Customers Participating	Commercial and Small Industrial Customers Participating		Agricultural Customers Participating	Large Industrial Customers Participatin g	Additional Generation Installed
Peak Load	**Peak Load Reduction**	**Duration of Peak Load Reduction**	**Overall Load Reduction**	**Energy Savings**	**Greenhouse Emissions Reduction**
					0.53 tC02-e

HOW LOAD REDUCTION WAS MEASURED

HOW GREENHOUSE EMISSIONS REDUCTION WAS CALCULATED

The emissions reduction achieved by the project was calculated by multiplying the fuel savings by the emissions factor for the fuel.

TIMING OF LOAD/EMISSIONS REDUCTION

AVOIDED COSTS

The savings from using the prototype hybrid electric vehicle were estimated as more than EUR 500 per annum in reduced fuel and vehicle maintenance costs.

ACTUAL PROJECT COSTS

PROJECT COST FROM THE SOCIETAL PERSPECTIVE

ASSESSMENT OF OVERALL PROJECT EFFECTIVENESS

PROJECT INFORMATION RESOURCES

Contacts

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Sources

"Development of hybrid vehicle: project Besel-Boyaca". Conference about Fuel and Alternative Propulsion Systems, Madrid, November 2008.

EMR-ES02 ENVIRONMENTAL PROGRAM OF TORRES PAPEL

Last updated	5 November 2010
Location of Project	Nine factories at various locations across Spain
Year Project Implemented	2004
Year Project Completed	2006
Name of Project Proponent	Torres Papel SA
Name of Project Implementor	Torres Papel SA
Type of Project Implementor	Electricity end user
Purpose of Project	Achieving a mandatory greenhouse emissions target
Project Objective	Reducing the project proponent's greenhouse emissions
Project Target	Network element (eg a specific line or substation)
DSM Measure(s) Used	Distributed generation Energy efficiency Optimisation of manufacturing processes
Specific Technology Used	Cogeneration
Market Segments Addressed	Large industrial electricity end users

REGULATORY REGIME

In January 2005 the European Union Greenhouse Gas Emission Trading Scheme (EU ETS) commenced operation as the largest multi-country, multi-sector greenhouse gas emissions trading scheme world-wide. The scheme was implemented through Directive 2003/87/EC, which entered into force on 25 October 2003.

Additionally, in January 2008, the EU put forward a major package of measures to implement strict climate and renewable energy targets, including a commitment to achieve at least a 20% reduction of greenhouse gas emissions by 2020 compared to 1990.

DRIVERS FOR PROJECT

Torres Papel SA is a manufacturer of paper and paper products.

The main driver for this project was to reduce greenhouse gas emissions from its factories so that Torres Papel could comply with the EU Directives.

DESCRIPTION OF PROJECT

Torres Papel implemented various initiatives to reduce energy consumption and greenhouse gas emissions in its factories.

One initiative was to maximize the ratio of cogenerated electricity with respect to total electricity consumed. The cogeneration systems produce electrical and thermal energy using natural gas and biomass as inputs.

By optimizing its manufacturing processes, Torre Papel has succeeded in reducing its specific energy consumption, thereby achieving lower greenhouse gas emissions. The company launched an energy-saving plan in all its factories in 2005, analyzing all the stages in the manufacturing process in which energy could be saved, and implementing actions that soon resulted in reduced energy consumption, particularly electricity consumption.

RESULTS

Residential Customers Participating	Commercial and Small Industrial Customers Participating		Agricultural Customers Participating	Large Industrial Customers Participating	Additional Generation Installed
Peak Load	**Peak Load Reduction**	**Duration of Peak Load Reduction**	**Overall Load Reduction**	**Energy Savings**	**Greenhouse Emissions Reduction**
				0.23 MWh per tonne of product	0.04 tCO_2-e per tonne of product

Specific consumption of energy per tonne of product has reduced by about 8 per cent, going from 2.83 MWh/t in 2004 to 2.60 MWh/t in 2006.

HOW LOAD REDUCTION WAS MEASURED

HOW GREENHOUSE EMISSIONS REDUCTION WAS CALCULATED

To estimate the emissions reduction, the energy saved was multiplied by an average emissions factor of 0.538 tCO_2-e/MWh, while taking account of the proportional use of electricity and gas by each manufacturing plant.

TIMING OF LOAD/EMISSIONS REDUCTION

Between the hours of 7mpm and 10 pm seven days per week.

AVOIDED COSTS

ACTUAL PROJECT COSTS

PROJECT COST FROM THE SOCIETAL PERSPECTIVE

ASSESSMENT OF OVERALL PROJECT EFFECTIVENESS

The project has proved to be quite successful in reducing both energy consumption and greenhouse gas emissions.

PROJECT INFORMATION RESOURCES

Contacts

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Sources

http://www.torrespapel.com

EMR-ES03 ELECTRICITY GENERATION FROM BIOMASS

Last updated	5 November 2010
Location of Project	Almácera, a village close to Valencia, Spain
Year Project Implemented	
Year Project Completed	2002
Name of Project Proponent	Maicerias Españolas SA
Name of Project Implementor	Maicerias Españolas and Institute for Diversification and Saving of Energy
Type of Project Implementor	Electricity end user State or federal government agency
Purpose of Project	Maintaining the financial viability of the project proponent's business
Project Objective	Assisting electricity end users to reduce greenhouse emissions
Project Target	Network element
DSM Measure(s) Used	Distributed generation Fuel substitution
Specific Technology Used	Biomass-fuelled electricity generator
Market Segments Addressed	Commercial and small industrial electricity end users

REGULATORY REGIME

In January 2005 the European Union Greenhouse Gas Emission Trading Scheme (EU ETS) commenced operation as the largest multi-country, multi-sector greenhouse gas emissions trading scheme world-wide. The scheme was implemented through Directive 2003/87/EC, which entered into force on 25 October 2003.

Additionally, in January 2008, the EU put forward a major package of measures to implement strict climate and renewable energy targets, including a commitment to achieve at least a 20% reduction of greenhouse gas emissions by 2020 compared to 1990.

DRIVERS FOR PROJECT

Maicerias Españolas SA operates a factory processing cereals, particularly maize and rice.

The purpose of the project was twofold:

- to obtain value from the company's main production waste, rice husks; and
- to optimize the company's energy production system.

DESCRIPTION OF PROJECT

During its manufacturing process (6500 hours/year), Maicerias Españolas produces rice husk waste (12000 tonnes/year) which is hard to dispose of. The manufacturing process uses both electricity (9800 MWh/year) and process heat (2.8 GWh/year).

