Technology Innovation Topics

Topic 1: Optimization of Resource Dispatch: Building State Awareness & Control Optimization Tools For Dispatch and Hydro Operators

Background

Dams on the Columbia River and its tributaries have given the Northwest some of the nation's cheapest and cleanest electric power for nearly 75 years. Over time we learned to operate the system to meet multiple purposes of the dams – to control floods, produce power, provide irrigation, allow safe navigation and provide public recreation. It's a carefully choreographed operation.

In the last decade, the hydropower system has picked up a new function – balancing variations in the Northwest's burgeoning wind power resource. Currently, there is over 3500 MW of wind power integrated into the BPA Balancing Authority Area (BAA). By the end of 2013, approximately 6,000 MW of wind generation is expected to be operating in the BPA BAA, and Renewables Portfolio Standards in the PNW and California are projected to necessitate about 10,000 MW of renewables by 2020. Even though a significant share of the wind generation in the Northwest is integrated into the BPA BAA, most of the wind is meeting load in other Utilities BAA.

Learning to adapt our power and transmission grid to this new role is one of the engineering and economic challenges of our time.

Business Challenge

The BPA dispatch center and tools available to BPA dispatchers have served the utility and region well. However, there are fundamental changes taking place on the power system and grid. Variable renewable resources result in significant dynamic changes in power flows on the grid, along with an increased need for significant levels of Balancing Reserves supplied from new sources. These changes are resulting in changes in system operations and power flows on the grid. There is a need for new tools to provide visibility and help with resource dispatch and hydro operator decisions.

Technological Drivers

BPA would like to develop, test, and demonstrate technologies that enable the BPA BAA to incorporate numerous sources of Balancing Reserves. The modernized BPA BAA would provide all the visibility and tools dispatchers need to reliably mesh the operation of the Federal Columbia River Power System (FCRPS), wind generation in the BAA, and non-federal sources Balancing Reserves.

Technology Innovation Interest Areas

To address the business challenges and technology drivers above, BPA is interested in receiving technology innovation proposals that focus on advancing one or more of the following dispatch tools. The dispatch tools are listed from high to low priority.

1. Develop a Forecasting and Dispatch Stack Optimization Tool with Broad Interoperability Utilizing State Estimator in Security Constrained Dispatch
    - Forecast the deployment of resources based on performance characteristics (ramp, duration, reload time, et cetera), location, and operating costs to allow power and transmission operations to anticipate reserve deployments consistent with expected operating conditions. Include adjustments for transmission congestion, balancing reserves supplied by FCRPS, third party balancing reserves, contingency reserves, demand response, distributed generation and others.

    - Incorporate non-federal resources into Automatic Generation Control and other systems for adjustments to mitigate transmission congestion, balancing reserves supplied by FCRPS, third party balancing reserves, demand response, distributed generation and others.

    - Deploy the dispatch stack based on forecast and actual system conditions taking into account Area Control Error, transmission constraints, water management, and non-power hydraulic constraints in dispatch logic. Incorporate predictive information such as centralized wind forecasts, short-term load forecasts and predicted set up of FCRPS for the next few hours.

2. Enhance Dispatch Visibility into Neighboring Balancing Authority
    - Develop a regional platform for neighboring balancing authorities to share forecasted flow patterns ahead of operating hour.

    - Develop the capability for Neighboring Balancing Authority Area data to feed into the State Estimator, Automatic Generation Control program, and Reliability Security Operating Resource programs.

3. Develop Optimization Criteria and Algorithms for Dispatch Stack Tool
    - Optimize for reserve needs, hydraulic constraints, environmental constraints, economic considerations, and transmission congestion management.

    - Develop financial incentive structure to maximize participation and minimize uncertainty in dispatching non-federal resources.

4. Optimize Overall Region (WECC) Reserve Use
    - Track the performance of reserve deployments under the “in flight” wind initiatives and develop structure to maximize transmission and hydro operational certainty during reserve deployments.

    - Develop, in cooperation with other entities, methods for sharing diversity across the interconnection.

5. Develop Methods to Assess Long Term Performance of Resource Providers Overall Operation
    - Develop analytical methods that use real-time data to quantify and evaluate the performance of individual generators or operating regimes with respect to modeling and regulatory requirements.

