Smart Grid Regional Business Case for the Pacific Northwest: Summary

Helping Regional Decision Makers Identify Appropriate Smart Grid Investments

INTRODUCTION

The Regional Business Case (RBC) assesses the benefits, costs, and risks of a comprehensive regional smart grid (SG) deployment in the Pacific Northwest. The results presented in the RBC white paper (summarized here) will help policy makers, investors, and regional decision makers identify appropriate SG investments for the region.

KEY ISSUES

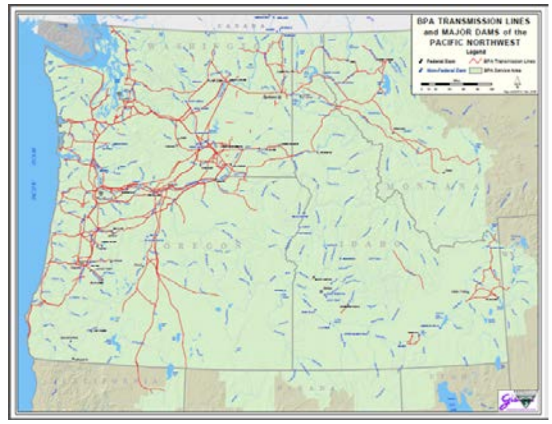
SG technologies promise many benefits for the Pacific Northwest:

- better reliability
- more efficient and flexible operation of the grid
- lower rates
- reduced carbon emissions

However, some of these promised benefits are unproven. Utilities and regulators will rightly approach these smart grid investments with caution until the technologies, investment risks, and business case are more fully understood.

THE APPROACH

The RBC performs a bottom-up analysis of benefits and costs, starting with individual SG technologies, and it uses a 30-year forward-looking discounted cash flow approach. The use of uncertainty (i.e., Monte Carlo) estimates and scenario analyses, along with generally conservative assumptions, are integral to the approach.

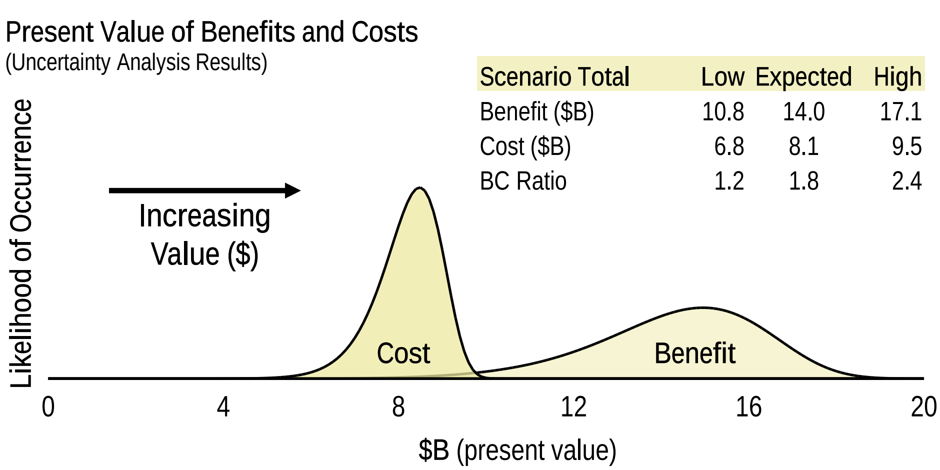


BACKGROUND

The RBC body of work was initiated in 2009 by BPA. The analysis leverages input data from a wide range of studies and demonstrations, including coordination with, and input from, the Pacific Northwest Smart Grid Demonstration Project.

Link to the full white paper found at: http://www.bpa.gov/Projects/Initiatives/SmartGrid/

Benefits Should Significantly Outweigh Costs



Scenario Total	Low	Expected	High
Benefit ($B)	10.8	14.0	17.1
Cost ($B)	6.8	8.1	9.5
BC Ratio	1.2	1.8	2.4

