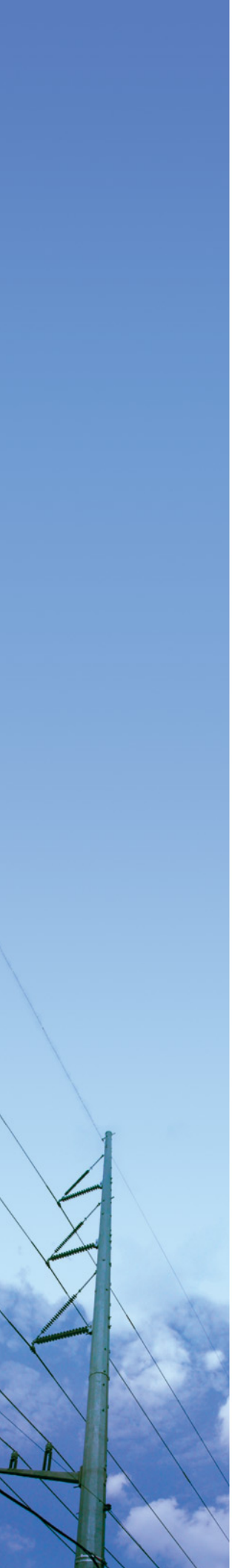

Benefit Analysis for Priority Projects

July 24, 2009

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Southwest Power Pool

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Introduction

By recommendation of the Synergistic Planning Project Team (SPPT), the Economic Studies Working Group (ESWG) was asked to develop benefit analysis techniques for transmission planning with the goal of creating a robust, flexible, and cost-effective transmission system. The ESWG is currently developing the metrics to be used in the Integrated Transmission Planning (ITP) process.

The Benefit Analysis Techniques Task Force (BATTF) was created as a quick response team to address the immediate need to determine the formulation of the metrics to support Priority Project analysis, an interim measure specified by the SPPT until the ITP process is functional.

Significant time is required to fully develop the metrics for the ITP and integrate the existing transmission planning processes. This document and the metrics contained within will be a "living document", subject to change as the process matures and develops.

This document is presented as a working draft of the benefit metrics to be used primarily for Priority Projects and as a starting point for the ITP benefit metrics calculations. The final list of Priority Projects and the ITP process will be presented to the SPP Board of Directors for approval in October 2009.

Scope of Work and Metrics for Formulation

The scope of the BATTF effort is to standardize formulation and analysis techniques for SPP study metrics so Priority Projects are evaluated on a consistent basis. Another goal of the BATTF is to develop a standard reporting format to maximize market participants' and stakeholders' understanding of the results.

If approved by the ESWG, results of the BATTF's efforts will be utilized as a starting point for future ITP process evaluation and will be incorporated into the ESWG's Economic Studies Manual.

The BATTF was asked to consider and formulate for use with Priority Projects the following metrics:

1. **Adjusted Production Cost** (APC) – Projects will be screened to determine their individual APC benefit for SPP. This benefit metric is typically simulated using a production cost modeling tool accounting for 8760 yearly hourly profiles of system-wide commitment and dispatch modeling taken over the course of the study period.

2. **Environmental Impacts** – SO_2, NO_X, CO_2, and mercury can be modeled in a study for the fuel type used in the generating units. Once stakeholders determine a value per ton for the emissions, the cost of emissions can be calculated for the units. Transmission upgrades can then be used to determine the net impact on emission pricing.

3. **Reliability Impact** – Economic transmission upgrades can have an impact on reliability. This benefit is seen when reliability projects are deferred or displaced through construction of more efficient, regional projects. The advancement of reliability projects must also be considered when determining the total overall impact of a collection of economic expansions.

4. **Deliverability of Capacity and Energy to Load** – Projects will be assessed on their ability to provide or act as enablers for power to be delivered from firm designated resources to respective loads. These projects are typically associated with transmission service requests for new designated resources, but could also be bulk EHV projects for regional transfer capability.

5. **Impact on Losses** – Lower impedance transmission lines provide a loss savings to the transmission grid. The energy component of the loss savings can be captured as part of a production cost analysis tool. Capacity savings associated with a loss reduction can be determined by looking at select hourly models to determine loss reduction.

6. **Local Economic Benefits** – Transmission construction provides local economic development and job creation benefits. These benefits will probably reside in the state where each project is constructed.

