Summer 2017

Demand Response Demonstration

Final Report

February 2018

Authored by: Energy Northwest with input provided by Bonneville Power Administration

Contents

Executive Summary

Starting in 2013 the Bonneville Power Administration (BPA) embarked on a four year plan to test commercial scale demand response (DR) through demonstrations. These demonstrations focused on developing and testing different contract models, gathering data on reliability of aggregated portfolios, integrating DR products into operational processes, evaluating demand response management systems, defining measurement and verification strategies, and testing acquisition models – utility, private, and public aggregation.

This demonstration marked the last of the commercial scale aggregation demonstrations in this four year commitment. This final demonstration was designed with several specific objectives in mind: refine the contracting vehicle for DR procurements, tackle how BPA Slice customers can participate in a DR program, and to develop and test processes for integrating a DR product into real time marketing and short term planning functions.

In November 2016, BPA solicited proposals for the Summer 2017 Aggregated Demand Response Demonstration (Summer 17). Energy Northwest (EN), a Richland, Washington, based joint operating agency providing cost-based generation and services to regional public power, assembled a team of public power utilities, technology providers, and other technical resources and advisors and responded with a proposal to the BPA solicitation. Upon review and consideration of the proposal, in December 2016 BPA provisionally selected the proposal and engaged with EN in contract negotiations. BPA and EN entered into the Summer 17 Demonstration Agreement on April 20, 2017. The timeline from contracting to go live was BPA's tightest of all their commercial scale DR demonstrations. EN had just 6 months to complete contracting, recruitment, enablement as well as building a notification system for BPA to use to dispatch events. EN was up for the challenge and on June 1st we went live with the program.

Key aspects of the program included:

- When called on, provide a 36,000 kilowatt (kW) net BPA system generation increase or "INC" by means of a reduction of served load and/or an increase in behind the meter generation.
- A window of performance Monday through Friday, 1:00pm through 8:00pm, June 1st through September 30th, 2017, excluding NERC holidays.
- Participants were provided 30 minutes advance notice of an upcoming event. Events were dispatched via a Digital Notification System (DNS) by BPA's real time marketers. The DNS sent a signal to EN's Demand Response Aggregated Controls System (DRACS) and DRACS in turn notified each participant, monitored and reported response in real time, and again gave notification of the event conclusion. The DNS was developed and implemented by EN for BPA in support of the Summer 17 Demonstration.
- At least 36 but no more than 40 1-hour duration "Events" were allowed to be called under the agreement. Up to 4 events could be called in succession for three successive days. Events were aligned with the WECC schedule hours.
- Participants included City of Richland, Cowlitz Public Utility District No.1, and Ferry County PUD in the State of Washington, and Columbia River PUD, Eugene Water & Electric Board, and City of Milton-Freewater in the State of Oregon.

The program was tested extensively over the 4 month demonstration calling 40 events of the available 40. Performance was measured by the average hourly actual reduction across each 60 minute period. Performance of the aggregated portfolio was stellar, 40 out of 40 events were successful, with EN delivering 100% or greater of the expected load shed for each event hour.

Introduction

Project Team - Bonneville Power Administration

This demonstration required team members from across the organization. The BPA core team included:

Name	Role
Mark Miller	Account Executive (Contract Signer)
Cara Ford (Contractor)	Project Manager & Information Systems Lead
Tom Brim (Contractor)	Project Manager
Adrian Allen	Account Specialist and Settlement
Fran Halpin	Power Operations – Event Scheduling
Rob Johnson	Power – Real Time Marketing
Tony Koch	Metering and Settlement
Melanie Smith	Demand Response Team Operations Mgmt.
Frank Brown	Demand Response Advisor
Lee Hall	DER Program Manager
Scott Wilson	Power – Account Executive
William Rimmer	Power - Account Executive

Project Team – Energy Northwest

The primary project team from Energy Services and Development included the following:

Name	Role
John Steigers	Project Manager / Applied Technology & Innovation
Tiebe Duggan	Lead - Project Specialist
Kristine Cavanah	Project Specialist
Jennifer Harper	Project Specialist
Jim Gaston	Project Oversight / General Manager-ES&D
Renada Bates	Treasury Support

Load-Response Participants

- City of Richland serves 24,300 customers in and near the community of Richland, Washington and contributed 1,500 kW of system demand voltage response (DVR) where utility distribution voltage is reduced, in these cases, to lower real loads.
- Public Utility District No. 1 of Cowlitz County, or Cowlitz PUD serving 48,500 customers in Cowlitz County, Washington. Cowlitz PUD's customer, the North Pacific Paper Company (NORPAC) operating an integrated pulp and paper manufacturing operation in Longview, Washington, contributed 27,880 kW of industrial load reduction.
- Columbia River Public Utility District, serves 18,900 customers in and around St. Helens, Oregon and contributed 500 kW of DVR.
- City of Milton-Freewater, serves 4,600 customers in and around Milton-Freewater, Oregon and contributed 340 kW of DVR and 240 kW of demand response units (DRUs), in this case, approximately 800 remotely controlled residential water heaters.
- Eugene Water & Electric Board (EWEB) serves 85,000 customers including the University of Oregon's Eugene campus. The University owns an on-campus combined cycle cogeneration facility and it operated its combustion turbine in single-cycle mode to contribute 5,500 kW of natural gas fueled distributed generation.

