

BPA Study of Smart Grid Economics Identifies Attractive Opportunities and Key Uncertainties

Bonneville Power Administration (BPA) and Navigant Consulting recently released a white paper¹ documenting the interim results of an economic assessment for smart grid technologies in the Pacific Northwest. The study, called the Regional Business Case (RBC), is the first bottom-up assessment to account for the interactions of various technologies and quantify the uncertainties and risks of regional smart grid investments. BPA initiated the RBC study to understand how smart grid technologies might help mitigate the costs associated with greater demand on the grid infrastructure, such as integrating intermittent renewable generation and accommodating regional growth.

Lee Hall, the BPA Smart Grid Program Manager:

“In the past several years there have been a lot of claims about the value of smart grid. When we looked under the hood, there often wasn’t enough rigor to support actual investment decisions. We needed to get a better handle on the opportunities and their risks.”

Erik Gilbert, the Navigant project lead:

“BPA was asking difficult questions about smart grid benefits and wasn’t satisfied with existing analyses. To answer these questions we had to develop a bottom-up, systems approach. The benefits and many of the costs of new technology investments are still uncertain. We knew that point values wouldn’t suffice—we needed to show the range of possibilities”

The RBC study applies a comprehensive benefit-cost approach that differs from other smart grid benefit-cost analyses in several important ways. It:

- presents a regional assessment across states, customer segments, and end uses
- examines an array of specific technologies used to implement over 30 integrated smart grid capabilities
- uses integrated uncertainty and risk analysis
- applies conservative values and calculations
- incorporates real-world data and demonstration results, as they become available.

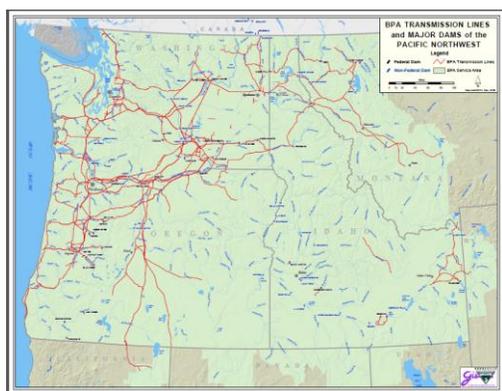


Figure 1. Map of the Pacific Northwest Region

Smart Grid Investment Is Coming into Focus, and Looks Promising Overall

Figure 2 indicates the range and likelihood of the benefits and costs associated with a deployment spanning through 2040 in the Pacific Northwest. Benefits are expected to surpass costs, with \$14.5B in total benefits and \$10.0B in costs over the analysis time frame. The expected NPV is \$4.6B, with low and high values ranging from \$0.6B to \$7.1B. The NPV is expected to surpass zero (i.e., producing a net benefit) with 96 percent confidence.

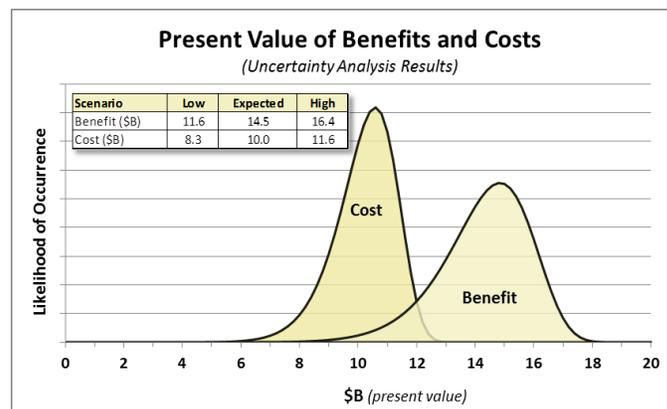


Figure 2. Smart Grid Investment Looks Attractive Overall

These aggregate results indicate that sufficient information exists today to create beneficial, region-wide smart grid deployment plans in the Pacific Northwest. Uncertainties remain high in some areas, however, as discussed in more detail in the sections below. Furthermore, results in different jurisdictions will vary due to a number of parameters (e.g., weather, capacity constraints) that may cause results for specific technologies to diverge from this regional average view.

About the RBC Study

The RBC study is sponsored and managed by BPA and implemented by Navigant Consulting. The RBC is being developed with input from a number of regional entities including the Northwest Power and Conservation Council (NPCC), and the Pacific Northwest Smart Grid Demonstration Project. The RBC also incorporates input from regional stakeholders including distribution utilities in the region and findings from smart grid studies nationwide.

The results described herein are considered interim. Final results of the study will be made available after the conclusion of the Pacific Northwest Smart Grid Demonstration Project. More information about the interim results can be found in the full white paper.