- Methods could have the two-fold purpose of identifying poor or non-performance, as well as predicting the system impacts of sub-standard performance in a manner that can be used by operators to assess the associated reliability risk.

6. Verify Distributed Generation and Demand Response
   - Develop the capability to determine availability and monitor within hour deployment of Demand Response and Distributed Generation within BPA's BAA, particularly for load following customers that have energy imbalance self-supplied by BPA Power Services to avoid unnecessary new variables in load forecasting.

Topic 2: Short-Term Reservoir System Modeling

Background

The 31 federally-owned hydro projects on the Columbia and Snake Rivers and tributaries, along with the many non-federal projects, play a major role in the ecological and economic well-being of the Pacific Northwest. The operation of these projects balance multiple purposes including flood control, fish and wildlife, power, irrigation, navigation and recreation. As such, comprehensive analytical tools are vital to support decision makers responsible for managing this important resource.

The modeling system currently used for short-term reservoir system modeling and planning is a deterministic (single trace) optimized simulation of the operation spanning the current day out to 20 days. It uses a single expected case for load demand and stream flows. Current short-term model uses the CPLEX solver on the simplex algorithm to solve the optimization problem using a single objective function that maximizes the value of the power produced within all other power and non-power constraints. The current computational design is single-thread and is not capable of utilizing advanced capability in modern computer processors.

The short-term model is used to conduct studies to support real-time and short-term water management and power operations. It is critical that the modeling system is capable of executing quickly and efficiently, producing high-resolution feasible results within the defined operational constraints.

BPA’s Weather and Stream Flow section is working on a stream flow system that will be able to produce multiple short-term stream flow traces. Additionally, BPA is developing a new system to manage loads, resources, and other obligations that may have the capability to provide multiple load scenarios.

Business Challenge

The operational world of the Federal Columbia River Power System (FCRPS) is much different now than when much of the current modeling capability was developed. Increased non-power constraints associated with Endangered Species Act obligations and additional variability associated with variable demand and generating resources, wind generation, balancing reserve obligations, and market conditions has consumed much of the system’s operational flexibility and significantly increased uncertainty.

Much of the power that is produced from the FCRPS is incidental to the water management activities required for other multiple non-power uses and objectives of the system. A single objective function is not adequate to describe the goals of operating the FCRPS under these conditions.

The ability to evaluate the future operation of the system under different stream flow and load scenarios is a major challenge for short-term modeling. While tools exist to evaluate and plan the operation of this vast reservoir network, operating it computationally efficient and producing feasible, high-resolution results while considering uncertainty remains a challenge.

Technological Drivers

BPA needs to employ state of the art computational methods and simulation capabilities that can be applied directly to efforts to expand and enhance BPA's reservoir system modeling capabilities. BPA wants to ensure that the systems, algorithms, and methods used to model the short-term operations of the FCRPS are robust and appropriate to support water management and power operations in a cascading reservoir network subject to multiple objectives and constraints. With the soon-to-be availability of ensemble stream flow and load inputs within the short-term modeling horizon, the modeling system needs to be able to efficiently ingest, process, and display results from these kinds of input data. This would allow planners and decision makers to analyze multi-scenario view of FCRPS operations and develop risk-informed operational and marketing strategies, capturing the most value out of limited operational flexibility.

Technology Innovation Interest Areas

To address the business challenges and technology drivers above, BPA is interested in receiving technology innovation proposals that focus on advancing of one or more of the following areas as they pertain to modeling short-term reservoir system operations.

- Computational methods and simulation techniques
  - This includes simulation and optimization algorithms, ensemble techniques, and stochastic methods.
- Uncertainty and risk analysis
  - With and without ensemble input and output, develop methods for evaluating risk of meeting operational objectives, quantify operational flexibility, and develop operational guidance that allows the system to manage contingencies.
- Information and data display methods
  - Develop effective and efficient ways to visualize and display large amounts of complex data to support real-time and planning decisions. This is especially of interest as it pertains to effective summary and representation of results from ensemble data.