Other Participants

- Resource Associates International (RAI) of Spokane, Washington, offers integrated turn-key data collection and control solutions to energy utilities, industry, and others. RAI was lead technical contributor in implementing the DRACS for the Summer 17 Demonstration and developing both hardware and software for the DNS solution.
- Ferry County Public Utility District made significant contributions to the EN team but was not able to field load response assets in the Demonstration.
- The real-time trading desks of EWEB and The Energy Authority (TEA) contributed power scheduling services to accommodate the load responses of University of Oregon and NORPAC, respectively.

Demonstration Objectives

BPA Objectives:

- Refine the contracting vehicle for DR procurements.
- Develop a process for how BPA Slice customers can participate in a DR program.
- Develop and test processes for integrating a DR product into real time marketing and short term planning functions.

EN Objectives:

- Further refine and validate features and performance of its DRACS, including a move to host the system in a commercial cloud services provider rather than within a research facility server.
- Gain further experience and validate EN's business model and structure in its role as a cost-based not-for-profit aggregator of public power distributed energy resources.
- Operation and management of a non-conventional aggregated demand side resource applied to grid-level peak load-shifting.

Contracting

Summer 17 Demonstration Agreements

BPA contracted EN to assemble and provide the Summer 17 Demonstration resource. In turn, EN contracted with each of the participants individually. The EN/participant agreements' terms largely mirrored the BPA/EN agreement.

- BPA compensated EN monthly with a capacity payment paid on a kW-month basis and an energy payment on a committed kW-hour delivered basis. EN compensated its participants similarly with both a capacity and an energy payment.
- Resource performance was measured as the sum of the individual responses averaged over each hour-long event. Each contributing asset was measured according to its type; DVR, DRU, industrial load reduction, and distributed generation.
- Penalties provisions were in place imposing increasingly severe penalties, up to total loss of the capacity payment if 3 or more Event failures occurred in a calendar month.
- Detailed 1-minute interval performance data for each contributor asset over each event was recorded by the DRACS. This data was relied upon for invoicing and settlement, transaction settlement, between both BPA and EN and EN and its participants.
- Where a participant's load response was not made by the hosting utility itself but a customer instead, that utility elected whether EN contracted with the utility or directly with the utility customer. Cowlitz PUD elected to be in the contract and EWEB to not be. In either case, the utilities received the same level of notification and coordination both contractually and operationally.

Over the course of the Summer 17 Demonstration learnings prompted EN and BPA to make some adjustments to their agreement including:

- On a case-by-case basis, allow asset performance to be measured at 5-minute rather than solely 1-minute intervals when necessary to accommodate pre-existing metering regimes.
- Make a number of edits to definitions and language to clarify intent and clarity of the Agreement.
- Revise Measurement & Verification criteria for direct load control metered type resources (NORPAC) to more equitably accommodate load operating conditions.
- Provide M&V language for direct load control not-metered type loads (Milton Freewater).
- Increase DVR committed capacity for July-August recognizing much increased system loads for summer months (Milton Freewater).

Other

EN separately contracted with RAI to provide both DRACS design/coding services and its deployment as well as operational and maintenance support of the DRACS through the course of the demonstration.

Resources

Resource requirements

- Events were allowed to be called June 1 through September 30, 2017, Monday through Friday, from 1300 to 2000 hours Pacific Prevailing Time, excluding NERC Holidays.

- Each event was 1-hour duration, from minute 00 (top of the schedule hour) to minute 60. Three following, successive events, each notified 30 minutes before the hour, were allowed for a total 4 hour response. The hours were required to be successive. A single response, from 1 to 4 hours in duration, could be called each day, with only 3 response days allowed in succession.

- Event notification was initiated by BPA's power trading desk via a touch screen interface of the DNS no later than 30 minutes prior the scheduled hour. The DNS communicated via secure cloud links to the EN DRACS. The DRACS validated the event call, assigned an Event Record Identification code, and further notified participants by means of direct control signals and text messages.

- EWEB and TEA trading desks were also notified by DRACS in order to fulfil a further Summer 17 Demonstration requirement that participants who also are BPA slice/block customers, EWEB and Cowlitz, amend their respective hourly schedules to reflect the participants' response.

- The agreement allowed a minimum of 36 and a maximum of 40 event hours over the duration of the project.

