CALIFORNIA AUTOMATED DEMAND RESPONSE SYSTEM PILOT - USA

In 2000 and 2001, California experienced a so-called "energy crisis" that comprised short-term shortages of electricity generation capacity following the failure of the introduction of a competitive electricity market in the State. By 2002, the immediate short-term problems had been resolved, but longer-term shortages of both generation and transmission network capacity remained.

Following the energy crisis, the California Public Utilities Commission (CPUC) approved several trials and pilot programs designed to achieve increased demand response in the State. One of these was a pilot of an automated demand response system (ADRS) in the residential sector. The pilot ran from July 2004 to the end of December 2005.

The ADRS pilot was a small-scale exploratory program deploying automated energy management technology in 175 California households. Pacific Gas & Electric (PG&E), Southern California Edison (SCE), and San Diego Gas & Electric (SDG&E) sponsored the program to host 75, 75, and 25 ADRS households respectively.

These three utilities created the ADRS program in response to a decision of the CPUC which required the utilities to develop a plan for evaluating the demand response capabilities of a full scale automated system. The particular role of the ADRS pilot was to help understand how residential customers might help solve the utilities' problem of unpredictable weekday afternoon peak loads during the summer.

The objectives of the ADRS pilot were as follows:

- to identify and rank-order those technical features and capabilities that would make an ADRS most appealing to residential customers and utility system dispatchers;
- to measure the demand response of participants, compare that demand response to other statewide pilots, and assess whether or not deployment of ADRS technology would be both cost-effective and appropriate;
- to gain insight into the overall customer ADRS experience.

The ADRS pilot was closely associated with the Statewide Pricing Pilot (SPP), a pricing experiment with several different time-varying tariff options. The SPP was approved by the CPUC prior to making a decision on full-scale deployment of the automated metering infrastructure required to support such time-varying rates.

Recruitment of Participants

The ADRS pilot participants were first recruited in 2004 from owner-occupied, single-family homes in a warm climate zone, located in neighbourhoods served by appropriate television cable providers (see Figure 1). Householders who participated in the ADRS pilot received incentive payments of USD100 in 2004 and USD125 in 2005.