Working with the State-owned Institute for Diversification and Saving of Energy (IDAE), the company investigated and implemented the installation of an electricity generation plant using vegetable waste as a fuel. The plant burns rice husks through a fluidised bed boiler process, which can cope with up to 15.000 tonnes of rice husks a year. The electrical energy produced powers a boiler which was previously fuelled by natural gas.

RESULTS

Residential Customers Participating	Commercial and Small Industrial Customers Participating		Agricultural Customers Participating	Large Industrial Customers Participatin g	Additional Generation Installed
Peak Load	**Peak Load Reduction**	**Duration of Peak Load Reduction**	**Overall Load Reduction**	**Energy Savings**	**Greenhouse Emissions Reduction**
				15.875 MWh	11,993 tC02-e

The implementation of the project has enabled an increase in the working hours of the plant form 6500 hours/year to 8000 hours/year. This has increased the quantity of rice husks processed (from 12000 to 15000 tonnes/year).

HOW LOAD REDUCTION WAS MEASURED

HOW GREENHOUSE EMISSIONS REDUCTION WAS CALCULATED

To estimate the emissions reduction, the energy saved by replacing grid electricity with on-site generation fuelled by biomass was multiplied by the average grid emissions factor.

TIMING OF LOAD/EMISSIONS REDUCTION

AVOIDED COSTS

ACTUAL PROJECT COSTS

The total cost of installing the on-site electricity generation plant was EUR 6 million.

PROJECT COST FROM THE SOCIETAL PERSPECTIVE

ASSESSMENT OF OVERALL PROJECT EFFECTIVENESS

PROJECT INFORMATION RESOURCES

Contacts

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Sources

IDAE (2002). "Instalción de producción de energía eléctrica con biomasa en Maiceras Españolas".

EMR-ES04 ULCOS - ULTRA LOW CO2 STEEL MAKING

Last updated	5 November 2010
Location of Project	European Union
Year Project Implemented	2004
Year Project Completed	2014
Name of Project Proponent	ArcelorMittal
Name of Project Implementor	Tecnalia Technology Corporation
Type of Project Implementor	ESCO/Energy management company
Purpose of Project	Achieving a mandatory greenhouse emissions target
Project Objective	Reducing the project proponent's greenhouse emissions
Project Target	Network element
DSM Measure(s) Used	Change in production technology
Specific Technology Used	Ultra low CO2 steel making production process
Market Segments Addressed	Large industrial electricity end users

REGULATORY REGIME

In January 2005 the European Union Greenhouse Gas Emission Trading Scheme (EU ETS) commenced operation as the largest multi-country, multi-sector greenhouse gas emissions trading scheme world-wide. The scheme was implemented through Directive 2003/87/EC, which entered into force on 25 October 2003.

Additionally, in January 2008, the EU put forward a major package of measures to implement strict climate and renewable energy targets, including a commitment to achieve at least a 20% reduction of greenhouse gas emissions by 2020 compared to 1990.

DRIVERS FOR PROJECT

The aim of the ULCOS project is to reduce the carbon dioxide (CO2) emissions of today's best steel making processes by at least 50 percent. It is a response by the steel industry to the European Union Directives on emissions trading and emissions reduction targets.

The ULCOS project is being implemented by a consortium of 48 companies and organisations from 15 European countries that have launched a cooperative research and development initiative to enable drastic reduction in carbon dioxide (CO2) emissions from steel production. The consortium consists of all major EU steel companies, energy and engineering partners, research institutes and universities and is supported by the European Commission.

DESCRIPTION OF PROJECT

Steel making companies are responsible for up to 27% of the worldwide greenhouse gas emissions generated in the industrial sector. Carbon dioxide is unavoidable in the current mainstream method of producing hot metal. The most modern steel plants today operate very close to the limits set by physics, and further reducing the amount of carbon used for making steel is not possible without technological change.

Currently, around 60% of the steel produced in the world comes from high ovens, in a process that generates between 1.8 and 2 tonnes of CO2 per tonne of product. Reducing the amount of emissions generated is a priority in the steel making industry.

In the ULCOS project there are four alternatives being considered. ArcelorMittal is developing one of these, consisting of recycling the gas emitted by high ovens to generate more heat. The concept of the Top Gas Recycling Blast Furnace relies on separation of the off-gases so that the useful components can be recycled back into the furnace and used as a reducing agent. This would reduce the amount of coke needed in the furnace. In addition, the process of injecting oxygen into the furnace instead of preheated air, removes unwanted nitrogen from the gas, facilitating carbon dioxide capture and storage (CCS).

During the in February 2008 meeting of the European Steel Technology Platform (ESTEP), both the ULCOS Consortium core members and the European Commission decided to launch ULCOS II which will explore some of the technologies investigated under ULCOS I in relation to their potential and feasibility under large scale, industrial production conditions. ULCOS II is planned to run from 2010 to 2015. The results of ULCOS II can potentially be rolled out into production plants some 15 to 20 years from now.

RESULTS

Residential Customers Participating	Commercial and Small Industrial Customers Participating		Agricultural Customers Participating	Large Industrial Customers Participatin g	Additional Generation Installed
Peak Load	**Peak Load Reduction**	**Duration of Peak Load Reduction**	**Overall Load Reduction**	**Energy Savings**	**Greenhouse Emissions Reduction**

The target of the ULCOS project is to achieve a 50% reduction in greenhouse gas emissions compared to a standard steel making process operated in a high oven.

HOW LOAD REDUCTION WAS MEASURED

HOW GREENHOUSE EMISSIONS REDUCTION WAS CALCULATED

TIMING OF LOAD/EMISSIONS REDUCTION

AVOIDED COSTS

ACTUAL PROJECT COSTS

PROJECT COST FROM THE SOCIETAL PERSPECTIVE

ASSESSMENT OF OVERALL PROJECT EFFECTIVENESS

PROJECT INFORMATION RESOURCES

Contacts

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Sources

http://www.ulcos.org/en/about_ulcos/home.php

EMR-IN01 CFL LIGHTING SCHEME – BACHAT LAMP YOJANA

Last updated	5 November 2010
Location of Project	Ranga Reddy district of Andhra Pradesh, India
Year Project Implemented	2009
Year Project Completed	Ongoing
Name of Project Proponent	Bureau of Energy Efficiency, Government of India
Name of Project Implementor	C-Quest Capital Malaysia Ltd
Type of Project Implementor	Private sector carbon finance business dedicated to originating and developing high-quality emission reduction projects around the world
Purpose of Project	Implementing government policy
Project Objective	Generating revenue from the sale of greenhouse emissions reductions
	Assisting electricity end users to reduce greenhouse emissions
Project Target	Network region
DSM Measure(s) Used	Energy efficiency
Specific Technology Used	Compact fluorescent lamps
Market Segments Addressed	Residential electricity end users

REGULATORY REGIME

The Bachat Lamp Yojana (BLY) scheme aims to achieve the large scale replacement of existing incandescent lamps in households with compact fluorescent lamps (CFLs). The scheme provides CFLs to households at a price similar to that of incandescent bulbs and utilises the Clean Development Mechanism (CDM) of the Kyoto Protocol to recover the cost differential between the market price of the CFLs and the subsidised price at which the CFLs are sold to households.