- Provisions for outages, whether planned or forced, were exempted from the performance obligation if 48-hour prior notice was made.

- Eligible participants were required to be a BPA preference customer.

Project Design and Implementation

Load Response Asset Overview

The City of Richland had previously installed a secure SCADA communications and translation system at each of its 8 substations as part of the first demonstration project. The substation-installed hardware consisted of a weatherproof enclosure mounted near each substation's load tap changing (LTC) transformer(s) which included: an RAI SCADA Nexus Gateway, DL05 Power Line Carrier (PLC), Cell Modem, Interposing control relays, power supply to accept 120 VAC and fused DC power distribution board, AC breaker, terminal blocks and wiring diagram to connection to up to three LTCs in the substation. The PLC output used a dry contact signal through the interposing relays to each LTC to run in Voltage Reduction Mode. There were ten enclosures, one for each City of Richland substation.

The DataCatcher (SCADA Nexus Cloud Server Application) was installed on a cloud-based server and configured to communicate with the following: (1) Energy Northwest DRACS server: for communicating the DR programs status and control and reporting the real-time and/or historical data for real-time feedback and auditing purposes of the DR events. (2) City of Richland Metering System FTP Server: for communicating the current and near past metering values on a 1-minute basis for voltage and power values to provide feedback that the system is operational when called upon. (3) SCADA Nexus Gateway devices transmitted current/changed values back to the Central Data server using "push" or "pitch" technology over an SSL secured connection, and the (4) City of Richland users and system administrators had a web interface based upon the user's credentials and role. Each user that was authorized for any given task was able to view dashboards which consisted of single line diagrams or other views to show the current system status including Demand Response status, historical charts, alarm limit checking and notifications via email and text messaging.

NORPAC had previously installed both a secure hosted firmware-based gateway to replace the functionality of an old style masters and secure hardware-based energy management system for installation in the field near the ION meters in the motor control center. Both gateways have functionality for interfacing to the various meters within the plant operations using both industry standard and custom protocols. The hardware gateway pitched data from the data site to RAI's SCADA Nexus Cloud Server using industry-standards-based, NERC secure, and NIST interoperability compliant Web-based Client/Server communication methods. The gateway polled for load data from a remote location next to the meter. NORPAC personnel had access rights to the SCADA using login and password security.

EWEB, CRPUD, and Milton-Freewater, due to the short duration of the Summer 17 Demonstration, elected to not install communication gateways allowing for direct two-way communication with the DRACS. Instead, each was notified of events by DRACS initiated text messages. As the resource was, effectively, an hour-ahead resource, a 30-minute advance notice, use of text messages was acceptable.

Energy Northwest Systems - Demand Response Aggregated Control System (DRACS)

Energy Northwest contracted with RAI to develop the Demand Response Aggregated Control System (DRACS) which is a comprehensive data gathering, monitoring, control and communications infrastructure. Communication devices are installed by participating utilities to report to and receive direction from the DRACS via secure cloud-based data paths. DRACS is hosted within Pacific Northwest National Laboratory's Electricity Infrastructure Operations Center, a DOE-funded incubator facility built and operated for such roles.

Event Signaling

Events were initiated by BPA's real time marketing desk, through a signal that was generated using the EN provided DNS. Upon receipt of the signal, DRACS acknowledged receipt of the signal and forwarded direct control signals or text message notifications to the participating demand response assets. Upon receipt of the forwarded signal, each asset began to reduce its loads. The load changes had to be complete within 30 minutes and sustained through the event, from 60 to 240 minutes in duration.

Reporting

During events, DRACS collected detailed metering information from each of the assets and reported total capacity response to BPA. Once an event ended, DRACS sent terminating signals to the assets which could then resume normal operations.

Upon event termination, DRACS made available CSV files for each asset's performance. The data was collected as average 1 minute load reductions, measured in kW. Each asset's performance was recorded in a time frame beginning 30 minutes prior to event through 30 minutes after event termination, regardless of event duration. For each event, a data file was produced for each asset. A log file was also produced, which recorded the date and time of each log event which occurred during the time of the event.

Participants not connected to DRACS collected data within existing systems and provided files to EN.

Measurement & Verification Approach

Direct Load Control Metered (NORPAC) – The original contract language for the baseline for Direct Load Control loads was calculated as the metered power (kW) averaged over the 5 minutes prior to the time of event notification. Capacity delivered on a minute by minute basis was calculated as the difference between the event baseline and each one minute average power (kW) measured during the event. This "meter before/meter after" baseline method can be challenging to apply (in order to produce an equitable delivered capacity) when

a participant is in the process of ramping demand up or down just prior to an event. In early discussions, BPA and EN initially explored an x of y (meter output for x number of previous days during the same timeframe of y previous days) baseline method but found it unsuitable for this application.

Distributed Generation (University of Oregon) – Similar to that of the Direct Load Control Metered but response is measured between generator net production and the measured baseline.