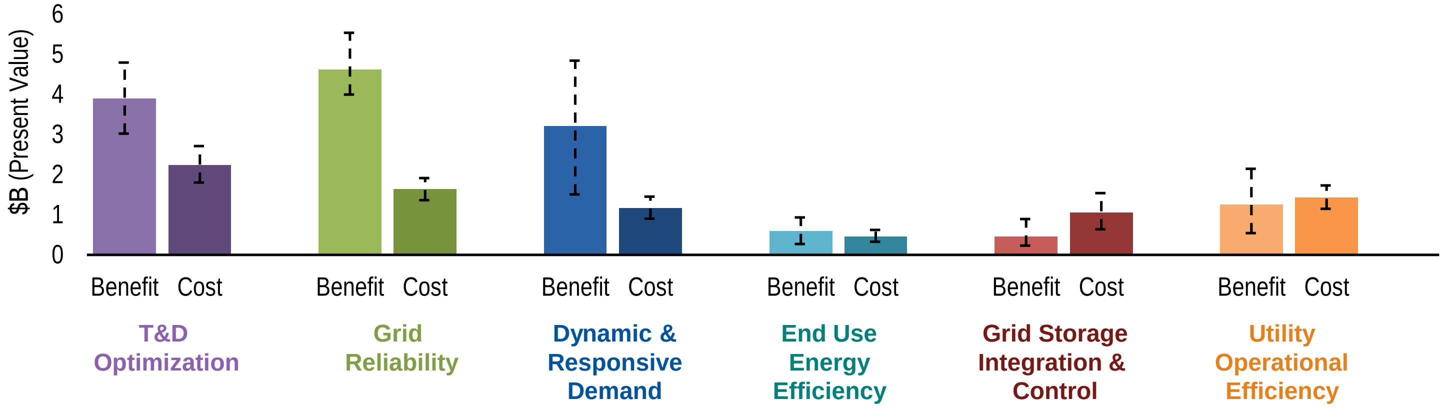
REGIONAL COSTS AND BENEFITS

- Benefits expected to outweigh costs by almost $6B in net present value (NPV).
- Costs have less uncertainty than benefits—as shown by the width of the curves.
- Risk of negative NPV outcome is very low (<1%).

Analysis Identifies Attractive Opportunities and Key Uncertainties

Benefits and Costs Are Separated into Six "Investment Categories"

Present Value of Smart Grid Benefits and Costs by Investment Category



Smart grid technologies, as defined in the RBC, use *two-way communications* and *automated intelligence* to enhance the traditional electricity delivery system. Each investment category is analyzed through the smart grid lens, thus *traditional* (i.e., non-smart grid) investments are excluded from the analysis. Technology costs are shared across investments, where appropriate, and the analysis is careful to avoid double counting of benefits.

KEY HIGH LEVEL DESCRIPTIONS AND FINDINGS

Transmission & Distribution (T&D) Optimization

Definition: improves the controllability or utilization of electrical infrastructure assets, leading to more efficient delivery of electricity.

Example Capability: Smart Voltage Reduction

Findings: High likelihood of favorable B/C ratio

Grid Reliability

Definition: reduces the likelihood, duration, or geographic extent of electricity service interruption, and maintains or improves the quality of delivered power.

Example Capability: Fault location, isolation, and service restoration (FLISR)

Findings: Very high likelihood of favorable B/C ratio

Dynamic & Responsive Demand (DR)

Definition: allows short-term influence of end-use consumption by signals provided through the electricity supply chain.

Example Capability: Energy management system (EMS) controlling HVAC load based on price signals

Findings: High likelihood of favorable B/C ratio

End Use Energy Efficiency (EE)

Definition: reduces end-use energy consumed through enhanced information feedback, indication of equipment condition, or other SG enhancements.

Example Capability: Smart thermostats automatically optimizing customer HVAC energy consumption

Findings: Significant likelihood of favorable B/C ratio

Grid Storage Integration & Control

Definition: provides the ability to store and control electrical energy in battery systems.

Example Capability: Customer-sited, utility controlled, Li-Ion battery

Findings: Low likelihood of favorable B/C ratio

Utility Operational Efficiency

Definition: improves a utility's ability to deliver energy with the same reliability and efficiency, but with lower O&M costs and/or with lower overall capital expenditures.

Example Capability: Automated Advanced Metering Infrastructure (AMI) meter reading & billing software

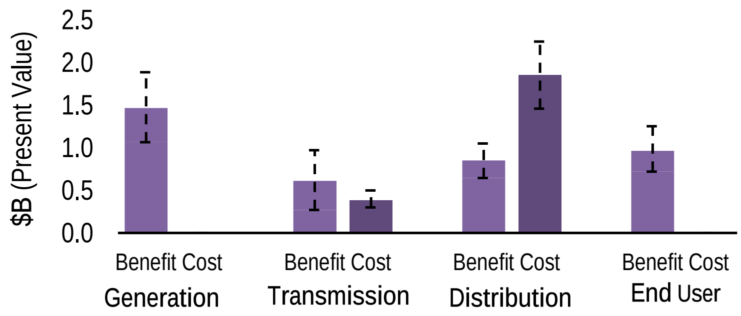
Findings: Low-medium likelihood of favorable B/C ratio

Smart Grid Investments in Distribution and Transmission Create Benefits across the Value Chain

These results show where the smart grid benefits and costs originate in the value chain from a total resource cost perspective. They do not consider the subsequent effects of regulatory recovery mechanisms, such as rate cases.

