Planning T&D "Reliability-Driven" Projects Using Cost-Benefit Analysis

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Research conducted by the Lawrence Berkeley National Laboratory estimated that power outages cost the U.S. economy $80 billion annually.[2] This staggering figure begs the question: Should utilities be investing more to prevent service interruptions?

Electric utilities strive to provide reliable service at a reasonable cost. But how do you properly balance "reliable service" with "reasonable cost"? These two objectives tend to work in opposite directions. For example, increasing tree trimming expenditures will likely lead to improved long-term reliability and also associated higher costs. Likewise, many "smart grid" investments offer the promise of lower interruption frequencies and smaller outage duration times but require large outlays of capital investment, which will eventually need to be reflected in higher electricity rates.

This paper supplies transmission and distribution utilities with a statistical framework for developing a cost-benefit analysis when evaluating reliability-driven projects and technologies. Most of the benefits of a reliability-driven project will be captured by the business and residents within the service territory, whereas the costs will be incurred by the utility itself. A project should be funded if the economic benefits of the project outweigh the costs. The cost-benefit analysis can be used to help justify projects to regulators and boards of directors, help prioritize projects given constrained budgets, and provide utility stakeholders with a statistical basis for deciding on given projects.

What is Value-Based Reliability Planning?

Strategies to provide reliable service are numerous and multi-faceted, and some of those strategies require high capital investments. An optimum investment decision can be made through value-based reliability planning (VBRP). In VBRP, it is assumed that consumers' preference for service reliability is measurable; and the measured preference can be used to set economically justifiable targets for transmission and distribution facility investments and operation and maintenance projects. Based on VBRP principles, it would be a sub-optimal strategy if a utility:

a) Over-built an electrical delivery system to reach a level of reliability that costs more than ratepayers are willing to pay.

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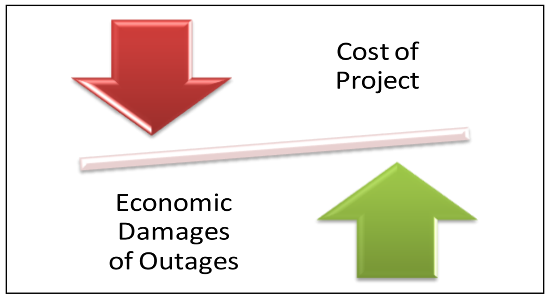
[2] Eto, Joseph H. and Kristina Hamachi LaCommare, "Understanding the Cost of Power Interruptions to U.S. Electricity Consumers." LBNL-55718, September 2004.

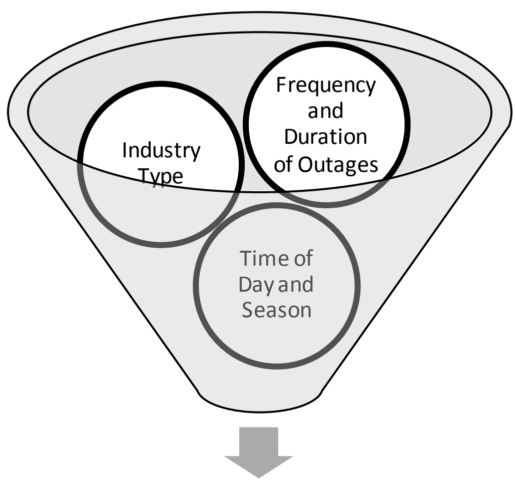
b) Under-built a system that results in more power outages than ratepayers are willing to bear.

For optimum reliability planning and investment decisions, it is indispensible to know what the cost of service interruptions is to consumers and how much they are willing to pay for reliability. VBRP attempts to balance the expected benefits with the anticipated costs of projects to provide an optimal cost/reliability balance. This concept is illustrated in the graph below.



Note: VBRP entails balancing benefits (which are reduced economic damages due to outages) with costs.

Costs associated with transmission, sub-transmission, and distribution outages occur at both the utility and consumer level. During an outage, the utility experiences a loss of energy sales as well as incurs operational and maintenance expenses to restore outages. At the consumer level, economic damages are incurred from either a loss of sales or product for commercial and industrial (C&I) consumers to the cost of inconvenience for residential consumers. Typically, the damages from outages are dominated by the losses incurred by consumers. The lost profits incurred by commercial and industrial consumers are typically large and can vary drastically by industry type, time of day, and the frequency and duration of outages.



Economic Costs of Outages for a C&I Consumer

The value of service reliability improvement to consumers can be conceptualized as equal to the reduction in economic losses that consumers bear when a given power outage occurs. The best way to estimate the economic losses resulting from service reliability problems is to conduct an outage cost survey of consumers randomly selected from each service class and to develop an econometric model of consumer damage cost by service class. Alternatively, to keep research costs low, surveys and research performed by other electric utilities in the nation can be relied upon for their estimations of the economic damage costs caused by electric power outages.

What Questions Can VBRP Help to Answer?

Measuring the economic costs of outages can help focus the attention of utility management on identifying cost effective approaches to improving reliability. It provides a comprehensive view of the costs of operation. The key questions that VBRP can help answer are:

1. What were the economic cost estimates this year, last year, and in previous years due to outages at our utility and at the substation/feeder level?

