Appendix J

Demand Response Pilot

City Light's power resources are unusual for an electric utility serving a major urban area. About 90% of the energy served to Seattle originates from water, or hydropower. A consequence of the dominance of hydropower in City Light's power resource portfolio is that it has substantial reserves of capacity. Releasing water from the reservoirs that exist at many hydroelectric plants allows for substantial, instantaneous power production, or "capacity." Capacity is the quantity of instantaneous electric power required by and delivered to customers for which a generator can supply. Reducing utility capacity requirements is the objective of demand response programs.

Demand-response is an action taken to reduce electricity demand for short periods of time in response to price, monetary incentives, or utility directives so as to maintain reliable electric service. Demand-response programs are growing rapidly across the nation – often at the behest of state regulatory agencies and with the encouragement of the Federal Energy Regulatory Commission. For most electric utilities, whose portfolios are dominated by thermal power resources burning fossil fuels, having sufficient capacity at all times is an expensive problem. Since their peak loads can be quite high, but also quite short-lived, it is very costly to have large operational power plants waiting online to provide sufficient capacity, yet idle up to 98 percent of the time. Demand response programs can help to avoid this situation by reducing utility capacity requirements during times of peak demand.

When the trade-off is building a power plant that is mostly unused, the cost of offsetting some amount of capacity with demand response programs can be quite high, yet still be cost-effective for most utilities. However, City Light is not "most utilities." City Light's hydropower resources are not capacity-limited. For hours and up-to days at a time, City Light can produce large amounts of capacity at a production cost not significantly above that of its normal low cost operations. Hence, demand response programs are currently not cost-effective for City Light and are not a part of City Light's 2010 Integrated Resource Plan. In fact, the costs of demand response and the predominance of hydropower in the Pacific Northwest led the Northwest Power & Conservation Council (a regional planning agency) to conclude in their Sixth Power Plan that demand response will not be cost-effective in the region before 2020. In aggregate, the region has proportionately less hydropower than City Light.

Despite demand response not being cost-effective for City Light now, the utility wants to ensure that it fully understands the future potential for demand response and some of its more promising technologies, especially as applied to a winter-peaking utility. To-date, most demand response programs in the West have been targeted to summer-peaking utilities. Better understanding of these technologies could help with evaluating future resource options intended to ensure reliability of service, while keeping costs low for customers.

In 2009, City Light teamed with the Lawrence Berkeley National Laboratory (LBNL) Demand Response Research Center (DRRC) and the Bonneville Power Administration (BPA) to demonstrate and evaluate open automated demand response (OpenADR) communication infrastructure. The objective was to test the ability to reduce winter morning and summer afternoon peak electricity demand in commercial buildings the Seattle area. LBNL performed this demonstration in City Light's service area at five sites: Seattle Municipal Tower, Seattle University, McKinstry, and two Target stores. This pilot project is described in detail in the LBNL report, "Northwest Open Automated Demand Response Technology Demonstration Project," (LBNL 2573E-Final), which is the source of the remainder of this appendix. The full report can be found at: http://drrc.lbl.gov/pubs/lbnl-2573e.pdf .

Seattle Demand Response Pilot

OpenADR is an information exchange model that uses a client-server architecture to automate demand-response (DR) programs. These field tests evaluated the feasibility of deploying fully automated DR during both winter and summer peak periods. DR savings were evaluated for several building systems and control strategies. The relationship between BPA and SCL creates a unique opportunity to design DR programs that address both BPA's and SCL's markets simultaneously. Although simultaneously addressing both markets could significantly increase the value of DR programs for BPA, SCL, and the end user, LBNL found establishing program parameters that maximize this value challenging because of complex contractual arrangements and the absence of a central Independent System Operator or Regional Transmission Organization in the Pacific Northwest.

The project studied DR during hot summer afternoons and cold winter mornings, both periods when electricity demand is typically high. This was the project team's first experience using automation for year-round DR resources and evaluating the flexibility of commercial buildings' end-use loads to participate in DR in dual - peaking climate. The lessons learned contribute to understanding end-use loads that are suitable for dispatch at different times of the year.