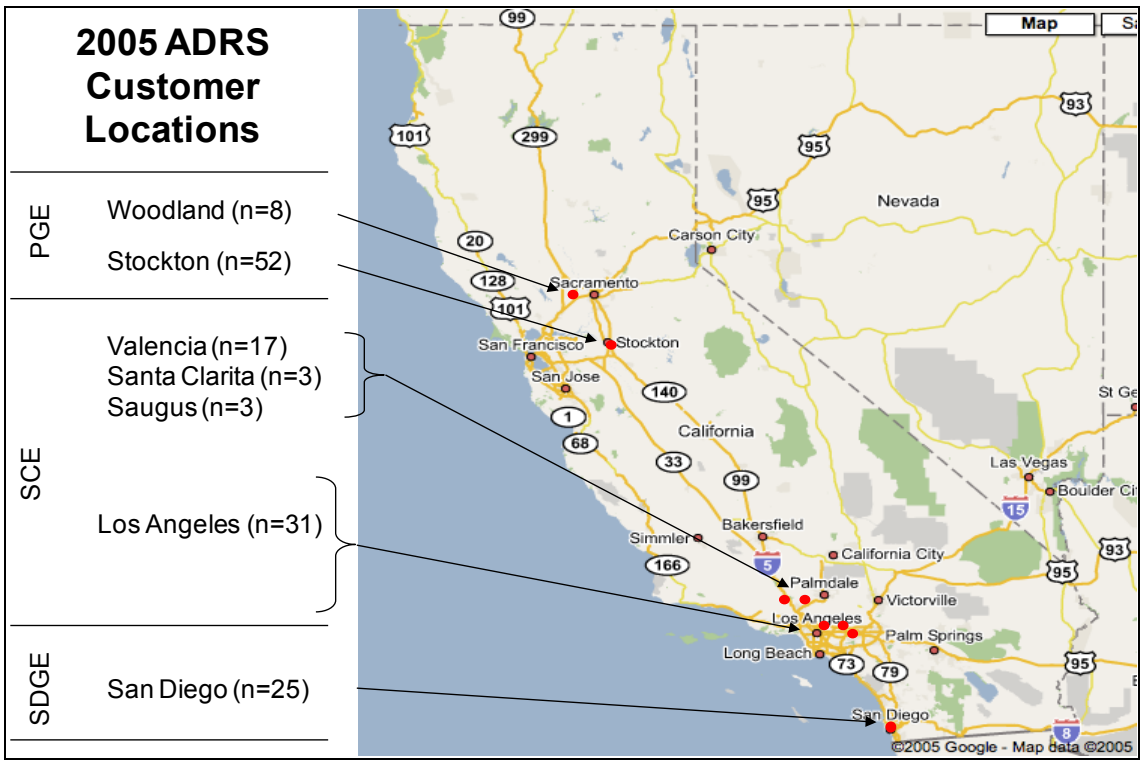

Figure 1. Locations of Participating Customers in the California ADRS Pilot, 2005

The original 175 homes that participated in the ADRS pilot were recruited at random regardless of historical consumption, although homes were screened for eligibility with respect to presence of central air conditioning, within prescribed zip codes. Because ADRS technology is capable of controlling end uses in the home in addition to central air conditioning, homes were screened for availability of other loads (ie swimming pool pumps and spas), but not disqualified from participation in their absence.

The ADRS trial was originally scheduled to run to the end of 2004, but was subsequently extended to the end of 2005. Homes used for the 2005 analysis consisted of those households that remained on the ADRS pilot program after the summer of 2004. In rental or sale situations, the ADRS program was offered to incoming residents of existing ADRS homes. However, no additional participant homes were recruited for the 2005 pilot extension.

Technology

The ADRS pilot participants had the GoodWatts system, an Invensys Climate Controls product, installed in their homes. GoodWatts is an "always on", two-way communicating, automated home climate control system with web-based programming of user preferences for control of home appliances. Via the internet, homeowners with GoodWatts can set climate control and pool or spa pump runtime preferences and view these settings at any time both locally and remotely. Participants can also view whole-house or end-use specific demand in real time and display trends in historical consumption.

The energy management technology included the following components:

- wireless RF communications network connecting all system components;
- two-way communicating whole-house interval electricity meter capable of recording consumption data in 15-minute intervals;
- wireless internet gateway and cable modem;
- programmable smart thermostats used to control air conditioning loads;
- load control and monitoring (LCM) devices to manage other selected loads (eg pool pumps and spas), where these were present;
- web-enabled user interface and data management software.

GoodWatts allows users to view at all times the current electricity price on-line or via the thermostat. It also allows users to program the thermostat and the pool/spa LCMs to automatically respond to changes in electricity prices. For example the devices can be set to automatically reduce load once a threshold electricity price is reached.

Tariff Schedule

To complement the installed ADRS technology, ADRS participants were placed on a time-varying electric tariff schedule called CPP-F.

CPP-F was a time-of-use (TOU) tariff, which included a critical peak pricing (CPP) element. Prices were high during the peak period between 2 pm and 7 pm on every weekday ('non-event' days). Higher critical peak prices were imposed during the peak period on event days ('Super Peak' days).

With slight variations, the CPP-F rate charged ADRS participants USD0.09/kWh in off-peak times, USD0.23/kWh during the peak period on non-event days and USD0.73/kWh during the peak period on Super Peak days. These rates compared with the participants' typical previous rate of USD0.13/kWh throughout the day.

Participating households received instruction manuals, online personalised energy information, and access to a customer service help desk to help them cope with the CPP-F tariff.

Event Dispatch

In 2004, 12 Super Peak events were called and in 2005 there were 11 such events (see Table 1). ADRS customers were notified by phone and email during the day before a Super Peak event.