KEY T&D OPTIMIZATION FINDINGS

T&D Optimization Benefits and Costs
by Value Chain Position



Approximately 4/5 of the investment is made in Distribution and 1/5 in Transmission, but benefits spread across the value chain:

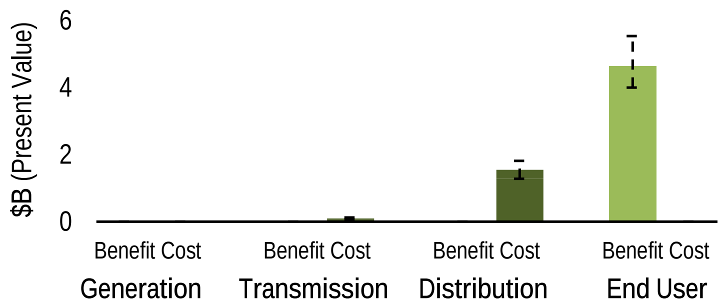
- The need for Generation capacity is reduced.
- Transmission shows a net positive benefit due to reduced need for capacity expansion and reduced losses.
- Distribution benefits are lower than required investments because most of the benefits flow to the End User (reduced consumption) and Generation (reduced need for capacity).
- The End User sees significant reduced energy consumption, and thus reduced costs.

KEY GRID RELIABILITY FINDINGS

Most of the investment is made in Distribution, with only a small percentage in Transmission

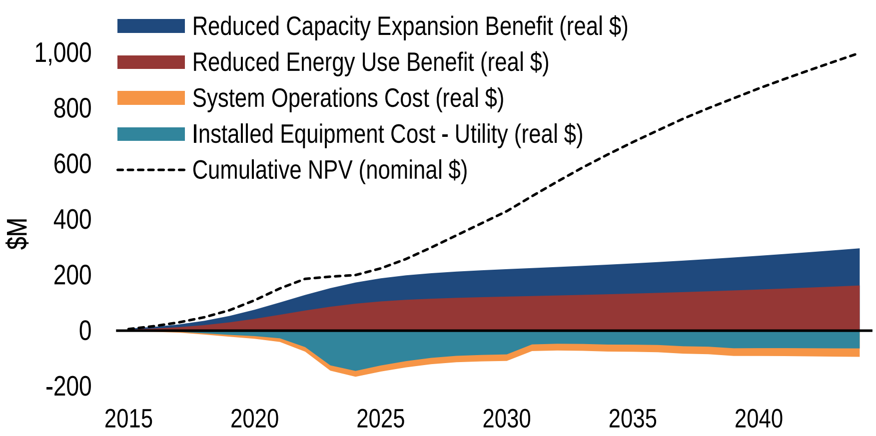
- Overall benefit value for the Region is very high..
- Benefits are largely generated from avoided customer downtime, which accrues to the End User.
- Benefits to the Transmission and Distribution are almost negligible by comparison.

Grid Reliability Benefits and Costs
by Value Chain Position



KEY SMART VOLTAGE REDUCTION FINDINGS

Time Series of Benefits and Costs of Smart Voltage Reduction



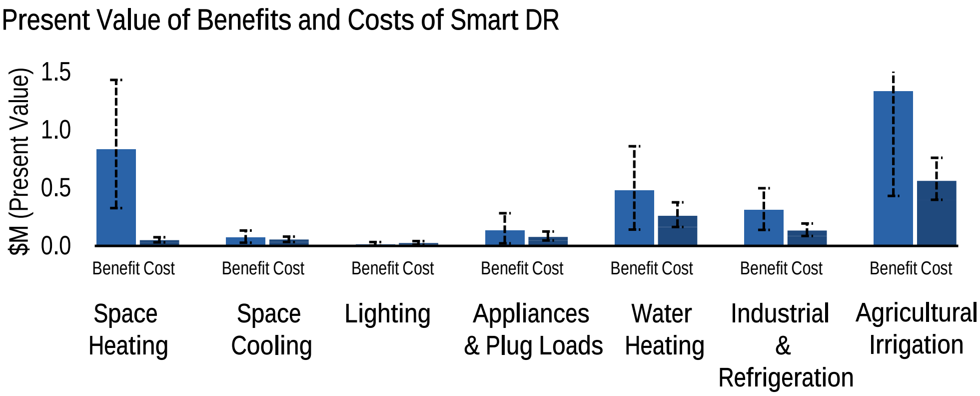
Smart Voltage Reduction is one of almost a dozen capabilities in the T&D Optimization Investment Category.

