Evaluating the Benefits and Costs of RTOs and Membership in RTOs

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Presentation Outline

- *Implications of RTO formation*
- *Expected costs and benefits*
- *Quantifying benefits using market simulation models*
- *Implication to individual RTO members*
- *Long-term dynamic impacts*
- *Sensitivity scenarios*
- *Review of RTO cost/benefit studies*
- *Case Study: RTO West*

Why RTOs?

- *The FERC concluded that "Order No. 888 has not been able to produce fully efficient and competitive outcome because it does not address ATC calculation, congestion management, reliability, pancaking of transmission access charges, and grid planning and expansion. These are regional problems. Therefore, we are proposing a rule to encourage the development of independent regional transmission operators that can promote both electric system reliability and competitive generation markets."*

What are RTOs?

- *Minimum Characteristics of RTOs:*
  - Independence from power market interest.
  - Scope and regional configuration.
  - Exclusive operational authority.
  - Maintain short-term reliability.
- *Minimum Functions of RTOs:*
  - Tariff administration and design.
  - Congestion management.
  - Parallel path flow.
  - Ancillary services.
  - Running a single OASIS node providing ATC &TTC info.
  - Market monitoring.
  - Planning and expansion.

Cost/Benefit Analysis of RTOs

- *The establishment of new Regional Transmission Operators requires analysis of the costs and benefits to identify gains to society, and individual stakeholders.*
- *There are costs associated with establishing the infrastructure, rules, and expertise, as well as software and hardware. As long as these costs are less than the benefits, RTOs are beneficial to society.*
- *The impact of RTOs on individual stakeholders, compared to the status quo, varies depending on their portfolio and the difference between the current market structure and that of the proposed RTO.*

Expected Costs of RTOs

- *There are two major categories of costs*
  - Start up costs
    - Software and hardware.
    - Could be high for specific implementation, less if standard market design software tools develop.
    - Infrastructure.
  - Operating costs
    - Staff and maintenance.
    - Could be traded against the current cost of operating and maintaining control centers for individual control areas.

Expected Benefits of RTOs

- *The economic benefits include a variety of factors:*
  - Increased economic efficiency from:
    - Eliminating pancaked transmission rates.
    - Eliminating pancaked transmission loss charges.
    - Sharing operating reserves.
    - Coordinating maintenance and scheduling of generation and transmission.

Expected Benefits of RTOs, Cont.

- Improved congestion management and internalizing loop flows.
- Increased competitiveness of markets.
- Lower transaction cost (one-stop shopping), easier business (especially for small players).
- Increased ATC over major transmission lines
  - Collapsing control areas eliminates need for Capacity Benefit Margin (CBM) and Transmission Reserve Margin (TRM) on major interfaces linking participating control areas.
- Other economic benefits
  - Coordinating system expansion and planning.
  - Adopting a single OASIS site.
  - Improved reliability on a regional basis.