Table DC07/1. 2004 and 2005 Super Peak Days in the California ADRS Pilot

	July	August	September	October
2004 12 Days	14, Wednesday 22, Thursday **26, Monday** **27, Tuesday**	**9, Monday** **10, Tuesday** **11, Wednesday** 27, Friday 31, Tuesday	**8, Wednesday** **9, Thursday** **10, Friday**	None
2005 11 Days	**12, Tuesday** **13, Wednesday** **14, Thursday** 22, Friday	26, Friday	**28, Wednesday** **29, Thursday**	**6, Thursday** **7, Friday** **13, Thursday** **14, Friday**

Back-to-back days are in bold

Results Achieved

The results for the ADRS pilot were generally reported as load reductions achieved by "high consumption" households. Households were designated as "high consumption" if average daily usage (ADU) during the summer season was greater than or equal to 24 kWh per day. Households with an ADU of less than 24 kWh per day were designated as "low consumption". At the beginning of the 2004 pilot period on July 1, 2004, there were 51 high consumption ADRS customers from the PG&E service territory, 72 high consumption ADRS customers from SCE, and 7 high consumption ADRS customers from SDG&E.

Figure 2 shows the statewide average peak period load reductions achieved by high consumption households participating in the ADRS pilot during 2004. The households achieved substantial peak load reductions, at least twice as much reduction on Super Peak event days as compared with non-event days.

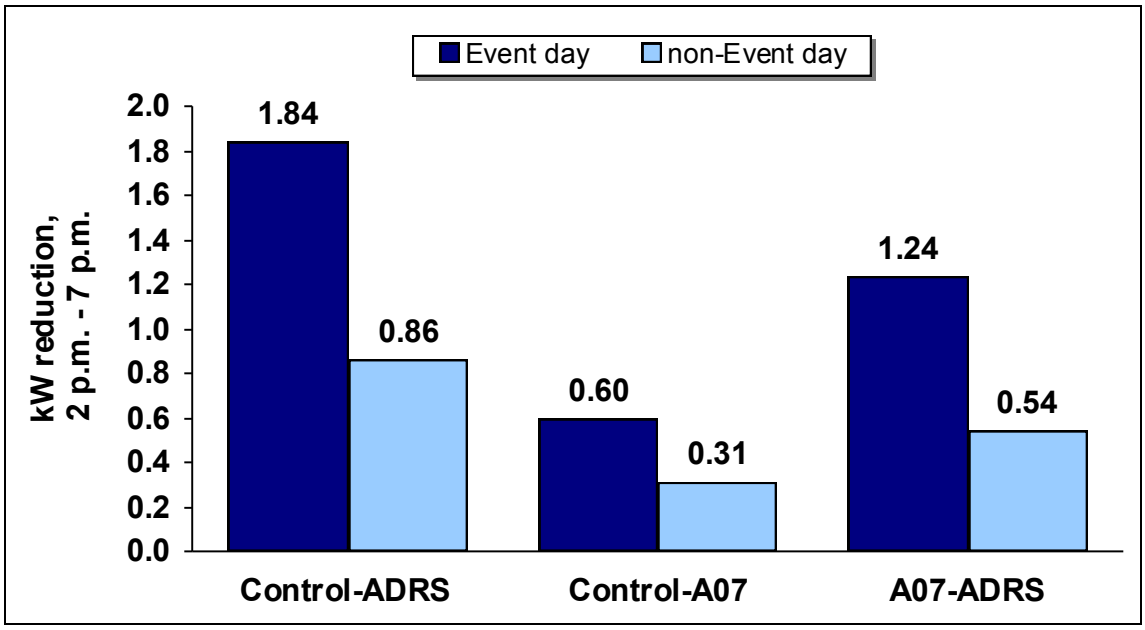

Figure 2. Statewide Average Peak Period Load Reductions Achieved by High Consumption Households, 2004

The results shown in Figure 2 were calculated as reductions from the average loads of households in a matching population that did not have an ADRS installed and was not subjected to the CPP-F tariff (identified as "Control" in Figure 2). In 2004 only, the ADRS participants' results were also compared with the load reductions achieved by households from a matching population in the Statewide Pricing Pilot that were on the CPP-F tariff but did not have an ADRS installed (identified as "A07" in Figure 2).