¹ Navigant Consulting, Inc. *Smart Grid Regional Business Case for the Pacific Northwest*. December 2013. See “White Paper” link at the bottom of: <http://www.bpa.gov/Projects/Initiatives/SmartGrid/Pages/default.aspx>.

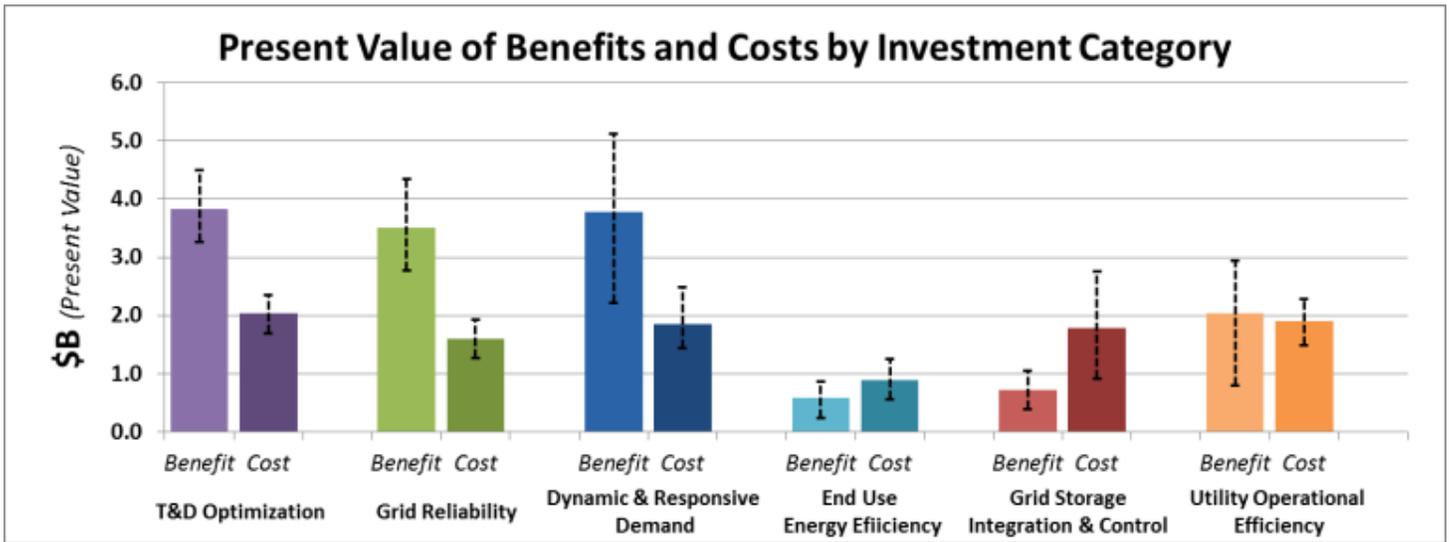


Figure 3. Six Investment Categories Show Different Returns and Risks.

Investment Outlook Varies by Category, with Clear Winners Emerging

The analysis breaks results into six broad investment categories to facilitate understanding. This section presents results for the six smart grid investment categories, described below. The results indicate that smart grid investments in Transmission and Distribution (T&D) Optimization, Grid Reliability, and Dynamic and Responsive Demand are generally expected to be attractive and low risk. Smart grid investments to enhance End-Use Energy Efficiency (EE) and Grid Storage Integration and Control are not seen to be generally attractive. Smart grid enhancements to Utility Operational Efficiency are expected to produce a small net benefit, but the analysis results show high uncertainty. Figure 3 indicates the range of the benefits and costs associated with each major investment category.

RBC Model Simulation Characteristics

- Discounted cash flow model that spans 30 year investment period
- Covers over 80 types of equipment, 30 new capabilities, and 30 ways the grid can be impacted
- Costs and benefits associated with vectors for over 150 actual grid characteristics
- Monte Carlo simulation allows uncertainty distributions for parameters
- Accounts for shared system costs and sequencing of investments

2.1 T&D Optimization

T&D optimization encompasses smart grid capabilities that improve the controllability or utilization of electrical infrastructure assets, leading to more efficient delivery of electricity. Example capabilities include conservation voltage reduction (CVR) and power factor control.²

² Utilities have long engaged in T&D investment and optimization activities using traditional (i.e., non-smart) technologies. Only optimization activities that apply two-way communications and some form of automated intelligence are included in the RBC analysis.

T&D optimization benefits tend to be fairly well understood compared to other investment categories. Some of the largest uncertainties occur in the areas of system and operational integration costs.