Methodology

The project team recruited sites for the demonstration, developed control strategies for the sites, deployed and enhanced the automation system, and evaluated the sites' participation in DR events. McKinstry assisted with recruitment, site surveys, strategy development, commissioning, and participant and control vendor management. Akuacom established a new DR automation server (DRAS) and enhanced its operations to allow for scheduling winter morning day-of and day-ahead DR events as well as geographical location differentiation among the DR resources. Sites received payment for participating in the project. Each facility and control vendor worked with LBNL and McKinstry to select and implement DR control strategies and develop automation.

Once the automated DR strategies were programmed, they were commissioned and electric meter data and trend logs were collected from the energy management and control systems (EMCSs) of each site. The DRAS allowed the sites to receive day-ahead and day-of proxies simulating pricing that indicated DR events.

Results

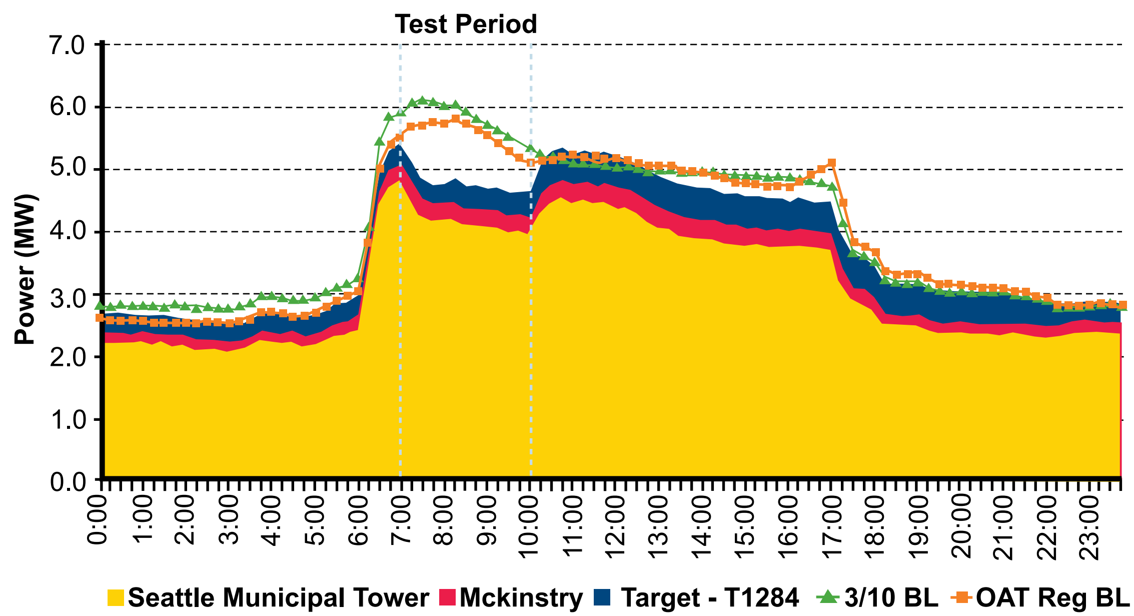
- **Lighting provides year-round DR.** Lighting load-sheds have fast ramp times and thus can provide excellent year-round DR although the change in lighting level is detectable by building occupants. However, centralized controls are necessary for DR with lighting systems, and most lighting control systems are not centralized. Most new lighting control systems that integrate with daylighting in commercial buildings have local, closed-loop controls.
- **Heating ventilation and air conditioning (HVAC) systems with natural gas heating have limited savings opportunities for winter DR.** Two buildings with gas-powered rooftop units (RTUs) selected duty cycling as a DR strategy. The DR opportunities in gas heating systems come from fan power savings (by contrast, electric heating systems offer good savings possibilities from fan power, see below
- **All-electric heating systems offer good opportunities for winter DR.** A global zone-temperature adjustment strategy, which is often used in California to reduce peak demand during summer afternoons, performed well in the electrically heated building in this study. Zone temperatures were temporarily reduced to minimize electrical loads.