The BLY scheme was developed by the Bureau of Energy Efficiency, an agency of the Government of India. The scheme has been established as a Programme of Activities (PoA) approved by the CDM Executive Board on 29 April 2010. Consequently, the scheme will generate Certified Emission Reductions (CERs) under the Kyoto Protocol and these can be sold in carbon markets.

A Programme of Activities is an umbrella under which small-scale CDM projects – referred to as CDM Programme Activities (CPAs) – are undertaken. The Bachat Lamp Yojana PoA has the potential to include 400 such CPAs. Each CPA is unlikely to exceed 270,000 CERs, as the CDM rules limit how much energy a small-scale project can save. The BLY PoA lasts for 28 years from November 2007.

In India, there is no mandatory requirement to use energy efficient CFLs at the household level. The development of the Bachat Lamp Yojana PoA is a voluntary action on the part of BEE which is not seeking any commercial revenues from the PoA. Key players under the BLY PoA, such as the distribution utility and households, are also voluntarily taking part in the scheme.

The Bachat Lamp Yojana PoA is being implemented as a public private partnership between the Government of India represented by BEE, private sector CFL suppliers, electricity distribution companies (DISCOMs), and investors who absorb the initial cost, which is the difference between the CFL's actual cost and the subsidised price paid by householders.

The CFL suppliers for a particular CPA project are chosen by the DISCOM from a panel of CFL suppliers established by BEE. BEE is responsible for monitoring each CPA after an electricity distributor and a CFL supplier have entered into a tripartite agreement with BEE.

DRIVERS FOR PROJECT

The lighting sector accounts for almost 22% of the total electricity demand in India, and also contributes almost fully to peak loads. The majority of lighting in the country is provided by incandescent lamps (ICLs), which are energy inefficient; only about 5% of the electricity is converted into light, the rest is lost as heat

In recent years, CFLs have emerged as an energy efficient alternative, because a CFL uses only one fifth as much electricity as an ICL to provide the same level of illumination.

In 2008, ICL sales in India were 734 million whereas CFL sales were just 199 million; the penetration of ICLs in the commercial and residential sectors was nearly 80%. The majority of CFL sales took place in the commercial sector rather than in the residential sector for the following reasons:

- typical electricity tariffs in the residential sector are very low (INR 1.2 to 5.6) as compared to much higher commercial sector tariffs (INR 4 to 11);
- the average hours of use of CFLs in the commercial sector is higher (>5 hours/day) than in the domestic sector (3-4 hours/day), leading to a faster return on investments in CFLs;
- the initial cost of a CFL is a barrier for households in the residential sector; the cost of a CFL is around INR 80 – 130 whereas the cost of an ICL is INR 10-15).

Some of the progressive electricity distribution utilities in India have tried bulk procurement and marketing of CFLs to households at below market prices and/or introducing ICL replacement schemes. These efforts by utilities in States like Andhra Pradesh, Karnataka and Haryana met with limited success. The CFL programs faltered as either the funding support dried up, or the subsidy was withdrawn, or the utilities themselves were in poor financial shape. As a result, these programs could not be continued on a long-term, sustainable basis.

Replacement of ICLs with CFLs in the residential sector throughout India would lead to a potential reduction of over 6000 MW in electricity demand. This would not only reduce emissions by way of efficient use of electricity, but also would result in the reduction of peak loads. Hence, initiatives to increase the use of CFLs in the residential sector are required. Consequently, the Bureau of Energy Efficiency initiated the Bachat Lamp Yojana scheme.

DESCRIPTION OF PROJECT

This case study covers the first CPA within the Bachat Lamp Yojana PoA. This project is distributing CFLs to approximately 200,000 households in the Ranga Reddy district of Andhra Pradesh in eastern India. The project is located in the Habsiguda Division of the Ranga Reddy North Circle of the Central Power Distribution Company of Andhra Pradesh Limited (APCPDCL).

A maximum of four CFLs are provided per household in the Habsiguda Division at a subsidised price of INR 15 per CFL; 34% of these are 14 watt CFLs replacing 60 watt ICLs and 66% are 23 watt CFLs replacing 100 watt ICLs.

Figure 1 (page 167) shows the operation of the Ranga Reddy CPA in the Bachat Lamp Yojana scheme. The roles and responsibilities of the major stakeholders in the project are outlined below.

C-Quest Capital

C-Quest Capital is a carbon finance business headquartered in Washington DC. The Malaysia office of C-Quest Capital is implementing and funding the Ranga Reddy CPA and, in return, will receive the CERs generated by the project.

C-Quest Capital's role includes:

- preparing the Small Scale CDM Programme Activity Design Document (SSC-CPA-DD) for the Ranga Reddy CPA and submitting the document to BEE;
- achieving validation of the SSC-CPA-PDD by a Designated Operational Entity (DOE) of the CDM Executive Board;
- achieving registration of the SSC-CPA-PDD under the United Nations Framework Convention on Climate Change (including payment of any fees);
- providing 10,000 hour CFLs with lumen output +/- 10% of the output of 60 and 100 watt ICLs at a price comparable to those of ICLs (i.e. INR 15), in exchange for functioning ICLs that are currently being used in the target households; the CFLs must be compliant with the latest standards applicable in India;
- securing financing of the initial investment in the cost differential (no subsidy from the Government of India towards reducing the cost of the CFLs);
- distributing the CFLs in association with APCPDCL to customers in Habsiguda Division;
- during the life of the CDM project, carrying out free replacement of CFLs that fuse within three years of distribution;
- collecting fused CFLs through buy-back schemes, and msking arrangements for their safe disposal.

Central Power Distribution Company of Andhra Pradesh

APCPDCL is an electricity distribution company with headquarters at Hyderabad and supplying 57.4 million consumers.

APCPDCL's role includes:

- defining the geographic boundary of the customer area of a Habsiguda Division of Ranga Reddy North Circle;
- defining a residential household based on the State level definition and tariff category;
- preparing a database of all grid connected residential households, including the name and address of the customer, average annual electricity consumption, etc;
- storing replaced ICLs for independent inspection and safe disposal.