Direct Load Control Not Metered (Milton-Freewater) – For direct control of residential water heaters where neither metering nor two-way communications of the controlled asset is available. Performance was established by establishing an agreed upon number of units under control, a deemed kW response from prior studies, and confirming power was provided the units over the duration of the event.

Demand Voltage Reduction (Richland, Columbia River PUD, and Milton-Freewater) - Capacity delivered on a minute by minute basis from demand voltage reduction is the product of measured load (kW), the % change in voltage for that minute (expressed as a fractional change), and a deemed demand voltage reduction (DVR) load response factor of 0.75 (%kW */%* voltage change). The % voltage change for each minute of an event was calculated as the difference between the voltage set point one minute prior to the start of the DR event and the voltage set point for the particular minute within an event. It was anticipated that the voltage set point could change within an event.

Outages, Timelines, and Outage Penalties

The Summer 17 Demonstration Agreement included an outage notification requirement. EN outage notifications delivered 48 hours in advance of the outage reduced EN's exposure to unsuccessful event penalties. A charge against the capacity payment was made for properly notified outages based on days out and the number of potential delivery days in that month.

Settlement Process

The settlement process and reporting and invoicing document templates were developed over the course of April 2017 through May 2017 in collaboration with, and ultimately accepted by, BPA.

As events occurred over a month, EN staff prepared an event-specific document set consisting of: (1) numeric summaries for each contributing load asset and (2) the 1-minute data tables generated by DRACS supporting those summaries. EN elected to provide those summaries to BPA and load assets within, generally, 1-2 working days after the event. The summary documents for all contract events are provided as Appendix B.

At the end of each month, EN assembled the event summaries and data tables for the month's events and documentation detailing outages, prepared a combined invoice summary, and provided these to BPA by the 5th working day of the subsequent month.

BPA staff reviewed the invoice package, worked collaboratively with EN staff to resolve questions and needed clarifications, and approved the invoice generally by the 12th day of the subsequent month. Payment was made by BPA to EN by the 20th calendar day.

Once BPA had indicated its acceptance of a month's invoice, EN staff prepared a similar document set for each of its participants and paid out incentives by the 7th day following receipt of payment from BPA to EN.

Performance Results

The Summer 17 Demonstration program went into service 00:00am June 1, 2017, and was taken out 24:00 September 30, 2017. The first event called under the agreement was 170606-045 on June 6th and the last 170927-095 on September 27th.

The convention for Event Record IDs is "yymmdd-000". For example 170927-095 was called on 9/27/2017 and was the 95th sequentially assigned event. The DRACS assigned IDs as entered into the DNS so apparent chronological and sequential discrepancies occurred due to the order of which events were scheduled in the DNS vs when, or if, they were notified as events to the DRACS.

Event Performance

Event Performance - The program was tested extensively over the 4 month demonstration calling all 40 of the available 40 events. Performance of the aggregated portfolio was stellar, 40 out of 40 events were successful, with EN delivering 100% of the expected load shed or greater for each Event hour. See Figure 1. A listing of called events is provided as Appendix A with each event's detailed summary report as Appendix B.