- Upfront investment is required from Distribution, but the benefit greatly exceed the costs over time.
- The benefits are from reduced energy use and reduced capacity expansion, achieved through both Conservation Voltage Reduction and Demand Voltage Reduction measures.

Incremental Benefits of "Smart EE" and "Smart DR" Justify Investments

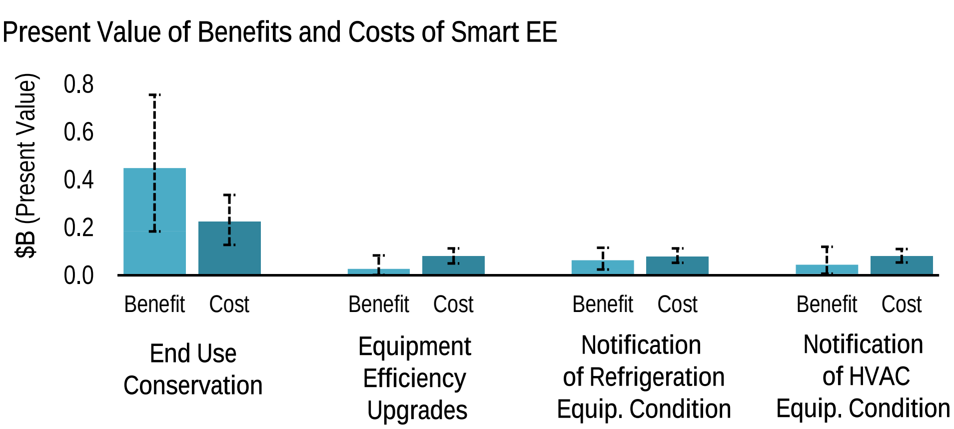
These results show the benefits and costs that can be attributed specifically to the application of smart grid to DR and EE. These benefits and costs are incremental to traditional DR and EE.

KEY SMART DR FINDINGS



- The analysis considers dispatchable, price responsive, and "flexible" (i.e., dispatchable and ancillary service) types of DR.
- The uncertainty is large, but Smart DR for space heating, water heating, industrial processes, and irrigation looks highly promising.
- Use of smart grid technologies for DR with space cooling, lighting, appliances, and plug loads holds less promise for the region.

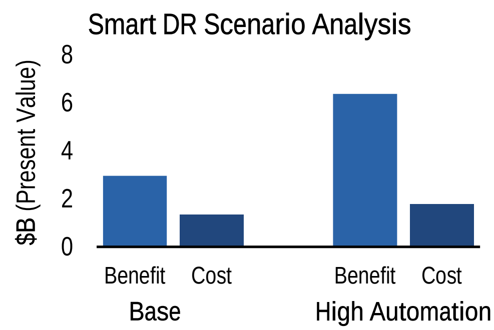
KEY SMART EE FINDINGS



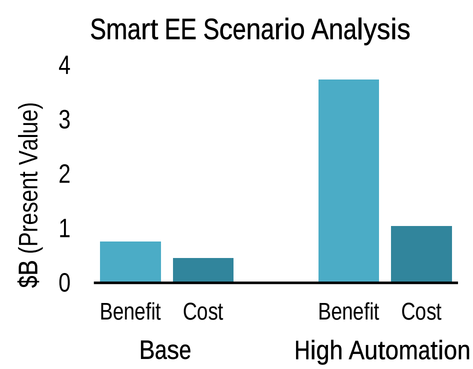
- End use conservation is the most cost effective Smart EE category—it includes both behavior change measures and the automated optimization of end uses like HVAC.
- Incremental benefits of using smart grid technologies for EE are generally less than Smart DR because conservation measures rely less heavily on automation and real-time feedback.

"HIGH AUTOMATION" SCENARIO FINDINGS

This scenario shows the effects of increased customer-driven adoption of automation technologies (e.g., Google's Nest thermostat). This scenario assumes a significant reduction in the cost of these technologies.



- High Automation Scenario assumes most DR within the region becomes Smart DR.
- Shows significant benefits with minimal program-related costs.