Topic 3: Wind Generation Situational Awareness For Operators and Planners

Background

BPA power and transmission schedulers rely on accurate, real-time wind generation forecasts to make many operations decisions, including short-term operations planning. While the state-of-the-science on wind forecast modeling continues to improve, the ability to monitor rapid wind changes in less than two hours is less mature. This, in turn, can hinder wind model accuracy since they rely partially on accurate short-term observations to forecast future wind behavior. Our ability to predict non-meteorological, but predictable wind generation factors such as high wind speed generation cutouts and turbine feathering is even less mature.

Several research projects, most notably work by Lawrence-Livermore Laboratory, has shown that the benefits which surface meteorological monitoring platforms provide for situational awareness and model improvement varies significantly, depending on where they're placed within a wind generation area. The costs of deploying and maintain surface meteorological monitoring towers are relatively high, which means optimal placement of the towers includes an important cost-benefit research component.

Initial research from NOAA-DOE collaboration over the central U.S., through the Wind Forecast Improvement Project (WMIP -- http://www.esrl.noaa.gov/psd/psd3/wfip) suggests that not only is surface met tower placement important, but also the placement of real-time, upper air monitoring radar or LIDAR sensors. This research, though, has been conducted over rather flat terrain, and may or may not be applicable to the complex terrain of the BPA balancing authority area.

Business Challenge

By the nature of variable generation resources, they can result in rapid and significant changes in output, requiring balancing resources to respond in kind. Advanced tools are needed to monitor rapid changes in wind resources in the near-term horizon (current time to hour +3) in order to allow system operators and planners to position balancing resources in the best position to provide balancing services while maintaining very high likelihood of meeting other system operational objectives.

The operations and planning staff have some tools to see the physical state of the wind generating resources within the BPA Balancing Authority Area (BAA). In 2009, BPA installed several surface monitoring stations to collect near-real time meteorological data in support of regional efforts to develop near-term forecasts.

BPA's goal is to improve wind power forecast model performance and real time situational awareness for operators.

Technology Drivers

With the current level of wind installed within the BPA BAA, generation resource operators and planners have a difficult time knowing when the state of the wind generation resource is or may be suddenly changing. The wind generation interconnected in the BPA BAA is expected to continue to grow over the next few years. While other initiatives are being explored to provide or reduce the need for balancing reserves, the hydro resources of the FCRPS will continue to need to provide the majority of this service. It is vital to have adequate state awareness of the wind resource in order to meet system objectives while providing balancing service.

Technology Innovation Interest Areas

To address the business challenges and technology drivers above, BPA is interested in receiving technology innovation proposals that focus on advancing of one or more of the following areas as they pertain to wind generation situational awareness for operators and planners.

- The determination and recommendation of optimal locations in the region for the placement of real-time weather observational instrumentation that supports wind power forecasting and situation awareness efforts.
- The determination and recommendation of the optimum type of instrumentation to be installed, be it Anemometers, LIDAR, SODAR or other technologies.
- The novel, efficient and effective design and layout of wind power forecasting and situational awareness displays for real-time and planning operational decisions.

Topic 4: Aging Hydro Power Assets: Impacts of Wear and Tear and Invasive Species Mitigation

Background

The existing equipment on the Federal Columbia River Power System (FCRPS) continually needs to be updated and replaced. A portion has been replaced under a yearly allocation of capital funding, but over the next 20 years, the majority of the equipment is approaching the end of its useful life. The primary purpose of the equipment budgets is to replace equipment that is not operating properly or already failed or near failure. The budget for these replacements is limited, and because of escalation, effectively gets smaller every year.

In addition, there is over 3500 MW of variable wind power integrated into the BPA Balancing Authority Area (BAA). By the end of 2013, approximately 6,000 MW of wind generation is expected to be operating in the BPA BAA. The nature of variable generation resources results in rapid and significant changes in output and frequent flexible start/stop deployment of aging hydropower assets.

On Jan 31, 2012 senior leaders of the Corps of Engineers, Bureau of Reclamation, and Bonneville Power joined together in a meeting to discuss how hydro system costs affect BPA rates.

Business Challenge

To retain its incredible value to the region, the aging hydro system requires significant maintenance and capital investment. The impact of variable generation on the wear and tear of aging hydropower assets associated with more frequent flexible start/stop deployment needs to be better understood to control costs. Other concerns are how to mitigate the costs and effects of invasive plant and aquatic species.