Measuring RTO Benefits

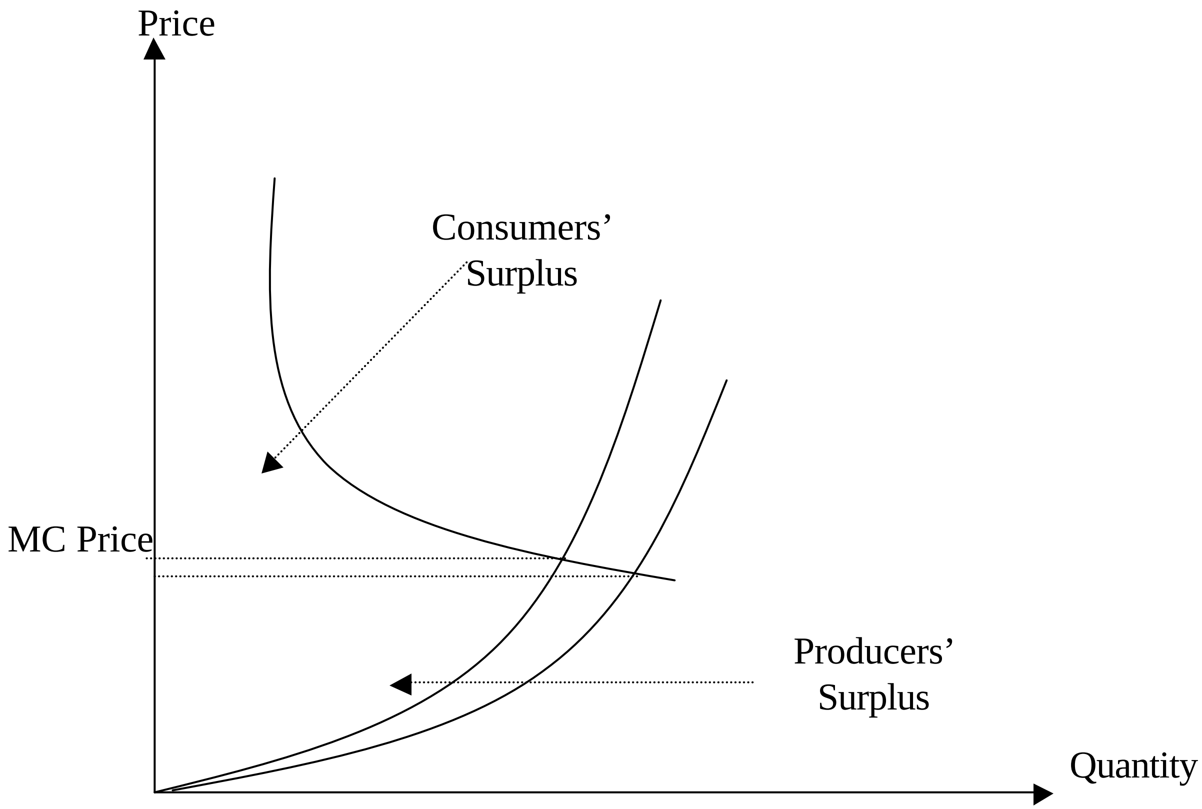
There are two major metrics to measure the benefits of RTOs (same in the case of inelastic demand):

- Production cost savings (Fuel and variable Operating & Maintenance costs)
- Societal welfare increase (consumers' and producers' surplus)

The next slides illustrate the benefits of eliminating pancaked transmission rates in terms of these two metrics.

Supply and Demand

As the supply curve shifts right due to more economic dispatch of generation resources, there is a net increase in both consumers' and producers' surplus.



Eliminating Pancaked Transmission & Loss Charges

- *Currently most regions have tariffs that include charges for transmission based on total transmission system annual revenue requirement.*
  - For transactions that cross more than one control area, charges for transmission usage are added irrespective of impact on the system (pancaked).
- *Currently most regions have tariffs that include charges for losses based on average loss factors*
  - For transactions that cross more than one control area, charges for losses are pancaked.
  - Eliminating the pancaking and charging for losses on a wider region could reduce total charges for some transactions.

Production Cost Savings

Eliminating pancaked transmission rates increases the economic efficiency of dispatching generation resources to meet demand at lowest cost, and thus lowers the total cost of producing electricity.

– For example, during peak hours, high-price areas could buy available steam gas-fired generation in other areas instead of starting a peaker. This peaker appears more economical due to the presence of several pancaked transmission rates, although it is much less inefficient than a steam gas-fired unit or a combined-cycle unit

Increased Social Welfare

Eliminating pancaked transmission rates increases market prices in some areas and decreases prices in other areas. Producers benefit in increased-price areas, while consumers lose, and vice versa for areas with lower prices

- Thus consumers' surplus increases in areas where prices go down and producers' surplus increases in areas where prices increase. The net benefit to both consumers and producers in all areas is the social welfare.
- Exporting areas will realize a net benefit even though prices are going up, since generation is higher than demand.