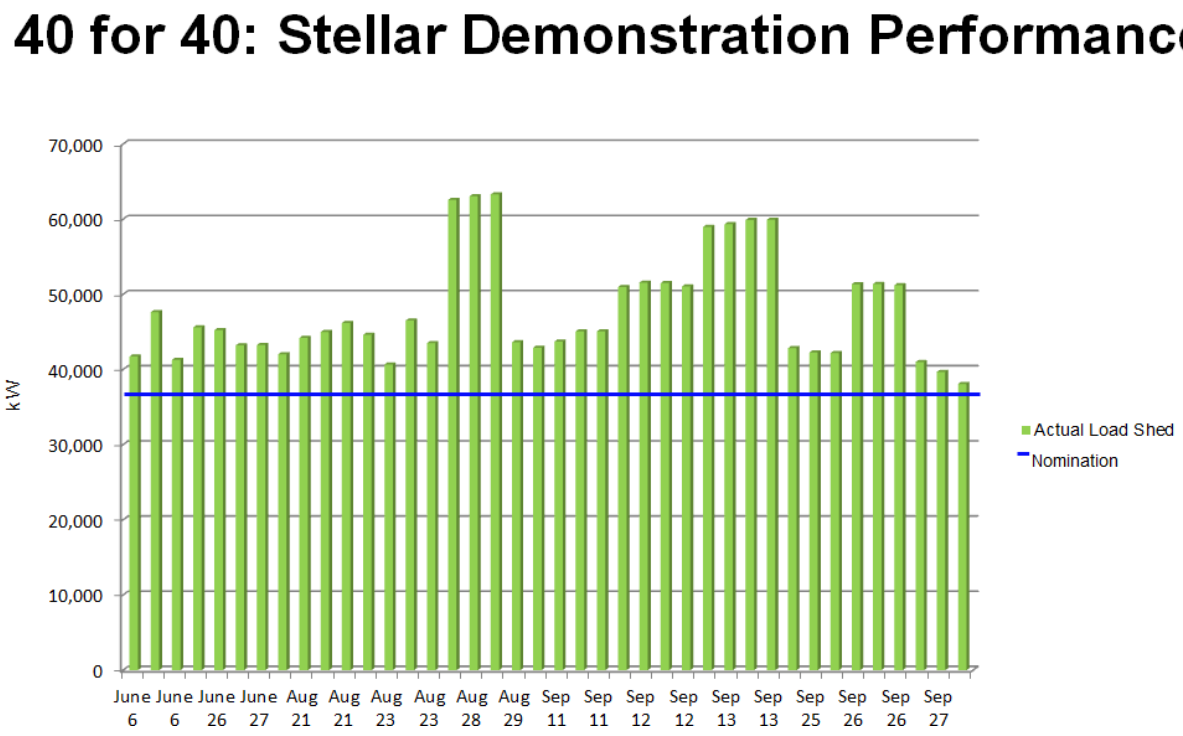

Figure 1 – Summer 2017 Resource Performance

Load Change Response Performance - The demonstration assets achieved sustained required capacity response typically in less than 10 minutes from notification.

Scheduled Outages/Availability

The Summer 17 Demonstration Agreement made provision for EN to call scheduled outages upon a minimum 48 hour notice. EN called no outages over the course of the demonstration.

Load Asset Performance

City of Richland, Cowlitz PUD/NORPAC, City of Milton-Freewater, and EWEB/University of Oregon all achieved successful response in 40 of 40 Events. City of Richland did not respond to Event 170823-063 solely due to not being notified by mis-operation of the DRACS as was thus deemed to have responded.

Columbia River PUD under-performed on Event 170925-083 due to a coordination error in operating its DVR controls thus had an ending rate of 97.5%, successfully responding to 39 out of 40 Events.

Energy Northwest Lessons Learned

Utility Engagement

Responding, in part, to feedback from multiple public utilities' experience in demand side programs elsewhere, the EN Team committed to a firm policy of engaging a prospective load's hosting utility. This policy came to be very strongly recognized and supported by regional public utilities. Some further aspects:

- Recruiting of loads for demand side programs outside of the host utility's balancing authority introduces potentially disruptive influences to that utility's system management. It can be particularly adverse when the utility is not a participant to the transaction.

- A further concern identified was the utilities' observation that the most cost-effective load prospects available among a host utility's customers were targeted for the demand side programs. Should a utility subsequently find itself in need of demand side resources those customers, having committed to other transactions or having made investment in communications/control infrastructure, may under some circumstances be less available for the utility's own programs.

- Demand side programs are very much in use elsewhere in the US. Many regional commercial and industrial utility customers participate, at a corporate level, in other markets and thus can be very familiar with the practice. The incremental revenues earned as incentives can contribute favorably to the bottom line. Host utilities, having no need for demand side resources themselves, saw this demonstration as an opportunity to meet their customers' interest while ensuring them a positive role in the transaction. Again, this was a source of strong interest in and support for the demonstration.

DRACS Development & Deployment

The DRACS was integral to the demonstration's functionality and operability and performed very well throughout the course of the demonstration. For the prior 2015-2016 Aggregated Demand Response Demonstration, the DRACS was hosted within Pacific Northwest National Laboratories. For the Summer 17 Demonstration, the DRACS was migrated to a commercial host, Amazon Cloud Services.

Generally this new host site worked well in supporting this project but indirectly contributed to the one DRACS-related issue observed. During successive events 170823-062, 063 and 064 the City of Richland's DVR, which was directly controlled by DRACS, was not signaled to operate. Investigation revealed a working file within DRACS related to the Amazon hosting had exceeded its storage allocation and resulted in failed signaling to City of Richland. RAI's routine maintenance practices were amended to include this working file and no further issues were observed.

Outage Notification

The demonstration agreement provided for EN giving BPA a 48-hour minimum notification to put the Demonstration resource into outage. While no outages occurred the 48-hour prior notification is not always readily accommodated by heavy industrial load response contributors such as NORPAC.

Forced outages are an inevitable aspect of industrial loads yet the reliability requirements of meeting BPA's system operational needs must be met for the resource to be seen as reliable and valuable. Potential accommodations to address this challenge should be more completely explored for future demand side programs.

DVR Performance Predictability

The three participants fielding a DVR asset, City of Richland, CRPUD, and City of Milton-Freewater, observed the constrained daily performance window, Monday through Friday 1:00pm to 8:00pm aligned closely with their respective typical summer load peaks. As DVR response is measured as a percent of actual minute by minute system loads their event response more reliably achieved committed capacity.