The CPP-F tariff without the ADRS technology had a small effect in achieving load reductions ("Control-AO7" in Figure 2). Adding the ADRS technology to the CPP-F tariff produced a larger load reduction ("AO7-ADRS" in Figure 2) and an even larger load reduction when compared with the population on a standard tariff ("Control-ADRS" in Figure 2).

Figures 3 and 4 show the statewide average peak period load reductions ("Control-ADRS" only) achieved by participating high consumption households in the three utility service territories during 2004 and 2005.

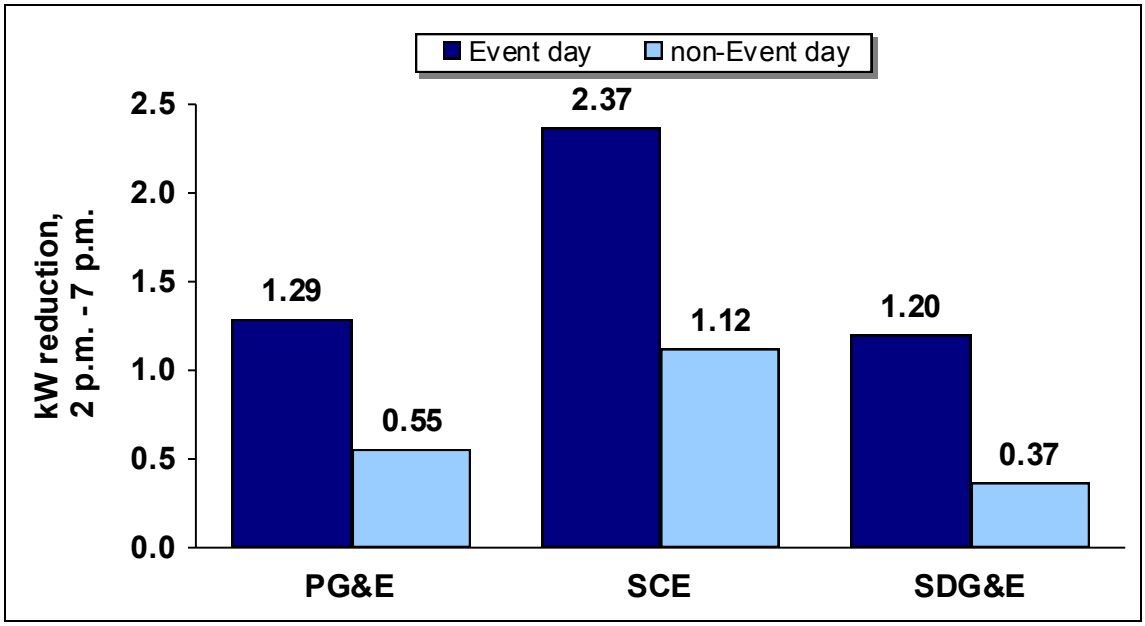

Figure 3. Statewide Average Peak Period Load Reductions (Control-ADRS only) Achieved by High Consumption Households in Three Utility Service Territories, 2004