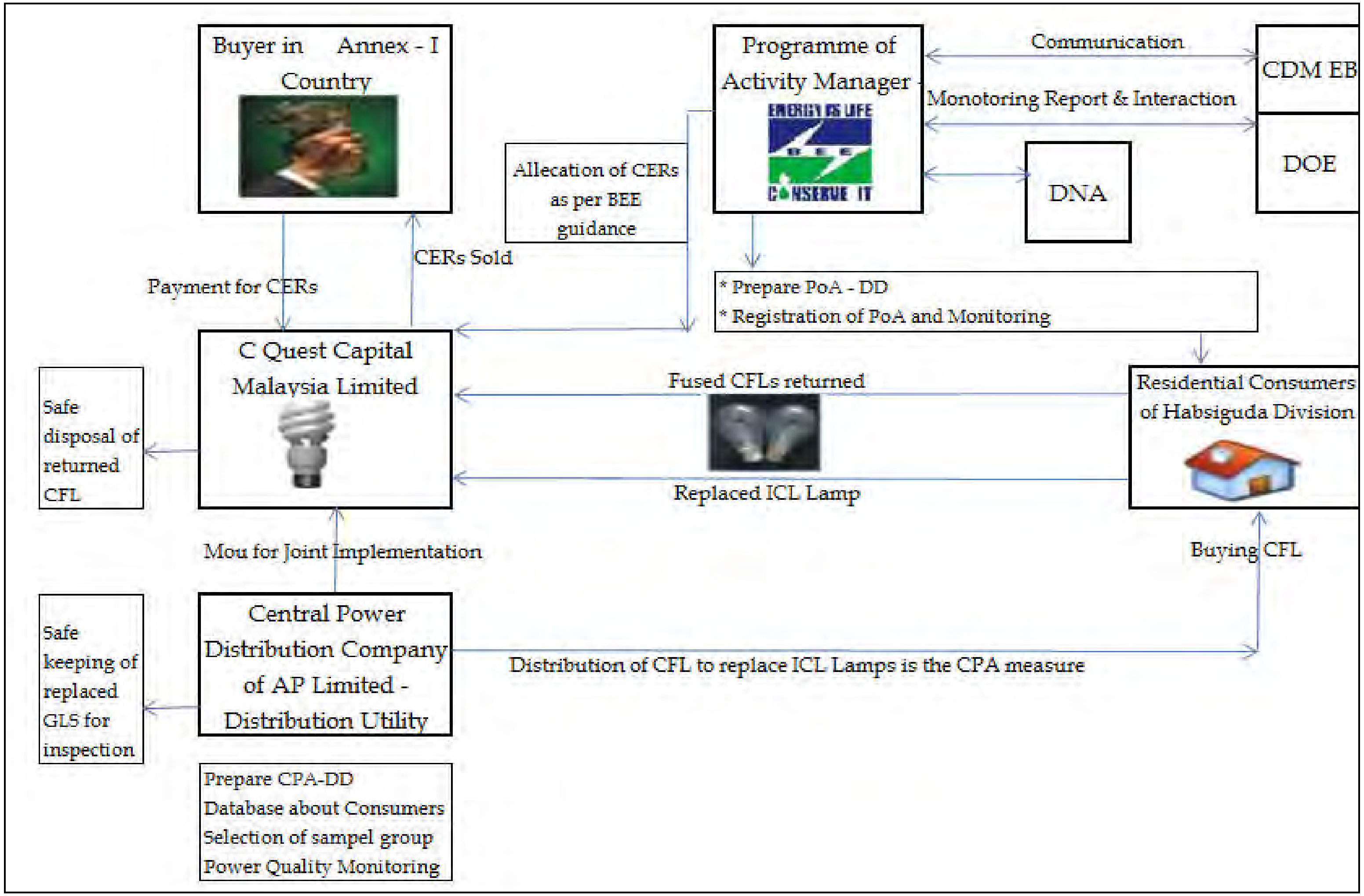

Figure 1. Operation of the Ranga Reddy CPA in the Bachat Lamp Yojana Scheme

Bureau of Energy Efficiency

BEE is a statutory body set up under the Energy Conservation Act, 2001 by the Government of India to promote energy efficiency in India.

BEE's role includes:

- developing the Small Scale Programme of Activities Design Document (SSC-PoA-DD) for the Bachat Lamp Yojana scheme;
- achieving registration of the SSC-PoA-DD by the CDM Executive Board;
- supporting C-Quest Capital in the preparation of the Small Scale CDM Programme Activity Design Document (SSC-CPA-DD) for the Ranga Reddy CPA;
- including the SSC-CPA-DD in the Bachat Lamp Yojana PoA upon satisfactory compliance of the eligibility criteria stipulated in the PoA;
- implementing an awareness and information campaign in the Habsiguda Division in association with APCPDCL;
- managing the monitoring of utilisation hours for lighting within the target households using the methodology approved by the CDM Executive Board and analysing the monitored data;
- allocating CERs to C-Quest Capital after verification that the replacement of ICLs with CFLs has resulted in the avoidance of greenhouse gas emissions;
- determining any transaction costs for functioning as the managing entity for the Ranga Reddy CPA;
- maintaining official communication with the CDM Executive Board, the Designated Operational Entity and the Designated National Authority for CDM projects in India.

RESULTS

Residential Customers Participating	Commercial and Small Industrial Customers Participating		Agricultural Customers Participating	Large Industrial Customers Participating	Additional Generation Installed
200,000					
Peak Load	**Peak Load Reduction**	**Duration of Peak Load Reduction**	**Overall Load Reduction**	**Energy Savings**	**Greenhouse Emissions Reduction**
		3.5 hours		319,070 MWh	273,124 tC02-e

The distribution of CFLs in the Ranga Reddy project commenced in mid-2010 and verified actual results are not yet available. Table 1 (page 169) shows the estimated emissions reduction to be achieved by the project over a crediting period (operational lifetime) of 7.8 years, based on a rated life of 10,000 hours per CFL and lighting usage of 3.5 hours per day.

Table 1. Estimated Emissions Reduction Achieved by the Ranga Reddy Project	
Year	**Estimated Emissions Reductions (tCO_2 e)**
2009	0
2010	31,385
2011	34,715
2012	32,360
2013	29,843
2014	26,251
2015	22,980
2016	19,640
2017	15,522
2018	273
2019	0
Total estimated reductions	212,969
Total number of crediting years	7.8 years
Annual average	21,297

HOW LOAD REDUCTION WAS MEASURED

HOW GREENHOUSE EMISSIONS REDUCTION WAS CALCULATED

The greenhouse gas emissions reduction likely to be achieved by the Ranga Reddy project was estimated using the small scale CDM projects methodology AMS-II.J. "Demand-side activities for efficient lighting technologies".