Performance Criteria

In the 2015-2016 demonstration, successful performance required that the committed load response be achieved each minute of the event. This was very challenging to achieve and precluded, in many circumstances, the flexibility to monitor and respond to normal fluctuations of load response. Further, to ensure success participants found it prudent to take a very conservative approach to capacity, resulting in under-committing and, effectively, wasting the available capacity.

The Summer 17 Demonstration instead required the average of 1-minute reads averaged over the 60 minutes of each event must equal or exceed the committed capacity of participating industrial facilities. This resulted in a tremendous improvement in assembling and operating an aggregated resource. An example of the favorable impacts to flexibility, when Event 170912-074 was called NORPAC happened to be ramping up from an unusual short term interruption of its processing load and was concerned its base load would not support sufficient load change. Responding to the concern, EN requested both University of Oregon and Columbia River PUD to increase their respective response. Both timely responded and thus the potential fail of the resource was averted. This real time correction action would not have been possible under the 1-minute compliance regime.

City of Richland

An often expressed concern of host utilities when contemplating demand side programs is the prospect of reducing energy sales due to the increased "downtime" of loads. As seen also in the previous demonstration, Richland noted no significant overall load reductions and, further, received no customer concerns or perceived impacts of its system-wide voltage reduction.

Cowlitz PUD/NORPAC

Arguably one of the more successful assets in the demonstration, NORPAC consistently performed at a high level in both reliability and at a large scale by quickly curtailing portions of its pulp-producing equipment.

Eugene Water & Electric Board/University of Oregon

The University of Oregon combustion turbine typically sits in a ready but cold condition, available to operate 24/7 to ensure its Eugene campus is supplied with both electric power as well as heat and air conditioning

should normal sources be unavailable. To ensure its reliability normal practice is to briefly operate the unit at least monthly.

The relatively brief 30-minute prior notification initially presented a challenge to the operating staff but was overcome by streamlining internal communications and scheduling. The unit achieved its generation commitment typically 8 minutes before the hour. In a single instance, load was achieved 4 minutes after the hour but did not result in non-performance for the event.

Columbia River PUD

CRPUD's DVR system was implemented with the capability to be manually adjusted and features remote reporting end-of-line voltages enabling a much greater degree of adjustment. The one unsuccessful response for Event 170923-083 occurred when the system was not closely attended and system loads unexpectedly dropped thus reducing response to slightly less than CRPUD's committed capacity.

A goal for CRPUD's participation was to examine the degree of conflict between use of its DVR for a grid-level resource, Summer 2017 Demonstration, and managing its own internal peaks. Its conclusion is that when its own system peaks align with those of BPA then economics favor use for its own peak shifting. Depending on what purpose the resource is to be applied this consideration may impact future ability to recruit loads.

City of Milton-Freewater

Milton-Freewater contributed both system-wide DVR and some 830 direct water heater controls. This was very much to its advantage as in numerous occasions one or the other did not achieve its expected response but in all cases the other adequately covered for an overall successful response.

Like CRPUD, Milton-Freewater had interest in examining simultaneously operating for both the aggregated program and its own peak management. Milton-Freewater also concluded its peak and the BPA peak often aligned so economics would have to be closely examined to gauge future interest.

Milton-Freewater serves its loads through two substations, one of which has capacity to pick up the other's loads if it is down for maintenance or other reasons. If this occurs during Milton-Freewater's summer peak periods, DVR is not applied over concerns certain larger customers may experience excessively low voltages. Fortunately no events were called for Summer 17 Demonstration under the above circumstances but should be noted again for future programs.

Milton Freewater requested and was allowed to increase its DVR committed capacity from 340 to 440 kW for July & August 2017. Its normal and expected distribution system loads increase significantly in those months thus a higher response can be confidently predicted.

BPA Lessons Learned

Contracting

Leveraging previous DR contract work enabled BPA to expedite the contracting process. During the 2015-2016 DR demonstration with EN significant time was invested into developing and testing a Demand Response program contract, resulting in a contract that could be reused with minimal modifications for this demonstration. With both parties familiar with the structure, terms, and measurement and verification requirements the overall timeline for contracting was dramatically shortened compared to previous demonstrations.

Having a strong relationship between the aggregator, participant, and serving utility is helpful. Energy Northwest was able to quickly execute on contracts with participants and their serving utilities. Energy Northwest's strong relationship with each participant and their ability to work their participant and serving utility contracts in parallel with the BPA-Energy Northwest contract created efficiencies in participant contracting.