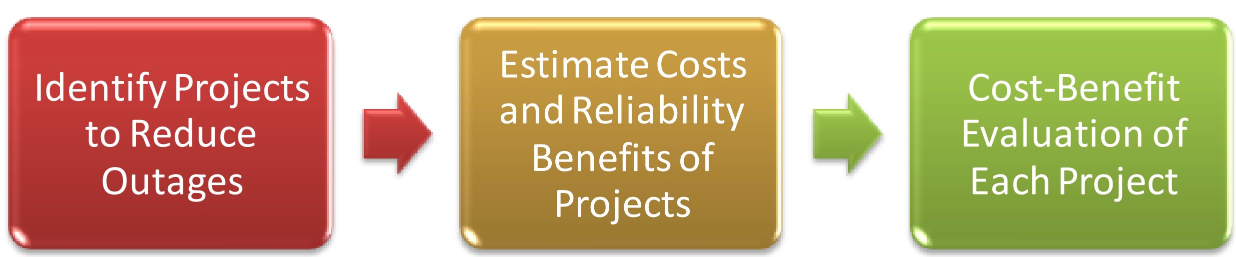
2. Should we move forward with a given reliability-driven project based on the cost-benefit analysis?

3. Which specific areas of the utility (i.e., substations and feeders) should have above average reliability compared to the other areas on our system?

What are the Steps in a VBRP Study?

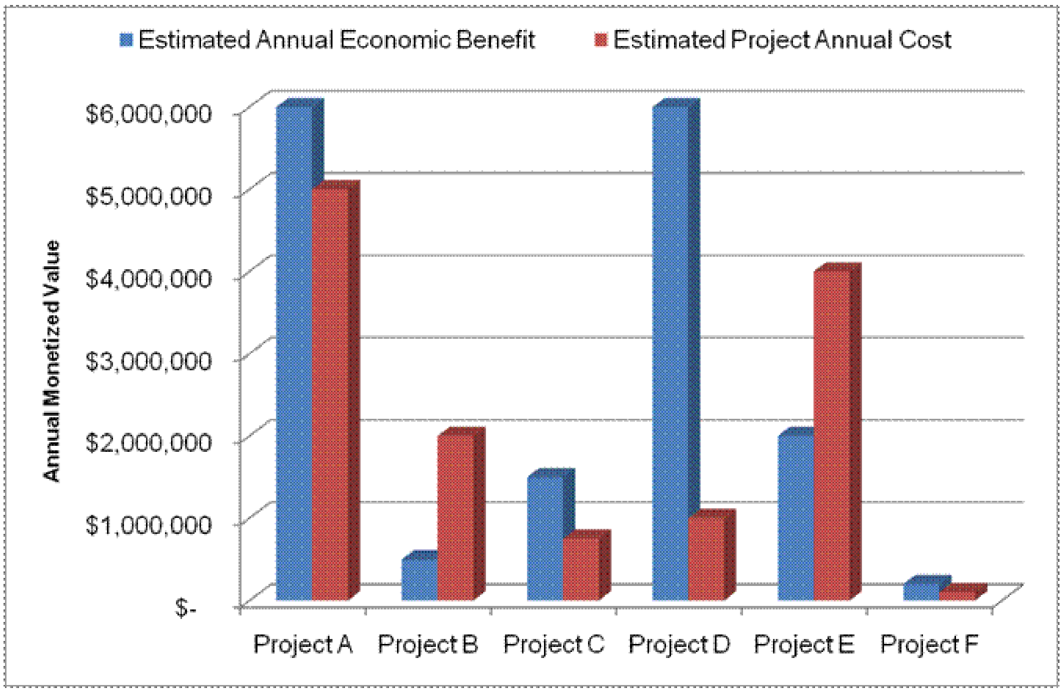
System plans can be developed, defended, and informed by examining the economic costs being incurred due to outages. These economic cost estimates can be disaggregated into specific measures at the system, substation, feeder, or consumer levels (depending on the granularity of outage data). Economic cost estimates can further be broken down by outage cause codes (e.g., power supply, maintenance, equipment failure, etc.). This can help in generating a list of projects to alleviate the damages being incurred in high-cost areas. Benefits and costs can be estimated based on this list to supply valuable information regarding the cost-benefit ratios of each contemplated project.

A possible process flow that the VBRP research can undertake is characterized by the steps laid out in the graph below.



Benefits are defined as the expected reduction in outage costs if a project is undertaken. The benefit estimates will depend on the expected annual reduction in outage frequency and duration resulting from the project. These estimates are derived from either a utility-specific estimate resulting from a survey or already developed industry models that have been econometrically estimated. Costs are defined as the annual cost of the project. For instance, if a large capital investment is involved, the annual costs are the capital carrying costs of the project. This will depend on the anticipated method of financing the project.

Benefits and costs by project are then summarized and prioritized by taking the ratio of benefits to costs. Those projects with higher cost-benefit ratios are more beneficial to end-use consumers. A graph showing the costs and benefits of six hypothetical projects are shown below. Projects A, C, D, and F appear to pass a cost-benefit test, whereas Projects B and E do not.



Conclusion and Other Considerations

It is important to emphasize that reliability-driven projects will cause the utility itself to incur added expenses, whereas the benefits will accrue to end-use consumers and bypass utility revenues entirely. This leads to a situation where a project may offer a net benefit to the service territory but increase the need for rate escalation. Given this reality of reliability-driven projects, it is important to be able to quantify the benefits of the project and effectively communicate this to upper management, boards of directors, regulators, and stakeholders.

Some stakeholders will greatly benefit from a given project, whereas other stakeholders could be made worse off. VBRP analysis can help design rates so that those accruing the benefits of the project are the ones paying for it.

VBRP analysis can help to better inform power suppliers regarding what projects to fund and the basis for that decision. Likewise, given limited budgets, transmission utilities who serve multiple distribution networks can prioritize projects and offer a rationale for their priority list using VBRP principles.

Understanding and quantifying the benefits of reducing outages is paramount in deciding what reliability-driven projects to fund and in what order. VBRP offers decision makers key information on how the reliability of their system influences economic welfare. By pinpointing the economic damages due to outages in given areas and due to specific causes, valuable projects can be identified, prioritized, defended, and enacted.