Emissions Reduction

The emissions reduction (ERy) likely to be achieved by the project is net electricity savings (NESy) times an emission factor (EFCO2ELEC.y)

ERy = NESy X EFCO2ELEC.y...(1)

Where:
ERy = Emission Reductions in year y (tCO2e)
NESy = Net electricity saved in year y (kWh)
EFCO2ELEC.y = Average Grid Emissions Factor in year y, sourced from the publicly available CO2 emission database by Central Electricity Authority (CEA) of India

Net Energy Savings (NESy)

NESy = ∑I QPJ,I X (1 – LFRi,y) X ESi X [1/(1-TDy)] X NTG ....(2)

Where:

ESi = (Pi,BL – Pi,PJ) X Oi X 365/1000..(3)

Where:

NESy = Net Electricity Saved in year y (kWh)

QPJ,I = Number of CFLs distributed or installed under the project activity. In total for all “I”, this value shall be equal to or less than the documented number of all baseline ICLs destroyed. Once all the project CFLs are distributed or installed, QPJ,I , is a constant value independent from y. QPJ,I will be obtained from the first ex post monitoring survey, which is to take place within the first 12 months of CFL distribution.

i = Counter for lighting devices e.g. 40 W incandescent bulb

n = Number of lighting devices

ESi = Estimated annual electricity savings for CFLs of type I (kWh)

LFRi,y = Lamp Failure Rate for CFL of type I in year y (fraction), calculated using the equation provided below

TDy = Average annual technical grid losses (transmission and distribution) during year y for the grid serving the locations where CFLs are installed. This (fraction) value shall not include non-technical losses such as commercial losses (e.g., theft/pilferage). Each CPA would have different TDy from the most recent average annual grid loss data published either by a national utility or an official government body e.g. by the Central Electricity Authority (CEA) of India. Only if no recent data are available, a default value of 10% will be used.

NTG = Net-to-gross adjustment factor, a default value of 0.95, unless a more appropriate value based on a lighting use survey from the same region and not older than 2 years is available

Pi,BL = Rated power of ICLs of type I, which are the baseline lighting devices (Watts)

Pi,PJ = Rated power of CFLs of type I, which are the project lighting devices (Watts)

Oi = Average daily operating hours of the ICLs replaced by CFLs. Fixed as 3.5 hours per 24 hours period.

Lamp Failure Rate

In the context of the SSC-CPA, the project lamp (CFL) failure rate shall be calculated ex-ante and then measured ex-post till the end of the crediting period as follows:

If y * Xi < Li, then LFRi,y = y * Xi * (100 – Ri)/(100 * Li) ....(4)

If y * Xi > or = Li, then LFRi,y = 1...(5)

Where:
LFRi,y = Lamp Failure Rate for CFL in year y (fraction)
Li = Rated average life for CFL type I (hours)
Ri = % of CFLs of type I operating at the rated lifetime (use a value of 50)
Xi = Number of operating hours per year for CFL type I (hours)
Y = Counter for year

TIMING OF LOAD/EMISSIONS REDUCTION

AVOIDED COSTS

ACTUAL PROJECT COSTS

PROJECT COST FROM THE SOCIETAL PERSPECTIVE

ASSESSMENT OF OVERALL PROJECT EFFECTIVENESS

PROJECT INFORMATION RESOURCES

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EMR-IN02 ENERGY EFFICIENCY IN CEMENT MILLING, WEST BENGAL

Last updated	5 November 2010
Location of Project	Durgapur, about 200 km north of Kolkata, West Bengal, India
Year Project Implemented	2000
Year Project Completed	2003
Name of Project Proponent	Durgapur Cement Works owned by Birla Corporation Limited
Name of Project Implementor	Durgapur Cement Works (DCW)
Type of Project Implementor	Electricity end user
Purpose of Project	Achieving a voluntary greenhouse emissions target
Project Objective	Reducing the project proponent's greenhouse emissions
	Generating revenue from the sale of greenhouse emissions reductions
Project Target	Network element
DSM Measure(s) Used	Energy efficiency
	Process improvement measures
Specific Technology Used	Flow control devices and more efficient grinding technology
Market Segments Addressed	Large industrial electricity end users

REGULATORY REGIME

There was no legal or regulatory requirement on Durgapur Cement Works to implement the project activity.

The project is registered under the Clean Development Mechanism (CDM) of the Kyoto Protocol so that the project proponent can benefit from the generation and sale of Certified Emission Reductions (CERs) from the project. Since the energy efficiency measures are at a single industrial facility, and the net energy consumption reduction is less than 15 GWh /annum, the project falls under the small scale CDM projects Category IID "Energy efficiency and fuel switching measures for industrial facilities".

DRIVERS FOR PROJECT

As reflected in the energy management policy of Durgapur Cement Works, energy efficiency improvement is one of the major initiatives taken up by the company in keeping with its commitment as a responsible corporate citizen contributing towards sustainable development.

The owner of the cement works, Birla Corporation Limited, is keenly aware of its social responsibilities. Besides providing education and healthcare facilities for its employees, their families and the community at large, the Group is involved in a number of philanthropic activities. The energy efficiency measures implemented at Durgapur Cement Works resulted in a reduction in electricity demand on the state grid which has indirect social benefits through reducing the demand-supply gap and the conservation of a corresponding amount of non-renewable resources.

The energy efficiency measures implemented reduced both the specific energy consumption for cement production and a corresponding amount of greenhouse gas emissions from electricity generation. Moreover, these efforts also reduced the use of coal, which is a primary resource for power generation and metallurgical applications. Reduction in electricity generation from thermal sources also helps in related pollution abatement.

DESCRIPTION OF PROJECT

Energy efficiency and process improvement measures were identified that involved technology upgrades and improved instrumentation in the cement milling section of the Durgapur Cement Works. The specific measure implemented are described below.

Installation of High Lift Liners

The most frequent problem in cement mill chambers is wearing of the mill liners leading to the formation of grooves. This results in increased energy consumption. DCW installed suitably designed high lift boltless liners with a hard surface made of high iron chrome which allows less abrasion of the lining and allowed the grinding balls to fall freely and maintain a correct trajectory motion. The modified liners also provided necessary lift to the grinding balls to achi8ve increased crushing/grinding efficiency with resultant energy savings.

Installation of Classifying Liner

In the grinding mills at DCW, grinding balls of 50mm, 40mm, 30mm, 25mm and 20mm diameters are used. Effective grinding requires ideal orientation of the balls with appropriate size grading. Classifying liners play a vital role in maintain this orientation, pushing the larger size balls backward, resulting in classification of the balls in a descending size order along the grinding path. The proper size adjustment of the grinding media increases fineness across the grinding path resulting in increase of grinding efficiency and leading to reduction in energy consumption for grinding.