Slice Participation

In previous demonstrations BPA had allowed Slice customers to participate but BPA did not coordinate with customers to develop a process for associated tag changes, and therefore, BPA did not benefit from the load reductions. As part of this demonstration BPA wanted to find a solution that would ensure the benefit of the load reduction was received by BPA. After exploring a variety of solutions the Slice and real time operations experts determined the only way to ensure benefit to BPA was to require an equivalent schedule (e-tag) change by the serving utility directly following event notification. In order to make this change each Slice participant's serving utility or scheduling agent was required to adjust their schedule. BPA modified its Slice policy to allow late e-tag changes for participants in this demonstration for the term of the demonstration. Participant scheduling agents submitted the adjusted e-tag for approval after their hourly schedule was locked at minute 30. The adjusted e-tag was required to be submitted and approved before minute 37. This process was repeated for each hour of the event.

Past event notifications included the duration of the event, and a single notification could be sent for a multiple hour event. The new approach required that each hour of an event, which could be up to four hours, be notified separately. EN updated their systems to accommodate this notification change.

Slice Settlement

The Slice team ran their monthly tag mismatch report and identified where tag mismatches were due to a DR event. When there was a mismatch due to a DR event an adjustment was made to the serving utilities deviation account to return the kW dropped back to them. The successful implementation of the new approach was monumental and achieved by tight coordination between the utilities scheduling agent, the participants and BPA's slice desk. The process worked well with minimal issues. There were a few instances when tag changes were not submitted within the agreed upon timeframe. EN and their scheduling agents quickly addressed the issue with additional training and an additional notification from the participant to the scheduling agent to ensure they were aware of the event.

The BPA Slice desk felt the process worked well and that it could scale if several more Slice customers were participating.

System

BPA used this demonstration as an opportunity to test an aggregator provided notification system. Energy Northwest and their technology partner RAI, developed a notification system that could be accessed via a small screen and keyboard. The system was housed in BPA's Duty Scheduling Center (DSC) and utilized a cellular connection for internet access. The system was not connected to any BPA internal networks or systems.

The EN provided system worked well for the real time marketers. Instructions were drafted and the system was used across an array of operators who were able to schedule events without issue. The real time marketers were happy with the simplicity of the interface. They were able to utilize the dashboard to view the number of hours remaining in the program, current load at the largest participant in near real time, past events on a calendar and schedule events with just a few short clicks. Events could be pre-scheduled which the team found valuable. BPA learned that in the future it would be beneficial if the notification system was web based

rather than a physical system. EN could have provided a web access to the system, but due to the short term of the contract BPA did not engage them to do so.

Conclusion

This demonstration, the last of BPA's planned commercial scale demonstrations during this 4 year period, allowed BPA to test a rapid deployment of a demand response program, systems, processes and procedures. The framework developed through these commercial scale demonstrations can be used as a launch pad for enabling the commercial use of demand response at BPA to meet future needs. As BPA continues to explore the use of demand response and distributed energy resources these learnings and the platforms built during this demonstration will be leveraged.

BPA continues to recognize that demand response must meet several objectives to succeed at BPA: it has to be highly reliable, it has to be cost-effective, and it has to be easy to use and deploy. In each of these areas, the demonstration continued to build a track record that shows promise for the future. Energy Northwest has built a comprehensive program working with BPA to meet those objectives, and continues to prove their ability to act as an aggregator, delivering an automated, highly reliable, fast DR product.

BPA will continue exploring what types of DR are going to best meet current and future needs, whether it's for supplementing the federal hydro system in the supply of balancing capacity, reducing temporary transmission constraints or deferring transmission investments, supporting power operations, meeting winter or summer peak load events, or potentially increasing consumption when wind and hydro power is generating more than the system needs.

Appendix A – Event List

Summer17 - BPA 17PM-13885	Events Called To-Date 30Sep2017	Prepared by Energy Northwest: 03Oct2017

