



Palo Verde-Devers No. 2 (PVD2) Transmission Line

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Back-of-the-Envelope View of PVD2 Upgrade

- Historically, California imports a significant amount of energy from the Southwest
 - Lower-priced electricity available than can be produced from existing units located near major Southern California load centers
- Increasing frequency of congestion on transmission lines into California from Southwest
 - Limits amount of imports from Southwest
- According to Appendix D of Technical Appendices of ISO's PVD2 Report more than 10,000 MW of new generation capacity will be built in Arizona by 2013
 - Without a significant upgrade of transmission paths into California, this energy cannot get to California load centers



Back-of-the-Envelope View of PVD2 Upgrade

- PVD2 upgrade provides 1200 MW increase in transfer capability into California for approximately \$667 million 2008 dollars
 - Assuming 75% utilization of new line and 7 percent real discount rate on capital cost implies approximately a \$6 per MWh delivered to California charge to justify line
- \$6/MWh is within expected difference in delivered prices to Southern California load between new Arizona supply and supply from existing units in Southern California
 - Transmission upgrade provides access to inexpensive Arizona power
- Transmission upgrade provides insurance of against risk of high energy prices in California
 - Limits costs of hydroelectric energy shortfalls from within California and in Pacific Northwest



Beyond Back-of-the-Envelope View

- Moving beyond back-of-the-envelope view requires explicitly modeling reduction in wholesale energy costs paid by California consumers as a result of the upgrade
 - Actual reduction on wholesale energy costs depends on future system conditions
- Data and technical requirements to perform these simulations include forecasts of future:
 - Transmission network for Western Electricity Coordinating Council (WECC)
 - Before and after PVD2 upgrade
 - Demand conditions in WECC
 - Input fuel prices—primarily natural gas
 - Supply conditions—primarily hydroelectric energy
 - Extent of unilateral market power exercised in California and rest of WECC



Beyond Back-of-the-Envelope View

- Benefits of PVD2 transmission expansion to California consumers depends on values of each of these variables
 - Ex post benefit of upgrade for a given set of future system conditions depends simulated market outcomes with and without upgrade
- Considerable amount of uncertainty associated with each of these dimensions of future system conditions
 - This implies a distribution of ex post benefits of transmission expansion
 - Major result of modeling effort is pairs of
 - (Probability of future system conditions, Ex post benefit of upgrade for that set of system conditions)
 - System conditions = (gas prices, hydro conditions, demand growth, market power, supply conditions, network configuration)



Beyond Back-of-the-Envelope View

- Currently there is no internally consistent set of forecasts of joint distribution of future system conditions
 - California Energy Commission (CEC) has constructed forecasts of future demand growth in California and future natural gas prices individually
 - Other sources used for future hydroelectric energy conditions and other sources of supply
 - ISO TEAM methodology combines each of these forecasts to form a joint forecast of combinations of future system conditions
 - Joint probability high demand growth, low hydro conditions, high natural gas price, significant exercise of unilateral market power



Beyond Back-of-the-Envelope View

- Internally consistent joint distribution future system conditions would reduce uncertainty in ex post benefits of transmission upgrades
 - Benefits estimates are only as good as input data
 - ISO's methodology has used best data currently available, this data could be improved at relatively low cost
 - CEC ideally suited to produce these joint distributions of future system conditions
 - Collects or could collect necessary data to perform such an analysis
 - Would require significant staff effort, but would have significant payoff in terms increasing quality of benefits estimates associated with transmission upgrades



Beyond Back-of-the-Envelope View

- An important source of benefits from the transmission upgrade is increasing the number of independent suppliers competing to supply energy to Southern California load centers
 - Suppliers located near load centers face increased competition a larger number of hours of the year
 - Increased competition causes them to bid closer to their minimum marginal cost to supply energy
 - Modeling the extent of unilateral market power suppliers possess is extremely complex task
 - Modeling change in extent of unilateral market power as a result of a transmission even more challenging
 - TEAM methodology chooses one approach, but there many others possible
 - Current methodology provides a conservative estimate of competitive benefits of upgrade
- Future research on alternative methodologies for quantifying market power benefits of transmission expansion particularly valuable to California
 - Reluctance of FERC to provide stringent local market power mitigation mechanisms to California ISO increases expected benefits of this research effort



Other Sources of Benefits of Upgrade

- Current version of TEAM approach does not explicitly account for certain tangible sources of benefits of the transmission upgrade in simulations of future system conditions
 - Real-time operational benefits—Less need to keep local generation units operating at minimum operating level to deal with contingencies associated with real-time operating nomograms
 - Transmission loss savings—Increase transmission capacity can reduce line losses associated with transporting power to California loads
 - Capacity cost saving—Cheaper to build generation outside versus inside California
 - Emission savings—Less need to run dirtier units located near load centers reduces amount of NOx emissions in Southern California
- ISO's methodology for estimating these benefits appears to be conservative
 - Operational benefits based on current levels of demand and supply conditions
- Incorporating these sources of benefits into simulation methodology will significantly increase usefulness of TEAM approach



Other Sources of Benefits of Upgrade

- Current benefits assessment framework assumes Locational Marginal Pricing (LMP) throughout WECC
 - This is unlikely to be case outside of California for near to distant future
 - LMP pricing in TEAM approach assumes all flows on transmission lines into California pay congestion charges which are refunded to California consumers
 - Actual congestion on transmission lines into California managed through re-dispatch of generation units into California
- Alternative approach to valuing benefits of transmission upgrade attempts to replicate actual distribution of congestion costs among WECC market participants
 - Alternative approach yields greater estimated benefits of upgrade because reduction in congestion into California reduces re-dispatch costs paid by California consumers
 - Under LMP pricing for WECC, reduced congestion into California reduces level of congestion charge refunds to California loads
 - Reduced benefits of upgrade relative to the alternative congestion management mechanism



Concluding Comments on TEAM and PVD2

- TEAM approach is extremely ambitious state-of-the-art approach to valuing proposed transmission expansions
 - Although there are many untestable assumptions associated with use of methodology, it is an extremely valuable tool that is worthy of further enhancement
 - California parties engaged in transmission planning should make use of results of ISO's development of TEAM
 - CEC can be important source of input data to TEAM approach
 - South Coast Air Quality Management District (SCAQMD) source of emission costs
- Both quantitative results of TEAM methodology and back-of-the-envelope calculation of benefits favor undertaking upgrade
 - Very attractive real rate of return of 5% under very conservative assumptions
 - Between 15% to 30% under more reasonable assumptions
 - Common stocks have provided a 9.3% historical real rate of return from 1926 to 2004
 - Long-term government bonds have provided 2.7% over same period
- Transmission network also provide insurance against extreme events
 - More extensive transmission network limits downside associated with rare, but costly system conditions
 - Distribution of benefits from TEAM methodology illustrates this point
 - Upgrade has large ex post benefits for some extreme, but plausible, sets of future system conditions
- Overall conclusion of MSC—PVD2 upgrade should be undertaken



Other MSC Activities

- MSC has been actively participating in the CPUC resource adequacy process
 - Discussion of costs of capacity markets and capacity payments in other markets
 - Devising alternative mechanisms for ensuring California load is met at least cost to California consumers while respecting physical resource need of ISO operators
 - Mechanisms for fostering symmetric treatment of load and generation in California market
 - Upcoming March 2005 MSC meeting at CPUC