2.2 Grid Reliability

End-use energy reliability encompasses smart grid capabilities that reduce the likelihood, duration or geographic extent of electricity service interruption, and maintain or improve the quality of delivered power. Example capabilities include fault location, isolation, and service restoration (FLISR), enhanced fault prevention, and wide area monitoring (WAM).

Many technologies that improve reliability are already proven, but results can still vary widely. Benefit-cost analysis indicates that these investments have a high probability of producing a net benefit.

2.3 Dynamic and Responsive Demand (Smart DR)

Dynamic and responsive demand encompasses smart grid capabilities that allow short-term influence of end-use consumption by signals provided through the electricity supply chain. Demand response (DR) was analyzed for seven end-use categories (i.e., lighting, space heating, space cooling, appliances/plug loads, water heating, refrigeration/industrial processes, and agricultural pumping), four sectors (i.e., residential, commercial, industrial, and agricultural), and three program approaches (i.e., pre-enrolled participant events, price signals, and fast-acting/ancillary services).

Cost and benefit results for smart dynamic and responsive demand are incremental to those generated by traditional DR programs that do not require smart grid technology.³ Results indicate the potential for significant benefits from smart DR investments; however, these results vary greatly by customer segment.

³ See Appendix B of the full white paper for more discussion on the distinction between smart DR and traditional DR.

2.4 Smart End-Use Energy Efficiency

Smart end-use energy efficiency encompasses smart grid capabilities that reduce energy consumed by customers through enhanced information feedback, identification of poorly performing equipment as candidates for replacement or maintenance, and other enhancements to EE that require smart grid functionality. Capabilities encompass consumer behavior change, automated energy management, efficiency equipment upgrades, and improved maintenance.

Cost and benefit results for smart EE are considered incremental to traditional EE investments, which do not require smart grid functionality. Investment in smart EE does not appear to be attractive, with less than a 20 percent chance of benefits exceeding the costs. Note that this analysis only addresses end-use efficiency to the degree it is impacted by smart grid functionality, and does not indicate the cost effectiveness of traditional end-use energy efficiency measures.

2.6 Utility Operational Efficiency

Utility operational efficiency encompasses smart grid capabilities that improve the ability of a utility to deliver energy with the same reliability and efficiency, but with lower operations and maintenance costs. Example capabilities include automated meter reading and billing, reduced truck rolls from targeted repair work, and improved planning and forecasting.

Utility operational efficiency investments are viewed as very uncertain, with almost equal chances of producing a net benefit or a net loss. However, much of the costs in this category are in advanced metering infrastructure (AMI), which serves as a platform to enable or enhance the other more beneficial investment categories.⁴ Considering the pivotal role of AMI in many smart grid capabilities, this investment is likely a prerequisite for deployment of many smart grid capabilities. This interpretation is consistent with the evidence of broader AMI deployment already occurring in the region and the country.