Event ID	Event Notification	Event Start	Event End	Obligated Energy [kWh]	Actual Energy [kWh]	Delivered Energy [kWh]	Remarks
170606-045	06Jun2017 12:30:30	06Jun2017 13:00:00	06Jun2017 14:00:00	36,080	41,722	36,080	
170606-048	06Jun2017 13:30:30	06Jun2017 14:00:00	06Jun2017 15:00:00	36,080	47,625	36,080	
170606-049	06Jun2017 14:30:30	06Jun2017 15:00:00	06Jun2017 16:00:00	36,080	41,279	36,080	
170626-053	26Jun2017 16:30:30	26Jun2017 17:00:00	26Jun2017 18:00:00	36,080	45,590	36,080	
170626-051	26Jun2017 17:30:30	26Jun2017 18:00:00	26Jun2017 19:00:00	36,080	45,240	36,080	
170627-054	27Jun2017 16:30:30	27Jun2017 17:00:00	27Jun2017 18:00:00	36,080	43,199	36,080	
170627-055	27Jun2017 17:30:30	27Jun2017 18:00:00	27Jun2017 19:00:00	36,080	43,254	36,080	
170627-056	27Jun2017 18:30:30	27Jun2017 19:00:00	27Jun2017 20:00:00	36,080	42,001	36,080	
170821-058	21Aug2017 15:30:30	21Aug2017 16:00:00	21Aug2017 17:00:00	36,180	44,204	36,180	
170821-059	21Aug2017 16:30:30	21Aug2017 17:00:00	21Aug2017 18:00:00	36,180	44,980	36,180	
170821-060	21Aug2017 17:30:30	21Aug2017 18:00:00	21Aug2017 19:00:00	36,180	46,190	36,180	
170821-061	21Aug2017 18:30:30	21Aug2017 19:00:00	21Aug2017 20:00:00	36,180	44,620	36,180	
170823-062	23Aug2017 16:30:30	23Aug2017 17:00:00	23Aug2017 18:00:00	36,180	40,645	36,180	DRACS host issue resulted in no COR notification. Per EN/COR Agreement Section 10 (a), no penalty assessed.
170823-063	23Aug2017 17:30:30	23Aug2017 18:00:00	23Aug2017 19:00:00	36,180	46,517	36,180	
170823-064	23Aug2017 18:30:30	23Aug2017 19:00:00	23Aug2017 20:00:00	36,180	43,492	36,180	
170828-067	28Aug2017 15:30:30	28Aug2017 16:00:00	28Aug2017 17:00:00	36,180	62,576	36,180	
170828-068	28Aug2017 16:30:30	28Aug2017 17:00:00	28Aug2017 18:00:00	36,180	63,055	36,180	
170828-069	28Aug2017 17:30:30	28Aug2017 18:00:00	28Aug2017 19:00:00	36,180	63,291	36,180	
170829-070	29Aug2017 18:30:30	29Aug2017 19:00:00	29Aug2017 20:00:00	36,180	43,627	36,180	
170911-071	11Sep2017 14:30:30	11Sep2017 15:00:00	11Sep2017 16:00:00	35,960	42,894	35,960	
170911-072	11Sep2017 15:30:30	11Sep2017 16:00:00	11Sep2017 17:00:00	35,960	43,710	35,960	
170911-073	11Sep2017 16:30:30	11Sep2017 17:00:00	11Sep2017 18:00:00	35,960	45,063	35,960	
170911-074	11Sep2017 17:30:30	11Sep2017 18:00:00	11Sep2017 19:00:00	35,960	45,067	35,960	
170912-075	12Sep2017 14:30:30	12Sep2017 15:00:00	12Sep2017 16:00:00	35,960	50,976	35,960	
170912-076	12Sep2017 15:30:30	12Sep2017 16:00:00	12Sep2017 17:00:00	35,960	51,559	35,960	
170912-077	12Sep2017 16:30:30	12Sep2017 17:00:00	12Sep2017 18:00:00	35,960	51,492	35,960	
170912-078	12Sep2017 17:30:30	12Sep2017 18:00:00	12Sep2017 19:00:00	35,960	51,035	35,960	
170913-079	13Sep2017 14:30:30	13Sep2017 15:00:00	13Sep2017 16:00:00	35,960	58,953	35,960	
170913-080	13Sep2017 15:30:30	13Sep2017 16:00:00	13Sep2017 17:00:00	35,960	59,328	35,960	
170913-081	13Sep2017 16:30:30	13Sep2017 17:00:00	13Sep2017 18:00:00	35,960	59,899	35,960	
170913-082	13Sep2017 17:30:30	13Sep2017 18:00:00	13Sep2017 19:00:00	35,960	59,927	35,960	
170925-083	25Sep2017 15:30:30	25Sep2017 16:00:00	25Sep2017 17:00:00	35,960	42,837	35,960	
170925-084	25Sep2017 16:30:30	25Sep2017 17:00:00	25Sep2017 18:00:00	35,960	42,249	35,960	
170925-085	25Sep2017 17:30:30	25Sep2017 18:00:00	25Sep2017 19:00:00	35,960	42,192	35,960	
170926-086	26Sep2017 16:30:30	26Sep2017 17:00:00	26Sep2017 18:00:00	35,960	51,354	35,960	
170926-089	26Sep2017 17:30:30	26Sep2017 18:00:00	26Sep2017 19:00:00	35,960	51,388	35,960	
170926-088	26Sep2017 18:30:30	26Sep2017 19:00:00	26Sep2017 20:00:00	35,960	51,207	35,960	
170927-093	27Sep2017 16:30:30	27Sep2017 17:00:00	27Sep2017 18:00:00	35,960	40,977	35,960	
170927-094	27Sep2017 17:30:30	27Sep2017 18:00:00	27Sep2017 19:00:00	35,960	39,680	35,960	
170927-095	27Sep2017 18:30:30	27Sep2017 19:00:00	27Sep2017 20:00:00	35,960	38,075	35,960	

Appendix B – Event Summaries located in separate document titled: EN DR Summ17 Part 2 of 2