Technological Drivers

To retain its incredible value to the region, the aging hydro system requires significant maintenance and capital investment. The impact of variable generation on the wear and tear of aging hydropower assets associated with more frequent flexible start/stop deployment needs to be better understood to control costs. Other concerns are how to mitigate the costs and effects of invasive plant and aquatic species.

Technology Innovation Interest Areas

To address the business challenges and technology drivers above, BPA is interested in receiving technology innovation proposals that focus on advancing of one or more of the following areas as they pertain to impacts of wear & tear and invasive species mitigation on the aging hydro power assets.

1. Wear and tear costs associated with more frequent flexible start/stop deployment of aging hydropower assets will increase in the future. What are the modeled vs. current actual wear and tear impacts and associated costs of the variable demand requirements on the aging hydropower assets such as turbines, generators, breakers? What are the modeled probable wear and tear impacts and associated replacement costs of the unmitigated

variable demand requirements on ancillary auxiliary equipment such as pumps, motors, relays, and control systems? What are the requirements for proactive maintenance strategies to minimize costs?

2. The FCRPS is vulnerable to aquatic invasive species. Depending on the type of species and degree of colonization, the resulting habitation would reduce the efficiency of the FCRPS and require mitigation money. Research is needed to develop mitigation measures. What are the chemical, biological and/or physical measures that could result in the ability to continue and effectively operate the hydro, nuclear plants and other entities (such as non FRCRS municipal and industrial water supply, irrigation supply)? The purpose of the research and mitigation measures would be to effectively and efficiently delineate, contain, and when feasible, eradicate the invasive species identified.

3. Development of effective cleaning stations. Prevention is the first priority for addressing the risk of invasive aquatic plants, and zebra and quagga mussels in the FCRPS and its tributaries. This includes preventing contaminated watercraft from entering uncontaminated water bodies. Cleaning stations would be used to decontaminate watercraft detected at State Inspection Stations. These Cleaning stations, manual or automatic, have three basic criteria that must be met and they are: 1) to have a 100 percent mortality rate, 2) be able to remove the attached mussels, and 3) to exchange/remove and treat ballast water, engine cooling water, bait well water in accordance with the “Recommended Uniform Minimum Protocols and Standards for Watercraft Interception Programs for Dreissenid Mussels in the Western United States”.

Topic 5: Faster and Lower Cost End-Use Field Studies To Support Verification of New Energy Efficiency Measures

Background

BPA's current practice for qualification of new energy efficiency measures requires extensive in situ field-testing to measure and verify annual energy savings across the range of expected installations. A 12-month field study of commercial or residential technologies typically costs $10,000 - $20,000 per site, requires 30 to 100+ sites, and takes 18 months or more to complete. Additionally, after a field study is completed, it may take an additional 6-18 months for review, refinement, approval, and full incorporation into BPA's standard Implementation Manual guidelines and requirements. Typically these are one-off studies without concern for potential future studies.

The majority of the costs and time requirements of field studies are for skilled engineering and technician expertise for a) design, scoping and contract documents, b) installation, configuration, troubleshooting of sensors and data loggers, c) data acquisition, communication, and management, d) analysis (using flexible but time intensive customized spreadsheet calculations, e) interpretation, presentation, discussion, and decision making. Significant per unit data logging equipment costs also constrain field studies to small samples of large populations, leaving great uncertainty and risk of achieving desired aggregate savings.

The Northwest Power Planning Council's Regional Technical Forum sets standards for approval of energy savings in its Guidelines for RTF Savings Estimation Methods, Release 6-1-11. This document, and the RTF review process, set the quality standards for determination of efficiency measure energy savings. Determination of energy savings for a significant portion of the 6th Power Plan measures is simply beyond practical reach considering time and budget limitations. Only a few high value measures can be addressed each year, and those at great cost in both time and dollars, with less than desired certainty of aggregate savings.

BPA must shift the paradigm by changing how technologies are evaluated. While large field studies are considered definitive and the best way to find the true energy usage of a new technology, it is also the most expensive and time consuming way to determine electrical energy savings; a more forward thinking approach is required.