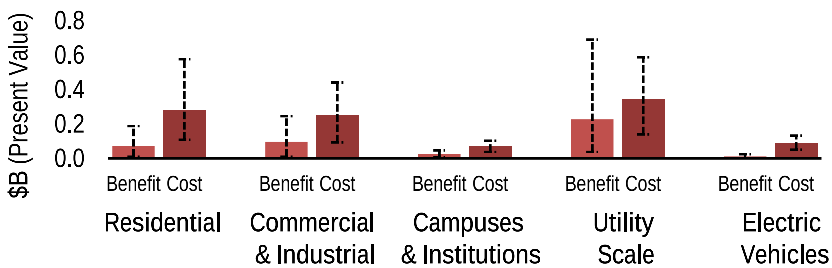
- The High Automation EE scenario also shows significantly improved cost effectiveness for Smart EE.

Sum of bars in left figures are equal to "Base" scenario bars in right figures.

Cost Breakthrough is Key to Unlocking Storage Value

KEY GRID STORAGE FINDINGS

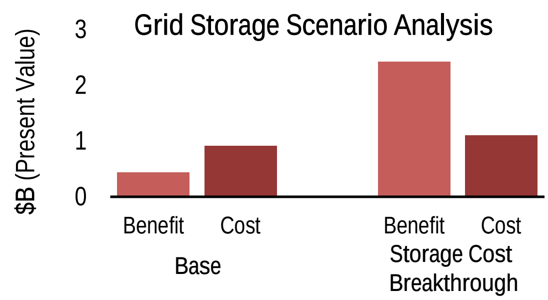
Present Value of Storage Benefits and Costs by Capability



- The benefit-cost ratio increases with battery size due to a downward trend in installed cost per kW as battery size increases.
- For customer owned systems, customers are expected to leverage time-of-use (TOU) rates for energy arbitrage, charging the battery when prices are low and discharging when pricing are high.
- For medium and large battery systems, customers also benefit from reducing their demand charge.
- Utility-scale batteries provide peak load reduction during select hours, and renewables integration and ancillary services such as regulation, voltage support, and short term reserves during the remaining hours.

"STORAGE COST BREAKTHROUGH" SCENARIO FINDINGS

This scenario considers the effects on the RBC from a future scenario where the costs of battery storage drop considerably from current levels and the level of deployment increases as a result of lower costs.

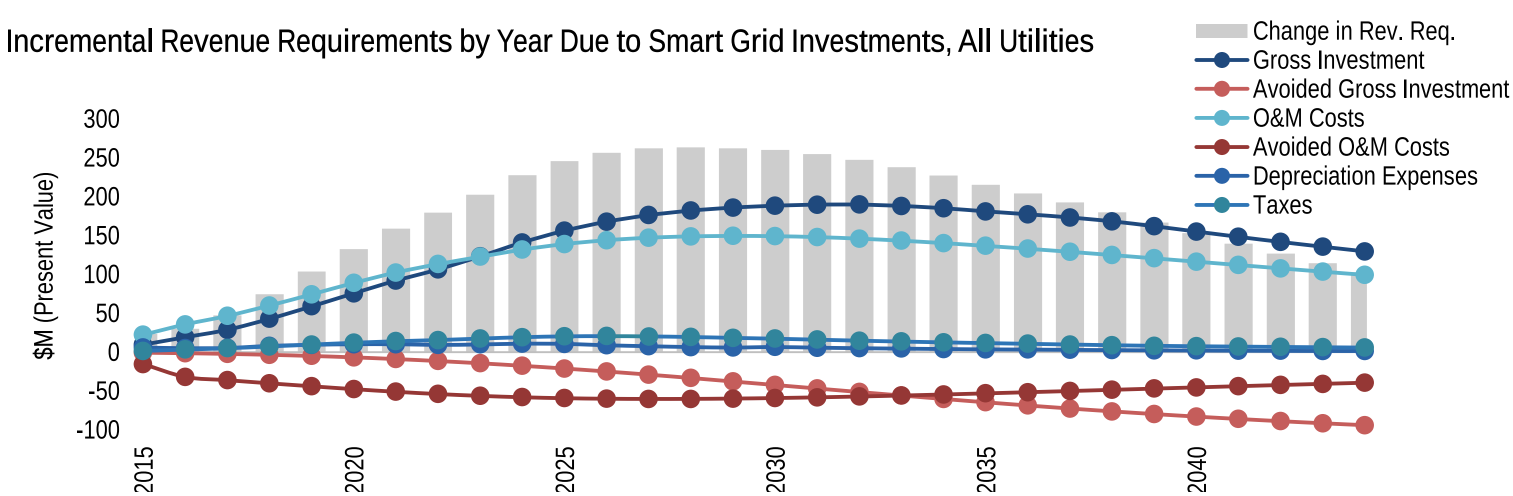


In the Storage Cost Breakthrough scenario, an unanticipated drop in battery costs leads to increased deployment of batteries. The result causes battery storage to become a cost effective investment.