- **OpenADR communication infrastructure is applicable to both winter and summer DR in commercial buildings.** On average, using an outside air temperature regression (OATR) baseline, the buildings that participated in the winter DR events delivered 14% demand reduction per site or 0.59 watts per square foot (W/ft²) over three hours. The summer DR events delivered at least16% demand reduction per site or 0.47 W/ft² over five hours. HVAC and lighting systems appear to present major opportunities for automated DR in commercial buildings in Seattle for both winter and summer loads. In this study, HVAC systems both with and without electric heating offered DR opportunities because significant savings from fan power in both seasons are possible Average demand reductions for winter and summer events were 767 kilowatts (kW) and 338 kW, i.e., 14% and 16% average peak load, respectively. Figure ES-1 and Figure ES-2 show the aggregate load profiles for winter and summer. Note that although the base load remains similar, the shapes of the loads and peak periods differ significantly in each season.

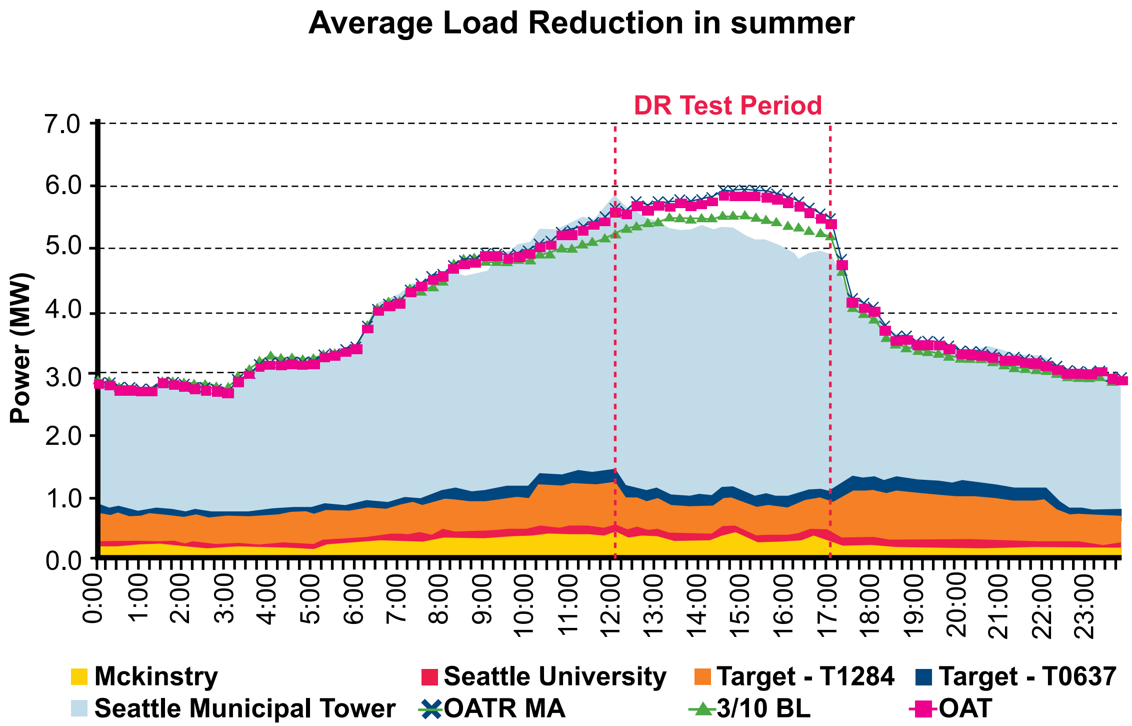
Summary of Winter and Summer DR Events Using Outside Air Temperature Regression Baseline

	Winter	Summer
Average demand reduction (kW) for each DR event	767 kW	338 kW
Total energy savings from four DR events (kWh)	8589 kWh	6455 kWh
Average per customer cost for control and commissioning	$4,057	$4,962
Average control and commissioning cost per kW (one time)	$76/kW	$108/kW

Aggregate Load Reduction in winter



- **Commissioning of DR strategies plays an important role in DR's success in dual-peaking regions.** During the DR tests, the sites did not have a way to trigger the 'event pending' signal through their interface (the "mysite" webpage). Experience from the summer DR tests shows that customers need to be able to replicate all DR operating modes (DR event pending, DR strategy active, and DR strategy idle) to properly commission and test the control strategies. A significant finding is the importance of having the ability to trigger the "pending" signal manually during commissioning so that strategies are accurately translated into control systems. Commissioning of all the signals prior to testing improves the reliability of DR strategies.
- **DR works best in well-tuned buildings.** For one building where the DR performed well in the winter, the summer DR strategies did not perform well because the sequence of operations did not maintain zone temperatures.