Business Challenge

Accepting these typical timelines, costs and constraints dramatically threatens BPA's ability to meet the conservation targets in the 6th Power Plan. Modest incremental improvements are ongoing but are not expected to have the needed impact. BPA believes that breakthrough improvements should be targeted for field studies used to assess the savings and cost effectiveness of energy efficiency measures. Therefore, for this focus area we are setting a target an order of magnitude reduction in both cost and time for complete field studies, including research design, contracting, metering, data acquisition, analysis, and decision making.

Technological Drivers

The general technology driver is the ongoing and accumulating performance and price improvements occurring in digital computing devices, software and communications. The immediate opportunity is transferring and applying these developments to electrical end-use field studies.

There are several concurrent technology drivers that currently may provide opportunities:

1. Portable end-use sub-metering equipment is becoming smaller, cheaper and more capable, with continued improvements anticipated. However, the cost and performance of current sub-metering equipment lags far behind consumer and general business computing.
2. Communications. Public networks such as Wi-Fi and cell phone combined with Web-based data hosting are expanding the reach and lowering the cost of gathering data from multiple field sites.
3. Powerful and low cost software and computer solutions are available and rapidly evolving in other domains.
4. Synergies exist within the smart grid, DSM, DR world for aggregating end use load information with fewer and simpler devices taking advantage of advances in communications.

Technology Innovation Interest Areas

The March 2011 Energy Efficiency roadmap includes a specific roadmap for Low Cost Savings Verification Techniques. Gaps identified on this roadmap include,

- Need to be able to attribute energy performance improvements and affects.
- Need to transform data into actionable insights.
- Lack of tools for savings verification.
- Available devices for measuring equipment performance are currently expensive add-ons that are expensive to retrieve information on.
- Need for (faster, more effective) feedback loops for energy related system design and operation.

Addressing faster and lower cost end-use field studies, begins with the March 2011 Energy Efficiency Low Cost Savings Verification Techniques Technology Roadmap, but tightens the focus to field studies, sets a specific goal, and provides some visionary examples.

Goal: This focus area targets an order of magnitude reduction, within 5-years, in both cost and time of field studies used to assess the savings and performance of energy efficiency measures.

The scope of this focus area is the entire end-to-end process of acquiring measured field data and transforming it into actionable information, but as a starting point we will describe several specific sub-areas to provide focus for proposals. We will also provide illustrative examples of possible innovative approaches. These examples are included only to provide some idea of the type of solutions BPA is looking for.

Progress across the entire process is desired, and ultimately integrated solutions are needed for order of magnitude reductions in cost and time. Specific sub-areas of interest for innovation and improvement include:

1. Research design and strategic approaches for field studies.
2. End-use metering equipment and practices.
3. Data communication, processing and management.
4. Analysis tools and practices.
5. Systems, tools, and practices for interpretation, presentation, discussion, and decision-making.

Most of our field-testing is for residential and commercial end-use technologies that are installed in large numbers in the Northwest Region. For further focus, some specific technologies of interest for field-testing include:

- Packaged Rooftop Units Enhancements (economizers, demand controlled ventilation, web-enabled thermostats, variable speed drive fan, variable capacity compressors).
- Variable Capacity Heat Pumps (commercial and residential applications, VRF, DHP, water heating).
- Adaptive Lighting Controls (Especially occupancy/vacancy based).
- Heat Pump Water heaters (residential and commercial applications).

Two specific sub-areas are described in more detail below. These sub-areas are expected to have good potential for near term innovative solutions.

1. Innovative Research Design for Field Studies. BPA is interested in innovative field study design approaches that can dramatically reduce cost and time requirements. Current practice for field studies typically involves a one-off study design for a particular measure (e.g. heat pump water heaters installed in 40 homes with multi-channel 1-minute interval data collected for 1 year). Installation of test technologies in multiple field sites and in-field metering is inherently expensive and time consuming.

How can this standard approach be improved upon? Are there better combinations of secondary research, lab testing, and field measurements? To minimize costs, what is best measured in the field, what does not need to be measured in the field? Are there more effective ways to combine lab test and field tests? How can one-off studies be replaced with reusable real-time information systems? How can relatively expensive engineering time be replaced? Are there synergies available by combining a series of improvements in the end-to-end process? Are there better experimental design approaches streamline the entire process?