Sums of bars in left figure are equal to the "Base" scenario bars in the right figure.

These Investments Have a Small Effect on Regional Revenue Requirements

- The smart grid investments considered in the RBC lead to an annual increase in revenue requirements of $0.0011/kWh or less for regional end-use customers.



Key Takeaways for Looking Forward

RBC is *regional,* not utility-specific.

- Utilities should conduct analysis specific to their customer demographics and preferences, installed assets, and management preferences.

Insights inform policy and regulatory decision makers, utilities, planners, and investors.

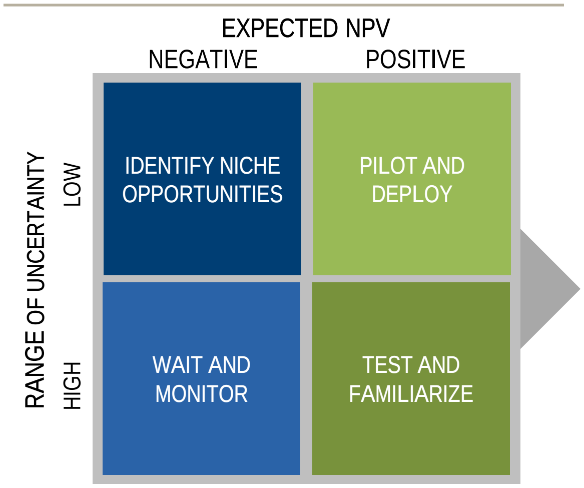
- Benefits of T&D investments flow across the value-chain.
- Significant benefits accrue to end-users: reliability, energy savings.
- Overall, revenue requirement impacts are small.

Regional stakeholders can leverage the results and information provided by the RBC to:

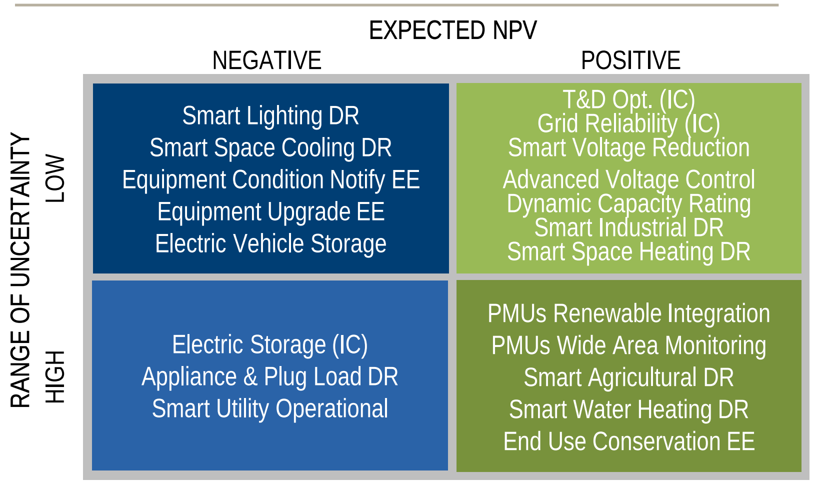
- inform their decision-making processes and
- help put the various smart grid capabilities into a context for decision-making.

The framework below divides smart grid investments into four zones based on their expected NPV and range of uncertainty. This shows there is sufficient information to begin or continue investing in some smart grid capabilities. For other capabilities, it is important that utilities test them and become more familiar so they can make appropriate investment decisions for their own service territories.

APPROACH



APPLICATION



*(IC) = Investment Category

ATTRIBUTIONS AND THANK YOU'S

Development of the RBC has benefited by input and review from numerous stakeholders and interested parties in a range of organizations across the Pacific Northwest. Special thanks to individuals at the following organizations for their significant contributions:

Bonneville Power Administration, Northwest Power and Conservation Council, Battelle Memorial Institute, Ecofys, Milton-Freewater, City of Port Angeles, and Idaho Power

Please see the full white paper for a complete list of reviewers, contributors, and collaborators.

Find the full white paper at: http://www.bpa.gov/Projects/Initiatives/SmartGrid/.