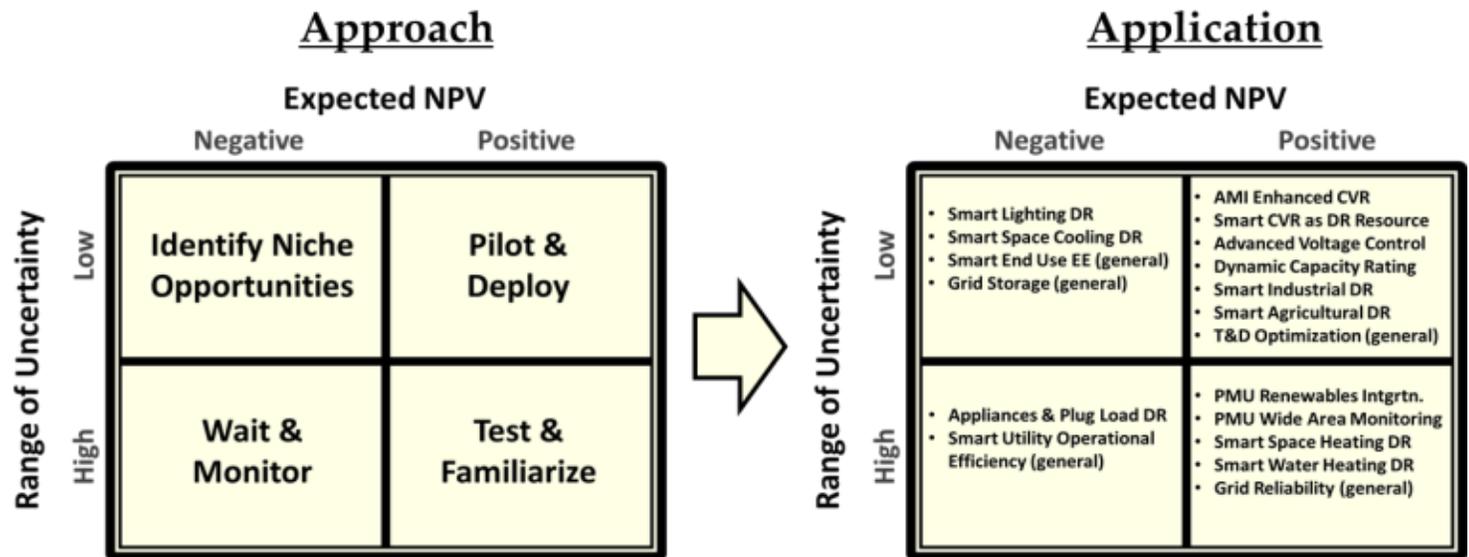


Figure 4. Some Smart Capabilities Warrant Investment, Others Need More Investigation.

2.5 Grid Storage Integration and Control

Grid storage integration and control encompasses all smart grid capabilities that provide the ability to store electrical energy in battery systems. This includes battery systems sited at end-use facilities (i.e., residential, small C&I, large C&I, and institutional facilities), on the distribution system, on the transmission system, and electric vehicle batteries when connected to charging stations.

Results indicate a less than a 20 percent chance that grid storage investments will create a net benefit outside of certain niche applications. However, with advances in battery technologies and new approaches being funded each year, it is possible that a breakthrough or new approach could change the benefit-cost equation.

Key Findings and Policy Implications

Regional stakeholders can leverage the results and information provided by the RBC on smart grid benefits, costs, and uncertainties to inform their decision-making processes and to help put the various smart grid capabilities into a context for decision making.

A primary objective of the RBC study is to characterize the uncertainty and risk of smart grid investments in the Pacific Northwest. Most graphics in this white paper present results with explicit uncertainty bounds. Even with an understanding of the uncertainties, questions remain about how utilities should invest.

⁴ Typically, avoided meter reads and remote connect/disconnect result in benefits that meet 55%-85% of total AMI costs. In some cases where meter reading costs are excessively high (e.g., a rural coop with a large geographic service territory) operational benefits can surpass total AMI costs without including other benefits.

Figure 4 presents an investment approach that accounts for the expectations and uncertainties of smart grid investments. This approach divides smart grid investments into four zones based on their expected NPV and their range of uncertainty. Smart grid capabilities that have a low range of uncertainty have sufficient information to confidently make deployment decisions based on their expected NPV (i.e., “identify niche opportunities” versus “pilot and deploy”). For smart grid capabilities that have a high range of uncertainty,⁵ there may not be sufficient information to deploy at scale, so investment should focus instead on investigating the capabilities and reducing their respective uncertainties (i.e., “wait and monitor” versus “test and familiarize”). The right-hand side of the figure indicates generally which zones the smart grid capabilities discussed in this white paper fall into. This graphic shows that there is sufficient information available today for some capabilities to begin or continue investing in smart grid pilots and deployment. It is important that utilities test those capabilities and become more familiar with them so that they might ultimately make appropriate investment decisions.

Looking Forward

To reduce the uncertainties in these areas, several activities are important to the RBC study going forward, with the goal of leveraging the best available information to advance the characterization of smart grid investments and to build a stronger smart grid business case. For instance, a primary focus will be incorporation of test results from the Pacific Northwest Demonstration Project as they become available. These results will provide information from a range of smart grid technology tests being conducted by participating regional utilities, as well as a better understanding of the use of a transactive control signal for regional benefit. Additionally, the RBC will strive to stay current with smart grid impact assumptions and key data inputs from pilots and demonstration projects that are taking place around the country.

The RBC study is also planning to undertake additional scenario analyses to examine the benefit-cost effects of different future directions, such as carbon pricing scenarios, changes in avoided capacity costs, and changes in energy cost projections. These scenarios will explore regional complexities such as wind power growth and the value of various ancillary services for grid flexibility to accommodate this growth.

Finally, continued outreach and stakeholder communication will be critical to achieving the goals of the RBC effort. This includes providing data-based, grounded analysis and information to regional decision makers, policy makers, utilities, investors, and planners.

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http://www.bpa.gov/Energy/N/smart_grid/index.cfm

⁵ Much of the uncertainty for investments in the lower quadrants arises from the uncertainty in the incremental impact of smart capabilities (i.e., those beyond investment in traditional or baseline capabilities). It can be difficult to determine what fraction of the benefit from smart grid investments might have been achievable with investments in traditional technologies. This is especially true for certain smart DR investments.