Results of the BATTF Efforts

The BATTF recommends using the Net Present Value (NPV) over 10 years with a terminal value rather than a benefit to cost ratio for the Priority Projects. This rationale is based on the following:

- The time frame for determining the Priority Projects is very short and there is currently no existing model that has a greater than 10-year time frame. Unless the Board directs the ESWG and SPP staff to develop a 20-year or greater model, a current model must be used.

- A positive NPV over 10 years is a fair indicator of determining a project's priority. This is not a decision to implement a project, just an indicator of the priority of a project. A project with a higher NPV may have a higher cost, so other metrics should be used when evaluating whether a Priority Project should be implemented. Conversely, if a project has a negative NPV, it can be eliminated from the list.

- The logical assumption is that after 10 years, if there is a positive NPV, then a BC ratio of more than 1.0 is more probable.

- If a cost benefit indicator over 10 years is used, the ESWG will need to determine what assumptions should be addressed beyond the 10-year horizon. This will require additional study and will not meet the projected delivery date of October 2009.

- The BATTF is unsure whether the cases for evaluation have adequate data and background beyond 10-year analysis, or whether or not they should be vetted with stakeholders before implementing them into a long-term model.

- The BATTF is assuming there is a limit on the amount of money for Priority Projects and will have to choose from projects with positive NPVs (the "low hanging fruit" projects). Other indicators will need to used to adequately pick the best projects based on the metrics that the group has identified below.

Based on conversations with the ESWG, the BATTF has been asked to concentrate its efforts on the following metrics:

Adjusted Production Cost

Adjusted production cost is a measure of the impact on production cost savings by node (LMP), accounting for purchases and sales of economic energy interchange. This benefit metric is typically simulated by a production cost modeling tool accounting for 8760 yearly hourly profiles of commitment and dispatch modeling, taken over the course of the study period.

Nodal modeling is aggregated on a zonal basis using weighted LMPs. There is concern that modeling the border points will not be accurate without additional Eastern Interconnection

points. For example, the border LMPs will have significant impact on the Adjusted Production Cost within SPP. If there are lower LMP prices outside SPP there will be no transfers from the western portion of SPP. Therefore, the BATTF recommends the model should broaden the footprint to include Southern Companies, Ameren, Basin, WAPA, TVA, PJM, MISO, and the DC ties (using the recent historic patterns) at a minimum when running the model to assess the impact on the borders. The group recognizes the increased run time required and the short time for analysis of the Priority Projects.

The BATTF recommends that gas prices should be based on Henry Hub NYMEX ten-year, plus a Panhandle basis difference. For other fossil fuel prices, publicly-available data should be used.

The BATTF recommends that wind in the models be at a rate of $6.00 per MWH, based on the variable Operation and Maintenance (O&M) cost of a wind farm for the first three years of operation. The BATTF recommends using the same rate for other renewables that was used in the Balanced Portfolio analysis.

A nodal analysis will be completed that aggregates on a zonal basis using the following formulation highlighted. The calculation, performed on an hourly basis, will be:

Adj Prod Cost = Production Cost - Revenue from Sales + Cost of Purchases
Where:
Revenues from Sales = MW Export x Zonal $LMP_{\text{Gen Weighted}}$
and
Cost of Purchases = MW Import x Zonal $LMP_{\text{Load Weighted}}$

Tools used for this analysis will include standard assumptions and modeling using PROMOD, PowerWorld, or equivalent production cost software.

The rationale for using this methodology is as follows:

- This formula was previously approved by stakeholders, the Market and Operating Policy Committee, and the SPP Board as part of the Balanced Portfolio analysis.

- The formulation represents the broad impact of new transmission projects in changing LMP costs (energy, congestion and losses cost) to rate payers within the SPP footprint. It therefore represents much of the savings/benefits or additional cost to rate payers for specific transmission projects.

Impact on Losses

Lower impedance transmission lines provide a loss savings to the transmission grid. The energy component of the loss savings is captured as part of the above production cost analysis tool. It is possible that losses will increase since generation sources will be remotely located from load centers.

Capacity savings associated with a loss change are determined by looking at the selected hourly loadflow models to determine the loss change associated with a transmission upgrade. The BATTF has established standard capacity prices to capture capacity savings. Formulation will be based on an aeroderivative Combustion Turbine (CT) replacement, currently priced around $750 per kW installed (based on the expected cost to install of various types of machines used by BATTF members).

There is a fixed O&M cost component based on $650,000 per year (average expected cost experienced by BATTF members). The energy component of losses is captured in the formulation above. This an additive benefit component for capturing the capacity component of that energy typically passed on to rate payers through Ancillary Service charges. This is variance in quantity of energy (capacity).