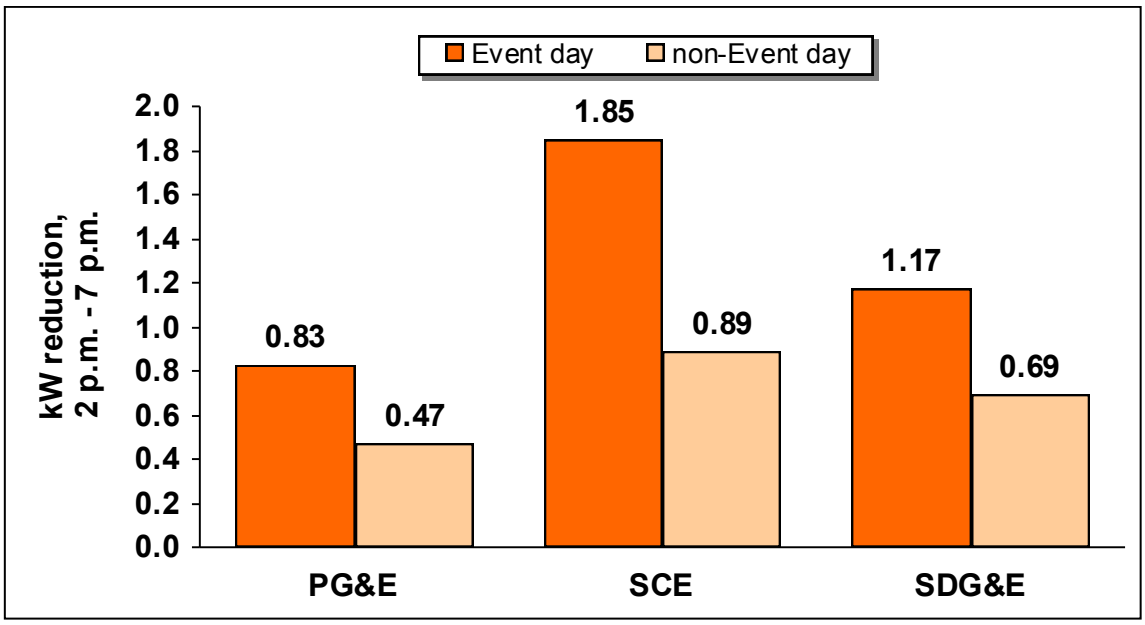

Figure 4. Statewide Average Peak Period Load Reductions (Control-ADRS only) Achieved by High Consumption Households in Three Utility Service Territories, 2005

Figures 5 and 6 show the average load profiles of high consumption households on Super Peak event days and on non-event days during 2004 and 2005.

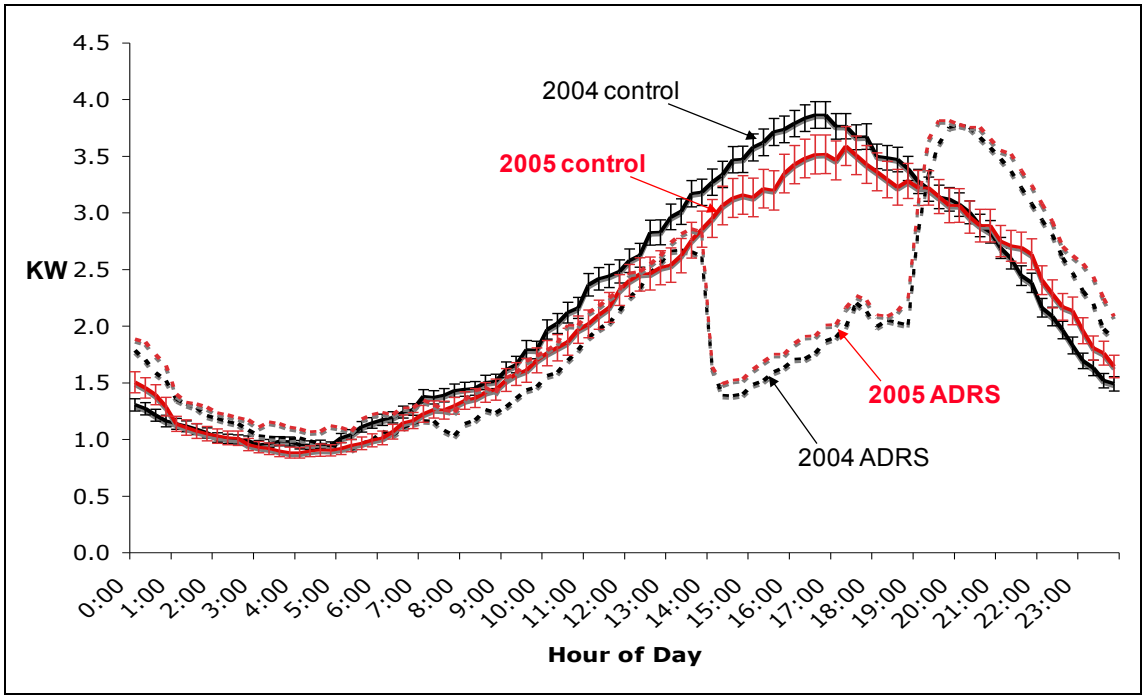

Figure 5. Average Load Profiles of High Consumption Households on Super Peak Event Days, 2004 and 2005