To help convey the type of solutions envisioned, an example scenario is offered below. (This example is only for illustration of the type of solutions envisioned and is not intended as a requirement, limitation, or preference).

Consider an upfront experiment design which integrates a longer term approach for reuse of data, uses permanent real-time systems for speed, limits field studies to measurement of key independent variables and confines equipment testing to lab setting. Envisioned is an intelligently designed permanent field test installation in real homes, collecting data in real time on key variables which can be used in conjunction with lab tests.
Instead of completing one-off studies of a certain technology in 75 homes, permanently partner with a selected group of homeowners to measure relevant independent variables (flow rates, temperatures, power, energy, occupancy, etc) that impact the performance of large residential end uses (water heaters, HVAC, lighting, appliances). This representative

data for key independent variables can then be applied to various technologies in focused laboratory testing. Large cost savings may accrue from reducing required number of field installations and reuse of data. Also, viewing in-field site studies as a last resort, instead of bringing the lab to the home, as is typical; this approach brings the home to lab.

Effectively this will create a real time study of the region with data stores easily accessible for use in testing new technologies in the laboratory, modeling them with computers, or utilizing in other ways. Ultimately combining emerging technologies, bringing metering to the next level, combining web capabilities; predict energy savings for order of magnitude reductions in time and expenses.

2. Innovative end-use metering equipment and practices. BPA is interested in innovative end-use metering and data management equipment and approaches that can dramatically reduce costs and time requirements for installation, configuration, communication, and data management during field studies. Are there options for low cost sensors, data loggers, and communications? Are there intrinsically safe, easy to install, self-configuring sensors and meters? Are there integrated sensor-logger-communication- web site-analysis-presentation systems? Can powerful low cost consumer and IT technology be applied to field studies? Can public networks and software services be leveraged? Is there simple sensor-data logging equipment that can be installed by untrained homeowners? Are there innovative low cost sensors that can be leveraged?

To help convey the type of solutions envisioned, an example scenario is offered below. (This example is only for illustration of the type of solutions envisioned and is not intended as a requirement, limitation, or preference).

For a field study of a new type of heat pump, a BPA energy efficiency engineer designs a field research project in one day using a software template including all the global parameters for the project. This software template is emailed to the logger manufacturer and 150 low cost data loggers are purchased for the project come preloaded with all global parameters (logging start, stop, interval, accessory configuration, etc.). The loggers are sent from the factory pre-calibrated and fully configured with any additional accessories.

Next, are mailed to participating homeowners. The homeowner safely installs the data loggers are safely installed by the homeowner in 15 minutes using a simple one-page installation guide. The homeowner presses a button on the logger to enter information and launch the logger. Once the logger acquires a web connection it automatically logs into the host website and identifies itself and begins uploading collected data. Local weather station data is automatically incorporated into the host website from the nearest weather station.

The BPA efficiency engineer can now access all loggers for the study from the host website, verify operation or change both global and local settings as needed. Data is automatically processed into tabular and graphical results. After 4-weeks of data collection, a BPA energy efficiency engineer spends one day reviewing and annotating the data. The following week these web pages are presented to the Regional Technical Forum for determination of proved Unit Energy Savings for the new type of heat pump. Elapsed time between start of research and RTF review was less than 3 months, at a cost to BPA of less than $5,000.

Topic 6: Variable Capacity Heat Pumps System Performance, Measurement and Verification Strategies

Background

According to the 6th Power Plan, Variable Capacity Heat Pumps (VC HP) represent 8.6 aMW to offset load growth. A Regional Technical Forum VC HP Sub-committee has been formed with the purpose of sharing research and results; the Sub-committee includes members of the Regional Emerging Technology Advisory Committee, NEEA, EPRI, VC HP manufacturer representatives and other stakeholders,

VC HP systems are being installed in the Pacific Northwest, but their performance has not been quantified or verified. VC HP systems are well suited to the Pacific Northwest because of their low ambient temperature performance and ability to offset resistance heat during winter peaks. There may be additional value for ancillary services, including demand response strategies to either shed or add loads as needed. VC HP systems are a promising but unproven technology.

Business Challenge

Very few VC HP systems have received utility incentives, because they represent very costly custom projects, requiring significant measurement and verification. This work will result in a more streamlined utility incentive process, meeting the TI framework by reducing the cost to acquire savings. This focus area will allow BPA to better understand VC HP system performance in order to reliably quantify and verify energy savings for a regionally consistent incentive program and to advance VC HP technology.