Installation of Auto Loop Control

The cement milling system works through an automated controller that ensures optimal feeding and mill filling at all times, resulting in efficient production and energy saving. Following installation of an auto loop control feeding system, feeding of the raw material (clinker, slag and gypsum) has been optimised for minimum power consumption at all times. Also, this controls the degree of grinding (final particle size) and avoids excess grinding. This measure reduces energy consumption with higher output of ground material.

Changing to High Chrome Grinding Balls

High chrome grinding balls do not de-shape on continuous wear and tear during grinding operation. Changing to high chrome balls provided a better grinding efficiency and resulted in a further reduction in energy consumption.

Installation of Flow Control Diaphragms

It is desirable to transfer only the optimum size and quantity of ground material from the first to the second compartment of the cement mill to save the extra milling work required to achieve the required fineness. For efficient grinding, material should be broken down in the first compartment so that particles are small enough to be efficiently downsized by the small grinding media of the second compartment. To control the flow of the materials effectively, DCW installed a diaphragm-like structure that acts as a regulator to control the flow of the ground material and allows it to pass only when the optimum level of grinding has been achieved. The material in the diaphragm passes through a grate with slots of designed width that let crushed material through yet holds back any particles that have not been sufficiently broken down. After installation of the flow control diaphragm, the efficiency of the grinding mills increased thus further reducing energy consumption in the milling process.

RESULTS

Residential Customers Participating	Commercial and Small Industrial Customers Participating		Agricultural Customers Participating	Large Industrial Customers Participatin g	Additional Generation Installed
				1	
Peak Load	**Peak Load Reduction**	**Duration of Peak Load Reduction**	**Overall Load Reduction**	**Energy Savings**	**Greenhouse Emissions Reduction**
	4.07 MW			32,160 MWh	26,469 tC02-e

Table 1 shows the estimated greenhouse gas emissions reduction that are likely to be achieved by the DCW project over a nominal 10 year crediting period under the Clean Development Mechanism.

Table 1. Estimated GHG Emissions Reduction at Durgapur Cement Works Over a 10 year Crediting Period

Operating Year	Actual Cement Production (tonnes)	Energy Saving (MWh)		Baseline Emissions Factor (tCO_2-e/MWh)	Emissions Reduction (tCO_2-e)	
		Estimated	Actual		Estimated	Actual
2000/01	473,115	1,260	1,260	0.823	1037	1037
2001/02	526,688	1,770	1,770	0.823	1457	1457
2002/03	550,408	3,300	3,300	0.823	2716	2716
2003/04	615,469	3,690	4,080	0.823	3037	3358
2004/05	683,003	3,690	4,880	0.823	3037	4016
2005/06	633,434	3,690	4,280	0.823	3037	3522
2006/07		3,690		0.823	3037	
2007/08		3,690		0.823	3037	
2008/09		3,690		0.823	3037	
2009/10		3,690		0.823	3037	
Total		**32,160**			**26,469**	

HOW LOAD REDUCTION WAS MEASURED

HOW GREENHOUSE EMISSIONS REDUCTION WAS CALCULATED

For the calculation of GHG emissions reduction likely to be achieved by the DCW project, the average grid emissions factor for the Eastern Region issued by Central Electricity Authority was used (0.823 kg of CO2 per kWh). The energy savings (MWh) were multiplied by the grid emission factor (tCO2-e/MWh) to give the estimated reduction in emissions.

TIMING OF LOAD/EMISSIONS REDUCTION

AVOIDED COSTS

ACTUAL PROJECT COSTS

PROJECT COST FROM THE SOCIETAL PERSPECTIVE

ASSESSMENT OF OVERALL PROJECT EFFECTIVENESS

The project activity is a demonstration of energy efficient technology implementation and does not by itself generate or release greenhouse gases. The project activity results in, (1) Greenhouse gas abatement (2) Primary resource conservation and facilitates sustainable development.

PROJECT INFORMATION RESOURCES

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EMR-IN03 BUNDLE OF 100 VILLAGE BIOMASS-BASED POWER PLANTS IN BIHAR

Last updated	5 November 2010
Location of Project	Araria District, Bihar, India
Year Project Implemented	2007
Year Project Completed	2012
Name of Project Proponent	Decentralised Energy Systems India Pvt. Ltd. (DESIPL)
Name of Project Implementor	DESIPL, local government gram panchayats, and other organisations
Type of Project Implementor	Electricity end user Third party aggregator Local government (municipality)
Purpose of Project	Sustainable development in unelectrified villages in Bihar State
Project Objective	Generating revenue from the provision of greenhouse emissions reduction services
Project Target	
DSM Measure(s) Used	Distributed generation Fuel substitution
Specific Technology Used	Gasification plant and producer gas-based engine
Market Segments Addressed	Residential electricity end users Commercial and small industrial electricity end users Agricultural electricity end users

REGULATORY REGIME

This project fits with the Government of India policy of decentralising power generation through biomass gasifiers as outlined in its latest policy statement. Subsidies are available for the purchase of producer gas engines for various categories of users. However, subsidies are not sufficient to make the project viable.

The project is registered under the Clean Development Mechanism (CDM) of the Kyoto Protocol so that the project proponents can benefit from the generation and sale of Certified Emission Reductions (CERs) from the project. CDM funds will provide support to biomass gasification based rural power solutions, and will substantially enhance the financial viability of these projects and dissemination of the technologies promoted by the Government of India.

DRIVERS FOR PROJECT

The project will contribute to sustainable development in the social, environmental, economic and technological sense, by providing electric power in remote villages where the only existing source of reliable power is diesel generator sets. By providing reliable power, the project will kick-start the local economy and create livelihood benefits and social development.

Greenhouse gas emissions will be reduced by replacing diesel-based power with biomass gasifier-based renewable energy generation units that supply individual households or users with a small amount of electricity. There are no GHG emissions from biomass gasifier-based renewable energy activity.

In the absence of the project, large numbers of existing and proposed future 2610 HP small diesel-based generator sets would cause high emissions of greenhouse gases due to their low efficiency and dependence on fossil fuels. Other renewable energy technologies are not financially viable at the village level in India. Given the abundant availability of biomass, biomass gasification is the most optimal option.

The project envisages building up the electrical load in the villages through the Empower Partnership model of village development, where micro-industry is financed together with the power plant. However the project requires income from Certified Emission Reductions because the biomass gasifier-based power plants cannot charge a high tariff for the power they supply and the revenue from associated micro-industries is usually very low in the early period of project development. Hence CER income is essential since it could be financing more than half the project capital cost upfront.