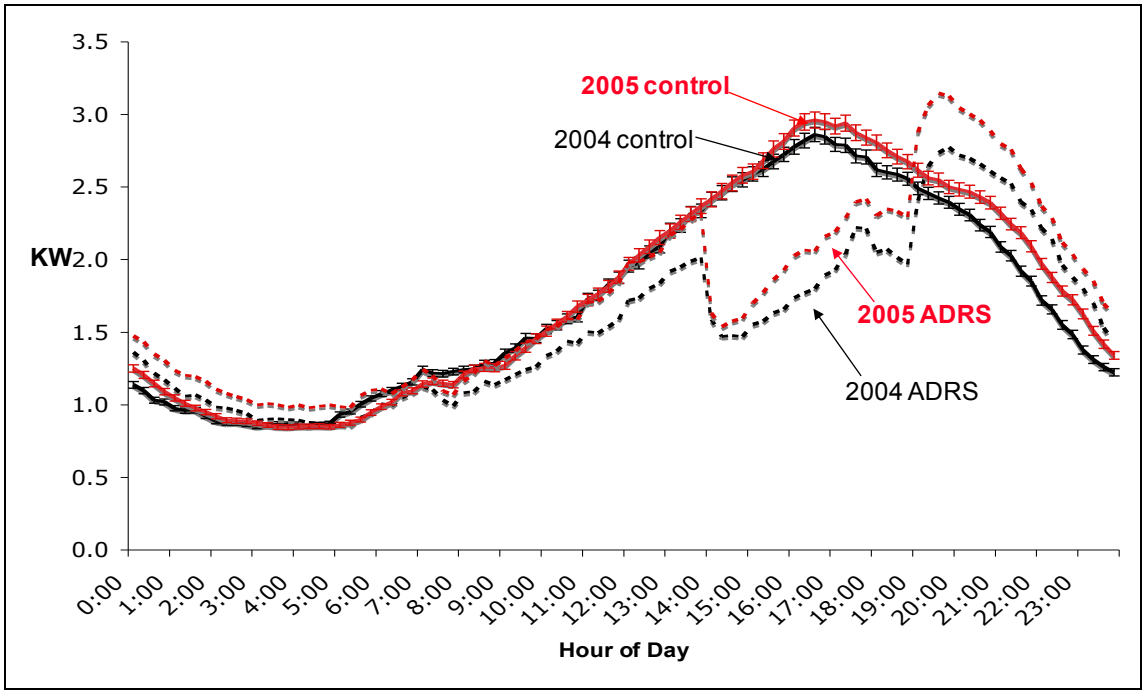

Figure 6. Average Load Profiles of High Consumption Households on Non-event Days, 2004 and 2005

During the period July to September 2004, high consumption ADRS households successfully and consistently reduced load relative to control homes by 1.84 kW or 9.21 kWh on average during the Super Peak period across 12 event days, called statewide. This translated to a 51% reduction relative to high consumption control homes statewide.

From July through September 2005, high consumption ADRS households successfully and consistently reduced load relative to control homes by 1.4 kW or 7.1 kWh on average during the Super Peak period, across seven event days, called statewide. This translated to a 43% reduction relative to high consumption control homes statewide.

The average load reduction by high consumption ADRS households was greater in 2004 than 2005, by 25% on Super Peak event days and by 15% on non-event days, statewide. The smaller load reduction on event days in 2005 is attributed mostly to lower loads in control homes in 2005. Average Super Peak period consumption by control households in 2005 decreased by 8% compared to 2004, in spite of the fact that 2005 was a hotter summer on average. The lower average load in control homes on event days in 2005 is counter-intuitive, and this difference in behaviour by control households could not be explained with available data.

In contrast, loads in high consumption ADRS households increased by 7% on average during Super Peak periods in 2005, as expected during a hotter summer.