- **Recruitment is a lengthy and ongoing effort.** The Northwest teams experience was similar to experiences with early field test recruitment in California. Recruitment is part education and part relationship building. DR participants must be comfortable that:
  - service levels in their facilities will be modified for periods of time;
  - ongoing assistance and monitoring will be available to help them; and
  - strategies can be modified following DR events, and participants can choose not to participate in an individual event by opting out through the DRAS internet portal.
- **A large potential pool of customers enabled us to enroll the targeted number of participants.** Of 11 facilities initially surveyed, eight sites indicated interest in participating. Of these eight, three could not participate in the test events because of one or more of the following:
  - limitations of control systems and the cost of overcoming these limitations,
  - communication problems within control systems that prevented the research team from monitoring and collecting data from each test DR event, or
  - concerns from tenants.

Recommendations and Future Directions

The project was an initial step in evaluating the flexibility and automation of building end-use loads for participating in both winter and summer DR events. The project tests demonstrated that OpenADR systems can be deployed for different seasons and demonstrated OpenADR's performance during seasonal electricity demand peaks. Both end-use customers and controls companies need guidance and education in: understanding DR concepts; evaluating DR end-use control strategies; and developing, implementing, and testing DR options. After an initial investment in education and technologies, OpenADR delivers consistently triggered and repeatable DR over time.

LBNL recommends that SCL and BPA consider enhancing whole-building energy simulation tools for estimating DR capabilities for buildings in hot summer climates in order to support the estimation of cold-winter-morning DR capabilities in commercial buildings. For the long-term, the main recommendations are to encourage SCL to expand the DR project in downtown Seattle area and to encourage BPA to facilitate the expansion of OpenADR within their control area. Most importantly, the local and regional value of DR must be characterized to develop automated DR programs. The project team's main recommendations are summarized below:

1. Interval meters are required for measurement and verification of DR participation. Many large buildings in downtown Seattle that have meters that record customer data at regular intervals as well as internet access to the data (through SCL's MeterWatch program) are excellent candidates to participate in an expansion of this project.
2. Establish an education package to accompany DR efforts: Extensive customer education and outreach are required for DR programs, including explanations of why DR is necessary, how customers can respond and how they will be compensated. SCL would like to use OpenADR for reliability purposes, so the value stream for both the utility and the customer should be considered.
3. Successful technology deployment requires a workforce that understands the technology and the new ways of using it, so the team recommends education for controls vendors on DR, the OpenADR communication platform, and DR strategies.
4. Commissioning building systems and DR strategies is important to DR's success. DR programs can be incorporated during retro-commissioning programs. Before the retro-commissioning team leaves a project, the team can work with the customer to develop, implement, and commission DR strategies. The added cost as part of a retro-commissioning project is expected to be lower than the cost of stand-alone individual DR projects.

5. Although this project evaluated DR strategies for winter and summer peak demand, with hydro power and wind integration, more DR may be needed during swing seasons. The local and regional need for and value of DR should be determined and taken into account when DR programs are designed and automated.

Three electric utilities currently use OpenADR to automate their DR programs, and it has been adopted by a wide range of building and industrial controls companies. It is also identified by the U.S. Department of Energy (DOE) as one of "the initial batch of 16 National Institute of Standards and Technology (NIST)-recognized interoperability standards announced on May 18, 2009" which "will help ensure that software and hardware components from different vendors will work together seamlessly, while securing the grid against disruptions." A detailed specification for OpenADR was developed over a two-year period and released as an official California Energy Commission and Lawrence Berkeley National Laboratory (LBNL) report (http://openadr.lbl.gov/pdf/cec-500-2009-063.pdf). The OpenADR specification will be the basis for ongoing DR communications standards development efforts within both the Organization for the Advancement of Structured Information Standards (OASIS - http://www.oasisopen.org/home/) and the UCA International Users Group (UCAIug - http://www.ucaiug.org/). Both of these highly regarded organizations are active within the emerging "Smart Grid" domain. With ongoing efforts of OASIS and UCAIug, OpenADR is on a path to become a formal standard within organizations such as the International Electrotechnical Commission (IEC - http://www.iec.ch/).