DESCRIPTION OF PROJECT

The project consists of 100 separate 50 kW and 100 kW rated biomass gasifiers located in the various villages with a total installed capacity of 5.15 MW.

The project will replace the diesel powered mini-grids installed by public programs or distribution companies in isolated rural areas. The new stand-alone gasifier-based power generation systems will be made more energy efficient by implementing energy efficiency measures for micro-industries connected to the systems.

RESULTS

Residential Customers Participating	Commercial and Small Industrial Customers Participating		Agricultural Customers Participating	Large Industrial Customers Participating	Additional Generation Installed
100 villages	100 villages		100 villages		5.15 MW
Peak Load	**Peak Load Reduction**	**Duration of Peak Load Reduction**	**Overall Load Reduction**	**Energy Savings**	**Greenhouse Emissions Reduction**
					449,962 tC02-e

Figure 1 (page 177) shows the estimated greenhouse gas emissions reduction that is likely to be achieved by the project.

Year	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	Total
No of 50 kW Units	1	8	22	50	78	98	98	98	98	98	
PLF for 50 kW units	24%	37%	41%	46%	50%	50%	50%	50%	50%	50%	
Annual Power Generation by 50 kW units (MU)	0.11	1.28	3.96	10	17.16	21.56	21.56	21.56	21.56	21.56	**140.31**
No of 100 kW Units	1	2	2	2	2	2	2	2	2	2	
PLF for 100 kW units	47%	51%	54%	58%	61%	61%	61%	61%	61%	61%	
Annual Power Generation by 100 kW units (MU)	0.42	0.89	0.95	1.01	1.07	1.07	1.07	1.07	1.07	1.07	**9.68**
Total Power Generation (MU)	**0.52**	**2.17**	**4.91**	**11.01**	**18.23**	**22.63**	**22.63**	**22.63**	**22.63**	**22.63**	**149.99**
Distribution Losses (%)	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	
Baseline Generation Avoided (MU)	**0.65**	**2.71**	**6.14**	**13.76**	**22.79**	**28.29**	**28.29**	**28.29**	**28.29**	**28.29**	**187.48**
Emission Factor for Diesel based generation (kg CO2equ/kWh)	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	
Total Emission Reduction CERS	1562	6513	14731	33029	54688	67888	67888	67888	67888	67888	**449962**

Figure 1. Estimation of the Greenhouse Gas Emissions Reduction That Is Likely to be Achieved by the Project

The generation by the biomass gasifier-based power generation systems (in GWh per year) is estimated based on the assumption that the Plant Load Factor of the power plants in the first year of the project will be 24% and 47.5% for the 50 kW and 100 kW plants respectively, rising to 50% and 61% by the fifth year. Further, it is estimated that the average technical distribution system losses in the new stand-alone renewable energy-based mini-grid systems are likely to be 20% less than in the 15 kW diesel engine-based mini-grid systems in the Araria District.

HOW LOAD REDUCTION WAS MEASURED

HOW GREENHOUSE EMISSIONS REDUCTION WAS CALCULATED

The power generated by the project activity will replace small local stand-alone diesel engine-based mini-grids and individual small diesel generating sets which were previously used to supply power to these same kinds of applications, including micro-industries and water pumping.

The calculation of GHG emissions reduction likely to be achieved by the project assumed that the energy generated by the biomass plants would directly displace diesel engine-based generation. The estimated energy generated by the biomass plants was multiplied by the emissions factor (2.4 kgCO2-e/kWh) for diesel-based generation specified under small scale CDM projects methodology AMS-ID "Grid connected renewable electricity generation" to give the estimated reduction in emissions.

TIMING OF LOAD/EMISSIONS REDUCTION

AVOIDED COSTS

ACTUAL PROJECT COSTS

PROJECT COST FROM THE SOCIETAL PERSPECTIVE

ASSESSMENT OF OVERALL PROJECT EFFECTIVENESS

Social Benefits

50 direct jobs will be created in every village. Individual homes will have access to affordable and reliable lighting through the battery-charging stations at each power plant. With power generation in the hands of local cooperatives, pumped water will be distributed more equitably to a broade r section of the population, thus increasing agricultural productivity and income. Micro-industries will be able to mill local agricultural produce such as paddy and wheat in larger quantities and thus more income will be generated for local people. Ethnicity will improve for local people, as

youngsters come up and get trained in new jobs, and the new generation has new opportunities in the village of their birth.

Environmental Benefits

In addition to GHG emission reduction, transport of diesel to and from the villages for power generation will be eliminated. New markets for fast-growing biomass species will be encouraged, thus creating more opportunities for people on the land, and reducing the dependence on urban and/or industrial type income sources. Well-planned mixed species fuel forests will contribute to a broader mix of agricultural practices, thus enhancing local species diversity of flora and contributing to strengthening and deepening the eco-system services in the region.

Economic Benefits

The business enterprises connected to the plant include: biomass briquetting machine, wheat grinder, Chuda (flat rice) mill, oil expeller, irrigation pumps and power lines, workshop, battery charging, battery lights, market, fish pond, and office. The turn-over of all these activities in the 100 villages will be around 250,000 USD per annum. This turnover will double the existing economic turn-over of each village, and lead to a regular income for 50 more people.

PROJECT INFORMATION RESOURCES

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EMR-IN04 ENERGY EFFICIENCY IMPROVEMENT IN ELECTRIC ARC FURNACE, MAHARASHTRA

Last updated	5 November 2010
Location of Project	Jejuri, Maharashtra, India
Year Project Implemented	2002
Year Project Completed	2004
Name of Project Proponent	Indian Seamless Metal Tube Limited (ISMT)
Name of Project Implementor	Indian Seamless Metal Tube Limited (ISMT)
Type of Project Implementor	Electricity end user
Purpose of Project	Achieving a voluntary greenhouse emissions target
Project Objective	Reducing the project proponent's greenhouse emissions
Project Target	Network element
DSM Measure(s) Used	Energy efficiency
Specific Technology Used	CoJet gas injection system (high efficiency burner)
Market Segments Addressed	Large industrial electricity end users

REGULATORY REGIME

There are no current regulations for improving energy efficiency in electric arc furnaces. Also no such regulations are envisaged for any time in future. The project proponent has implemented the project activity over and above existing national and sectoral policies.

The project qualified for registration under the Clean Development Mechanism of the Kyoto Protocol, enabling the generation and sale of Certified Emission Reductions from the project.

DRIVERS FOR PROJECT

Indian Seamless Metal Tube Limited (ISMT) has an electric arc furnace which is used for melting of iron. Initially, the energy required for melting in the electric arc furnace was provided by electricity only. Also, the oxygen and carbon injection for lancing was being done by a manual method.