Technological Drivers

Better understanding VC HP system performance and the development and vetting of VC HP measurement and verification strategies will enable utilities to reliably quantify and verify energy savings, resulting from displacing electric resistance heat throughout the region.

Technology Innovation Interest Areas

The target is an order of magnitude reduction in the cost and time of metering and analyses for incenting VC HP systems. To address the business challenges and technology drivers above, BPA is interested in receiving technology innovation proposals that focus on advancing of one or more of the following areas as they pertain to VC HP system performance, measurement and verification strategies.

- Developing a screening tool for cost effective VC HP system opportunities.
- Developing VC HP, including ventilation system, best practices and commissioning requirements to ensure comfort and electricity savings.
- Vetting building simulation model estimates of VC HP system savings.
- Vetting the accuracy of VC HP tenant billing systems for electricity use.
- Developing M&V strategy for reliable verification of VC HP system savings.
- Developing a VC HP system incremental cost database.
- Research to establish VC HP effective measure life.

Topic 7: Heat Pump Water Heaters Performance, Measurement and Verification Strategies

Background

According to the 6th Power Plan, Heat Pump Water Heaters (HPWHs) represent over 200 aMW to offset load growth.

Although the technology has been around for decades, the region has had historical experience with poor performing units, failed components, reliability & warranty issues, etc.

Three, large, US manufacturers began launching HPWHs in late 2008-2009. BPA gathered together a regional, HPWH Advisory Committee to develop a measurement and verification protocol to laboratory test the technology. The testing goals were to provide performance curves and operating ranges to determine energy savings estimates under any condition. Laboratory testing and field studies have shown that this technology does save energy and is cost effective.

Variable capacity heat pump water heaters could save more energy than the current products on the market, and low ambient air models could do the same. Other systems such as CO2 refrigerants and split systems likely will increase efficiency in our region, too. Demand response capability may be valuable to either shed or add loads to meet system requirements. These all look promising, but are still unproven technologies.

Business Challenge
The current HPWHs are “entry level” technology that has shown energy savings. However, better energy savings could come from using different refrigerants, variable speed components, split systems and a solution for cold air exhaust into a conditioned space. We need to expand and stretch this current technology. The results from these efforts will provide more advanced HPWHs to achieve greater savings in our regional incentive program.

This focus area will allow BPA to better understand and increase HPWHs performance and reliably quantify and verify energy savings for a regionally consistent incentive program and to advance HPWH technology.

Technological Drivers
We need a better understanding of the interactive effects from an interior located, non-ducted exhaust air HPWH and an interior located, ducted exhaust air HPWH. We do not have lab or field data for CO2 refrigerant HPWHs, variable speed capacity HPWHs, HPWHs with demand response capacity, or split systems that provide both conditioned air to the home and hot water. However, we do have limited lab data on a low ambient air, integrated unit, but no field-testing results to date. We must have lab and field data on these technologies to evaluate, understand, reliably quantify and verify energy savings, resulting in replacing electric resistance hot water heaters throughout the region. HPWHs that provide both conditioned air for the home and hot water use could replace not only the hot water heater, but the electric resistance or forced air furnace as well.

Technology Innovation Interest Areas

To address the business challenges and technology drivers above, BPA is interested in receiving technology innovation proposals that focus on advancing of one or more of the following areas as they pertain to HPWH performance, measurement and verification strategies.

1. While we currently have second generation, residential, integrated, heat pump water heaters (HPWHs) on the market today: for example, AO Smith, Rheem, GE, AirGenerate, we are only at the beginning stages of the potential for this technology. As this technology begins to take hold in the marketplace, BPA is in search of more efficient and better products.

Some examples for research area products would be,

   a. intake/exhaust air residential, integrated HPWHs for interior home installations
   b. CO2 refrigerant HPWHs – integrated and split systems
   c. Variable speed capacity HPWHs
   d. Low ambient air, integrated HPWHs
   e. Demand response HPWHs
   f. HPWHs that provide conditioned air for the home in addition to hot water use

2. We are also struggling within the region on the building science/interactive effects and aspects of this technology – the research questions being,
   a. what is the energy penalty for installing a non-ducted, exhaust air, integrated HPWH within a conditioned space (e.g. an interior laundry room, etc)?
   b. what is the energy penalty for installing it in a semi-conditioned space (e.g. a semi-conditioned basement)?