The calculation:

- Capacity Savings at Coincidental Peak = ((Capacity requirement at Peak (base case) – Capacity requirement at Peak (with projects upgrades included)) x (CT replacement cost)).

  This would be a straight savings estimate of the capacity, since the CT installation would be a one-time cost when the upgrade was energized.

- There is a fixed O&M cost savings associated with this calculation, usually captured in the Ancillary Services fee.

  It should be calculated as Fixed Cost Benefit = (Capacity savings (as determined from above per 150 MW) x $ 650,000/yr), escalated by the rate of inflation as reported in Bureau of Economic Analysis.

- The price differential would be calculated on an annual basis from the point the proposed upgrade would be energized to the end of the defined 20-year period. There should be no additional accommodation for savings after 20 years, because a CT has an estimated 20-year life span.

- This formulation is the estimated benefit or cost Impact of Losses.

Environmental impacts

The BATTF's primary assumption is that SO2 and NOX will be approximated using pricing curves from the Chicago Climate Exchange; this represents our best estimate of current market prices. Mercury will not be addressed in this metric due to the lack of valid market information. The BATTF discussed at length the merits for CO2; our assumption is that the high price in the long term (20 years) is determined by 100% sequestration currently valued at between $80 and $102 per ton ($91 per ton average) from the Mountain Air Plant DOE project. The low price is based on the current price of CO2 from the Chicago Climate Exchange.

Our assumption is to escalate the current price up to $91 per ton in year 20, based on unknowns with government regulation. Emissions values should be based in a range that reflects the maximum and minimum from various sources, using a high case and low case probability. Example: the high case could be current prices times 3 and the low case could be current prices times 0.5. The base case should be established using the ESWG's opinion of future scenarios (based on current information). Therefore, the reference future will be based on the latest information from sources such as legislative outlooks, technology improvements, state regulations, and other data sources.

The BATTF determined that this calculation is viewed as a less definitive, but still quantitative, formulation. Since Cap and Trade legislation is under discussion and there is no clear direction - but a higher probability - that that a higher price bias exists, we recommend using a 60-40 weighting. The BATTF believes there will be federal legislation; there is a 40% chance the lower case will happen and 60% chance the high price case will happen. (There is also the possibility of the federal government spearheading transmission construction.) Using this formula, we get (60% x $91/ton) + (40% x $0/ton)= $54/ton

The BATTF discussed whether modeling should reflect year 1, year 5, and year 10 evaluation points. It is the BATTF's opinion that as carbon prices increase, wind resources will increase. Therefore, a linear interpretation of the carbon cost curve is a reasonable cost curve. The BATTF discussed running two carbon scenarios with a low and a high carbon value; we need both of these to see what the impact will be on generation dispatch to provide the best determination of the impact of carbon on transmission projects. Without this type of modeling run, the CO2 benefits for transmission projects will cause any transmission project to have benefits in excess of its cost if it displaces coal or gas generation. Due to the time constraints for this type of modeling and runs, and given the current state of the model and the input and model development required, this analysis will not be delivered by October 2009. An approximation for the impact of CO2 can be to have the model produce the amount of tons of CO2 from the Base Case minus the amount of tons saved from the addition of the transmission projects and show a potential range of CO2 prices for comparative purposes. A table can be calculated as follows:

Case Description	Tons of CO2 Produced	Reduction from Base Case at $15/Ton	Reduction from Base Case at $54/ton
Base Case		N/A	N/A
All Priority Projects			

Priority Project 1			
Priority Project 2			
Priority Project 3			
Priority Project 4			
Priority Project 5			
Priority Project 6			
Priority Project 7			
Priority Project 8			
Priority Project 9			
Priority Project 10			

Based on the above discussion, the BATTF recommends that SO2 and NOX be evaluated for Priority Projects and CO2 be evaluated as a post analysis based on tons of CO2 produced at $15 and $54 per ton.

Increased Reliability

The advancement/expedition of SPP Board-approved reliability projects must be considered to determine the total overall impact of economic upgrades. The formula would be based on SPP Transmission Expansion Plan (STEP) reliability projects deferred or advanced, and the benefit would be linked to the dollar impact on the NPV of Annual Transmission Revenue Requirements (ATRR) savings for the deferral/advancement.