Using existing technology and methods, the specific energy consumption of liquid metal production was too high. Energy consumption was reduced by implementing energy efficiency and fuel substitution measures in the electric arc furnace, thus reducing greenhouse gas emissions and contributing to pollution abatement.

ISMT believes that this project has further potential to shape the economic, environmental and social life of the people in the region.

DESCRIPTION OF PROJECT

ISMT replaced inefficient burners with high efficient CoJet burners using a combination of electricity and liquefied petroleum gas (LPG), with the objective of improving the energy efficiency of the electric arc furnace. This measure reduced both specific energy consumption and demand for generation of electrical energy, thereby reducing and greenhouse gas emissions.

CoJet gas injection technology supplied by Praxair, USA is a state-of-the-art oxygen injection system that improves productivity of electric arc furnaces. The technology provides a safe, easy method for lancing/decarburization, post-combustion, and burner operation in a single, integrated system using oxygen. The CoJet injection system consists of two injection burners located in the furnace cold spots and mounted at the bottom of the furnace water cooled panels. The injector assemblies are connected with the oxygen supply, the LPG supply, the carbon injection supply and cooling water.

The CoJet injectors run through a pre-programmed operation cycle during each heat. The system has an high precision oxygen and carbon injection system, to avoid water cooling panel puncture due to metal splashing and allowing the formation of proper foamy slag. The highly accurate injection of oxygen and carbon at specific process stages achieves increased energy efficiency in the operation of the furnace.

RESULTS

Residential Customers Participating	**Commercial and Small Industrial Customers Participating**		**Agricultural Customers Participating**	**Large Industrial Customers Participatin g**	**Additional Generation Installed**
Peak Load	**Peak Load Reduction**	**Duration of Peak Load Reduction**	**Overall Load Reduction**	**Energy Savings**	**Greenhouse Emissions Reduction**
	10.6 MW			83,588 MWh	69,120 tC02-e

Figure 1 (page 184) shows the estimated greenhouse gas emissions reduction that is likely to be achieved by the project.

HOW LOAD REDUCTION WAS MEASURED

Operating Year	Annual Estimated Baseline Emission ($t\ CO_2$ eq)	Annual Estimated Emission Due to Project Activity ($t\ CO_2$ eq)	CO_2 emission reduction (t of CO_2 eq)	Emission Factor (kg of CO_2 / kWh)	Equivalent Energy Saved (GWh)
Nov to Dec 2006	22192	21040	1152	0.758	1.52
2007	133152	126240	6912	0.758	9.12
2008	133152	126240	6912	0.758	9.12
2009	133152	126240	6912	0.758	9.12
2010	133152	126240	6912	0.758	9.12
2011	133152	126240	6912	0.758	9.12
2012	133152	126240	6912	0.758	9.12
2013	133152	126240	6912	0.758	9.12
2014	133152	126240	6912	0.758	9.12
2015	133152	126240	6912	0.758	9.12
Jan to Oct 2016	110960	105200	5760	0.758	7.60
			69120		**83.59**

Figure 1. Estimation of the Greenhouse Gas Emissions Reduction That Is Likely to be Achieved by the Project

HOW GREENHOUSE EMISSIONS REDUCTION WAS CALCULATED

The emissions reduction likely to be achieved by the project was calculated using the small scale CDM projects methodology AMS-II.D. "Energy efficiency and fuel switching measures for industrial facilities".

Baseline Emissions

For the calculation of greenhouse gas emissions, the baseline average grid emissions factor for the Western Region issued by the Central Electricity Authority (CEA) of India is 0.7586 kgCO2-e/kWh and the power consumption for the oxygen injection system is estimated as 1.05 kWh per standard cubic metre (SCM). Formulae used for baseline emission estimation are listed below.

BE = BE electricity + BE O2..(1)

Where:
BE = Baseline Emissions (tCO2/annum)
BE electricity = Emission due to electricity used in the furnace (tCO2/annum)
BE O2 = Emissions from the oxygen used in the furnace (tCO2/annum)

BE electricity = SEC electricity X EF electricity X Qlmt ....(2)

Where:
SEC electricity = Specific electricity consumed in the furnace (kWh/ton)
EF electricity = Electricity emission factor (kgCO2/KWh)
Qlmt = Quantity of liquid metal produced (tons)

BE O2 = SEC O2 X SOC X EF electricity X Qlmt ....(3)

Where:
SEC O2 = Specific electricity consumption for oxygen production (kWh/SCM oxygen produced)
SOC = Specific oxygen consumption per ton of liquid metal (SCM/ton liquid metal)

Project Emissions

Since the electrical energy will be displaced by LPG, the project activity will also contribute to onsite emission. The formulae used for project emission estimate are listed below.

PE = PE electricity + PE LPG + PE O2...(4)

Where:
PE = Project emissions (tCO2/annum)
PE electricity = Emission due to electricity used in the furnace (tCO2/annum)
PE LPG = Emissions due to LPG used in the furnace (tCO2/annum)
PE O2 = Emissions from the oxygen used in the furnace (tCO2/annum)

PE electricity = SEC electricity x EF electricity x Qlmt..(5)

Where:
SEC electricity = Specific electricity consumed in the furnace(kWh/ton)
EF electricity = Electricity emission factor (kgCO2/KWh)
Qlmt = Quantity of liquid metal produced (tons)

PE LPG = SEC LPG X EF LPG x Qlmt ....(6)

Where:
SEC LPG = Specific energy consumption of LPG (GJ/ton of liquid metal)
EF LPG = Emission factor of LPG - IPCC default (kgCO2/GJ)

PE O2 = SEC O2 x SOC X EF electricity X Qlmt ....(7)

Where:
SEC O2 = Specific electricity consumption for oxygen production (kWh/SCM oxygen produced)
SOC = Specific oxygen consumption of liquid metal (SCM/ton liquid metal)

Emission Reductions

Baseline Emissions - Project Emissions = (1331520) – (1262400)

= 69120 tCO2-e

TIMING OF LOAD/EMISSIONS REDUCTION

Generally 24 hours a day, seven days a week

AVOIDED COSTS

ACTUAL PROJECT COSTS

PROJECT COST FROM THE SOCIETAL PERSPECTIVE

ASSESSMENT OF OVERALL PROJECT EFFECTIVENESS

The project activity is a demonstration of energy efficient technology implementation and does not by itself generate or release greenhouse gases. The project activity results in, (1) Greenhouse gas abatement (2) Primary resource conservation and facilitates sustainable development.

PROJECT INFORMATION RESOURCES

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