For both summers, there was a dramatic increase in loads in ADRS homes during the two hours immediately following the Super Peak and peak periods, from 7 pm to 9 pm. At the end of the Super Peak period, the thermostats in ADRS homes automatically reset from their warmer Super Peak setting to their cooler off-peak setting. This resulted in a sudden jump in load at 7 pm as the air conditioners suddenly turned on to meet the new, cooler set point.

This 'overshoot' could cause problems on network elements near their loading limits. In a full-scale implementation of ADRS technology, this issue would have to be managed by modifications to the load control technology to ensure that all the air conditioners did not turn on at the same time.

Figure 7 shows estimates of the relative impacts of price and of the ADRS technology in reducing peak load in high consumption households on Super Peak event days in 2004.

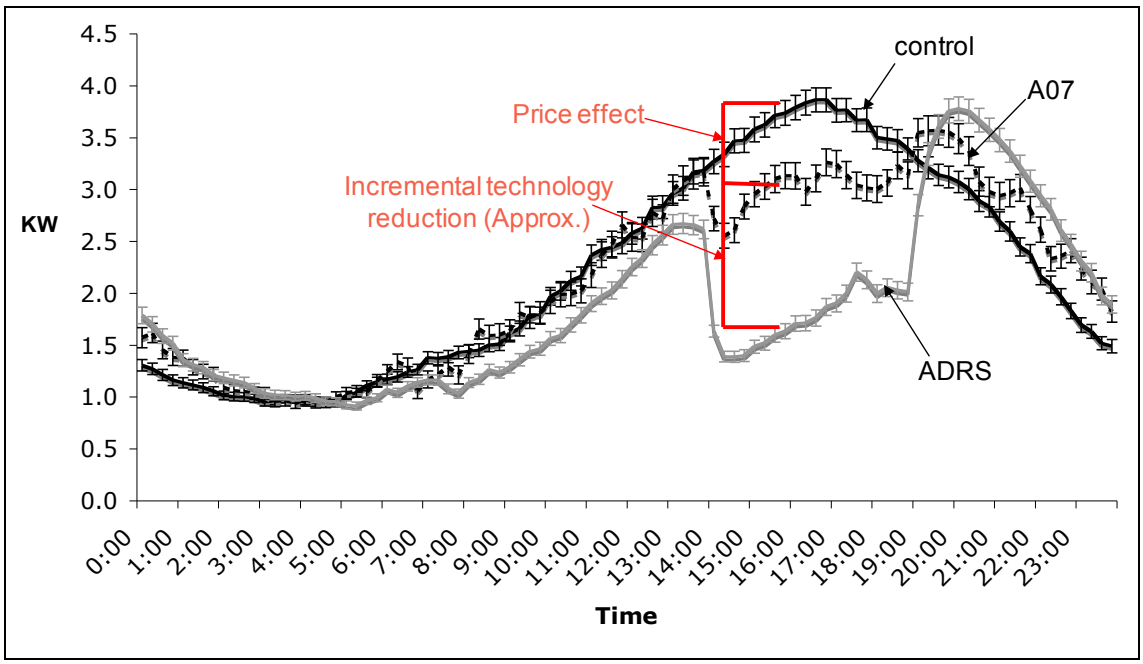

Figure 7. Impact of Price and Technology in High Consumption Households on Super Peak Event Days, 2004

Overall Project Effectiveness

The California Automated Demand Response System Pilot demonstrated the significant increase in load reductions that can be achieved by using automated load control technology. Figure DC07/7 shows that a significantly higher load reduction can be achieved by using automated load control technology with time-varying pricing, as compared with the impact of pricing alone.

Automated load control technology provides:

- higher load reductions;
- more consistent performance throughout the program and with varying conditions (eg temperatures);
- greater customer control;
- interval metering data available in real-time, which is valuable in a variety of ways.

The key to a successful program is to select a technology system that is cost effective.

This article was contributed by David Crossley, Managing Director of Energy Futures Australia Pty. Ltd and Senior Advisor at The Regulatory Assistance Project. For more information on this case study and others, visit Task XV, Network Driven DSM at:

http://www.ieadsm.org/ViewTask.aspx?ID=17&Task=15&Sort=1.