The recommended benefit calculation should be:

∑ (STEP Projects Deferred ATRR - STEP Projects Advanced ATRR), taken for years deferred/advanced

Note: If a STEP Project is eliminated, the ATRR for the 40-year life of the asset would be calculated based on the year in which the upgrade was scheduled to go into service.

Local Economic Benefits

Local economic development, job creation, etc. fall under the umbrella of local economic benefits. These benefits will most likely reside in the state where the each project is constructed. The task force recommends using an SPP or consultant model for economic studies to describe local economic impact, which can then be endorsed by the ESWG for ITP benefit analysis. Preliminary discussion suggests this calculation will be difficult to qualify on a multi-county or multi-jurisdictional basis. Historically, economic analysis for local economic benefits has taken 7-10 days per construction project. A more realistic calculation would be a formula based on standard economic impact analysis to provide analysis for the SPP region.

The BATTF recommends not using a detailed local economic impact calculation for Priority Project evaluation. The economic impact calculation should be part of the ITP process. This metric should be developed in conjunction with economic experts/consultants to provide the true local economic impact. For Priority Projects, the BATTF recommends using project construction costs instead of the full local economic impact on the project's location. The cost of the project needs to be framed and explained to avoid cost allocation issues.

Deliverability of Capacity and Energy to Load

A change in deliverability should be reflected in more or less variation in the LIP or LMP prices across the SPP footprint. If deliverability is improved, it would be reflected as a decrease in variation. Since variation and its statistical metrics are difficult to explain, the following metric has been developed using the capabilities of ProMod or a similar nodal modeling tool.

The LMP price at each node is the sum of three price components:
(1) the energy price component
(2) the price component for losses
(3) the congestion price component

All of these component prices are added to make the LMP price at each node. During each hour of the year, each node across the SPP footprint has an associated LMP price and quantity of energy injected (generation) or withdrawn (load) from the system. Generation or injected energy carries a positive sign (+) and loads or withdrawn energy is negative (-).

The congestion component of those LMP nodes will change as a new transmission line is added to relieve congestion. The sum congestion cost within the region will change as new transmission lines are added, providing an effective measure of the impact on deliverability. If the assumption is made that deliverability is the inverse of congestion, we now have a way to measure deliverability in dollars rather than using statistical terminology. These dollars are not additive to the APC metric, since doing so would mean congestion costs are being double counted.

The metric will determine which lines reduce the most congestion. It can also be seen as a variance in price.

The BATTF recommends capture deliverability using the following formulation:

> Congestion Cost at baseline – Congestion Cost with new project = Improved Deliverability Benefit[1]

An alternative formulation:

> Total System Congestion[2] Before Upgrade – Total System Congestion After Upgrade

SPP's PROMOD function has the capability to divide LMP points into energy, congestion, and loss components. The focus of this metric would be on the congestion component.

[1] losses must be fixed and captured separately before congestion cost can be calculated
[2] potentially shown as shadow prices

Additional Recommendations

1. The ESWG needs to determine the assumptions to be used in developing a 20-year model.

2. The ESWG needs to develop, with support of SPP staff, a 20-year model for the ITP Process.

3. To meet the October 2009 deadline for recommending Priority Projects, assumptions in the modeling and analysis need to be simplified:
    a. Use the existing Balanced Portfolio model as the primary model for benefit analysis.
    b. Assumptions used in the Balanced Portfolio for wind generation, or as recommended by the ESWG, should be used for analysis. This is a critical piece of data to begin modeling.

4. Another possible metric for consideration by the ESWG would be a Return on Investment (ROI) to capture those projects that yield better returns for the footprint.

5. Value at risk concepts can be applied directly to hourly LMP time series. We cannot use this metric to produce a dollar value that has value at risk meaning in a traditional sense. We would need to use Monte Carlo simulation and look at the problem hourly for this to work. However, we can still get a good look at the standard deviation, and make an ordinal decision regarding which project provides more benefit along the variance dimension. Here is how we would work the mathematics:

    a. Calculate LMP's for both the base case and change cases (e.g., run the cases).

    b. Calculate the LOAD weighted LMP for these cases for the entire SPP region for each hour. This will give us 8760 load weighted observations for each case.

    c. Calculate the natural log differences between the sequential hourly weighted LMPs for each case. That is, LN(HR2) - LN(HR1), etc.

    d. Calculate the standard deviation of these log differences for each case.

    e. If a project reduces congestion, the standard deviation of the change case will be lower than the base case. The greater the difference, the better the project is.

We are already using "other" metrics to evaluate our positive NPV projects given a budget constraint. This would be another good one.

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