Topic 8: Demand Response Emerging Technologies

Background

There are numerous active demand response pilot projects across the region, including several sponsored in part by BPA. Generally, these pilots are assessing the technical feasibility and programmatic requirements of using various load types to decrease (and/or in some cases increase) in response to utility peaks, integration of renewable generation or other grid conditions. These pilots involve several commercially-available technologies, including:

- Electric water heaters (residential and commercial)
- Cold storage
- HVAC (thermostats)
- Industrial processes
- Irrigation
- Battery storage
- Building energy management systems
- Space heating (thermal storage)
- In home displays

These pilots are providing and will continue to provide lessons and data that are useful in assessing the feasibility and scalability of deploying these technologies at larger scale.

Business Challenge

BPA plans to continue working with interested customer utilities, utility groups and/or other parties to design mutually beneficial Demand Response (DR) projects to address regional needs using commercially-available technologies. These projects (not a focus of this topic) will be larger in scale than the existing regional DR pilots and will be designed to address current utility, BPA and other regional needs. The business challenge associated with this topic is a separate need to continue testing emerging technologies and/or new uses of DR in smaller, proof-of-concept type pilots.

Technological Drivers

Innovation of demand response emerging technologies is driven by operational challenges facing BPA with regards to:

- Operational reserve and capacity constraints caused by increased wind integration.
- Federal Columbia River Power System (FCRPS) management and.
- Transmission expansion challenges.

BPA faces significant balancing reserve demands due to Balancing Authority obligations to integrate increasing amounts of wind with the next few years. Additional renewable development is expected in the BPA Balancing Authority, further affecting borrowing authority, over-supply, siting and reserve capacity challenges.

There may also be opportunities to avoid or defer contested and/or costly transmission infrastructure investments. In some of these cases, DR may be part of a cost-effective non-wires solution to help delay or avoid transmission construction.

Technology Innovation Interest Areas

BPA would like to test and demonstrate innovative approaches and technologies that provide both valuable and low cost solutions for BPA, benefits to local utilities, potential capital deferral benefits to BPA (e.g., deferral of transmission capital investment) and/or energy efficiency benefits. To address the business challenges and technology drivers above, BPA is interested in receiving technology innovation proposals that focus on advancing of one or more of the following areas as they pertain to demand response emerging technologies.

1. Testing of loads, technologies and control strategies suitable for providing both increased loads (DECs) and decreased loads (INCs) from a single investment.
    a. These loads would need to be dispatchable by utilities and/or BPA and would need to be available year-round.
    b. They would also need to be available at a lower cost than pumped storage or using existing or new combustion turbines.
    c. Performance of these loads would need to be measured, verified and evaluated.

   Potential uses of these loads include combinations of:
    a. Utility peak shifting: responding to a day-ahead request to decrease load, with duration of up to four hours.
    b. Balancing reserves: responding to a request to increase or decrease load within ten minutes, with a duration of up to ninety minutes.
    c. Transmission investment deferral: responding to a request to increase or decrease load within ten minutes, with a duration of up to four hours.

2. Testing of loads, technologies and control strategies suitable for increasing loads (DECs) during Light Load Hours (22:00 to 5:59 Monday through Saturday and all day on Sunday) in the spring and early summer (approximately April 15th through July 15th). These increased loads may be useful during over-generation events.
    a. Such increases could come from new loads and/or shifting from Heavy Load Hours (HLH) into LLH.
    b. These loads would need to be dispatchable by BPA and would generally need to respond within 10 minutes. Longer response times may be acceptable if achievable at low cost.
    c. Performance of these loads would need to be measured, verified and evaluated.

We are interested in receiving technology innovation proposals using any load types to achieve either or both of the above focus areas. It would be especially valuable to test and demonstrate the capability of some specific types of commercial facilities that consume significant energy, may have operational flexibility and are not included in BPA's current DR pilots. Data centers, municipal pump loads and wastewater treatment are examples of these commercial loads.