Sharing Operating Reserves

Pooling reserve resources (spinning, non-spinning and regulating) leads to lower operating costs in at least two ways:

- Lower reserve requirements because of load and generation diversity: load peaks during different times over wide geographic region, which makes system peak lower; also the probability of simultaneous multi-unit outage is lower in a larger region with more diverse generation mix.
- Carrying reserves on the most efficient resources rather than a local control area basis. For example, a system with large hydro generation carries spinning reserves at a much lower cost than a system with mostly thermal units.

- *Automatic Generation Control (AGC) requirements are lower mainly because of higher load diversity for larger geographic regions.*

Note: Most regions already have reserve sharing agreements to take advantage of load and generation diversity, and moving to RTOs might not reduce the total requirements but will optimize the dispatch of reserve resources.

Coordination of Maintenance Schedules

- *A coordinated maintenance schedule of generation units on regional basis allows for higher economic efficiency to meet the regional load and to take advantage of load diversity and generation mix.*

- *Similarly, a coordinated maintenance schedule of transmission system components allows for system-wide efficient and reliable use of existing transmission assets and dispatch of generation resources.*

Improved Congestion Management

- *Collecting real-time information on system-wide power flows will allow the RTO to better utilize the existing transmission system.*
- *Sending real-time signals to generators and consumers will signal when to best produce or consume on the short term, and where, when, and what type of technology to locate on long term.*
- *Charging for transmission congestion and losses on marginal basis will increase the economic efficiency and send the true marginal cost signal associated with moving power on the system.*

Increased Market Competitiveness

- *Establishing regional transmission operators with a single tariff, standardized rules and procedures, transparent market clearing prices and operation, increases the competitiveness of electric power markets by reducing transmission costs associated with moving power from sources to load, and the transaction costs, thus increasing the economic deliverability of generators.*
- *One-stop shopping reduces transaction cost and levels the playing field for small or unsophisticated players, by reducing the complexities of multi-tariff and multi-rules.*
- *However, it is essential to establish the right set of market rules and RTO operation procedures*

Increased Available Transmission Capacity

- *Mainly due to the elimination of the Capacity Benefit Margin and Transmission Reserve Margin.*
- *Due to better scheduling of transmission lines maintenance (a mechanism for sharing benefits and costs should be established).*
- *Due to standardized approaches to defining path ratings and transfer capabilities.*
- *Eliminating contract path contracts and scheduling limits increases the utilization of the transmission system, reduces total production cost, reduces transmission congestion cost, and lowers locational prices.*

Other Economic Benefits

- *Coordinated system expansion and planning*
  - In a competitive, vertically dis-integrated generation market, coordinated/centralized transmission expansion and planning becomes much more important, especially on a regional basis.
- *Adopting a single OASIS site*
  - The proliferation of OASIS sites by control area and different technologies used at each site makes trading electricity a difficult task, increases transaction cost and disadvantage small players. Thus a single RTO OASIS will resolve all these issues.
- *Improved reliability on regional basis*
  - The sharing of real-time and maintenance information on transmission and generation systems increase the capability of operators to properly avoid outages and respond to outages if they occur.

Impact on Individual Members

- *The impact of RTOs on individual members depends on the generation, load and contract portfolio that each member holds.*
- *The impact on each portfolio component can be determined by calculating the change in value of that component due to the RTO implementation:*
  - Change in cost to load would be the quantity of load times the change in market clearing prices.
  - Change in value of generation would be the difference in net generation revenues.
  - Change in the contract portfolio value would be the difference in value of the contracts due to the RTO.
- *There will be winners and losers. In areas experiencing lower prices, net sellers will lose while net buyers will benefit and vice versa for areas experiencing higher prices.*

Allocation of Benefits

- *RTOs, in addition to creating net benefits, could cause significant transfer of wealth from consumer to producers in some areas and in the opposite direction in other areas.*
- *Thus, there are major allocation issues to be resolved.*
  – First, how to allocate the net benefits among the participants of an RTO?
  – Second, what if the major beneficiaries of establishing the RTO are outside the RTO region?
  – Finally, how to allocate the benefits among consumers and producers in any given region?
- *Should we worry about these?*

Competitive vs. Regulated Retail Markets

- *One could argue that in regulated retail markets with utilities serving load from their own generation, most of producers' benefits will find their way to the consumers.*
- *However, in a deregulated retail market, it is not necessary that consumers will receive all the benefits at least in the <u>short term</u>.*

Quantitative Analysis of RTO Impact

- *To quantify the impact of establishing RTOs, one need a detailed model of the electricity markets that can model the current markets (Without RTO) and those envisioned under an RTO operation (With RTO)*
  - Should model the operating procedures, contractual and physical transmission constraints
  - Should model the economic operation and security least cost dispatch of electricity markets
  - Should provide insights into the theoretical economic operation of the electricity markets with and without RTO

TCA uses GE MAPS to model the electric power markets in the US and Canada.

GE MAPS and RTOs Modeling

- *The GE MAPS model is a security-constrained dispatch model that simulates the operation of the electricity market over time*
- *Assumes marginal cost bidding, although we can override with strategic bids*
- *Least-cost dispatch subject to thermal and contingency constraints*
- *Calculates hourly, locational-based marginal price of electricity*
- *Zonal prices can be calculated either as load-weighted average or simple average of locational prices*
- *Congestion cost is calculated as shadow prices multiplied by the power flows on each interface*

Important Long Term Dynamic Impacts

- *On the next several slides, we list some market elements that are indirectly impacted by RTO formation as it evolves.A dynamic framework is needed to evaluate these elements, which include:*
  - Emission cost analyses.
  - Transmission upgrades and related issues.
  - Transmission cost recovery.
  - Installed capacity markets.
  - Market volatility.
  - Reliability and loss of load potential.
  - Strategic behavior analyses.

Emissions Analysis

- *Generators currently incur costs for emitting NOx and SO2, and probably CO2 in the future.*

- *It is possible that an RTO can lower both the total emissions, and the cost of emissions:*
  - By shifting generation to cleaner units
  - By exploiting a difference in environmental regulations across the component regions of the RTO

- *It is possible to quantify these benefits when analyzing RTO formation with a production cost model or similar tool.*

Emissions Analysis

- *RTOs will need to consider the diversity of regulation within the suggested areas. For example:*
  - In NEPOOL, only MA regulates individual plant emission rates.
  - NOx regulations apply May-Sep in CT, but year-round in NY.
  - RTOs in the Midwest may include a mixture of states where the EPA NOx SIP call does, and does not, apply.
- *The recent NERTO study (NYISO + NEPOOL) did attempt to quantify environmental impact, and concluded that it would be small compared to the status quo.*

Transmission Upgrades

- *Current analyses have either ignored transmission upgrades, or applied simple ratios to current interchange capabilities.*

- *If numerical analysis is based on a model that has a full representation of the underlying grid, this can be replaced by a detailed look at the upgrades that are most economically justified in a given scenario.*
  - Identifying constraints with the highest congestion costs.
  - Relieving these constraints or interfaces preferentially.
  - Recognizing that the list may be different with and without RTOs.

Transmission Costs

- *Transmission owners currently recover some of their costs through charges levied on power flow between adjacent control areas or regions.*
- *These charges would cease to exist if the regions were combined in an RTO. However, TOs will still recover their revenue requirements. Thus we expect cost shifting among RTO members.*
- *An alternative cost recovery mechanism is required to minimize this cost shifting.*
  - A additional transmission charge can be levied across the RTO and the product distributed among transmission owners.
  - This would still allow economic flows within the RTO.

Installed Capacity Market

- *The creation of RTOs would impact the installed capacity market:*
  - Reserve margins would tend to drop as the size of markets increases and reserves are shared over larger areas.
  - Capacity reserves in more remote, surplus generation, regions could be applied to meet requirements in load pockets, if transmission allows.
- *Capital investments could be made more efficiently*
  - Explicitly: the RTO could set reserve margins based on demand forecast of a larger region, which would be less likely to be in error.
  - Implicitly: the market signals to prospective new entry would be different.

Market Volatility

- *In a larger market such as an RTO, price volatility might be expected to decrease:*
  - Unscheduled outages would have a less serious impact in general.
  - A larger region would probably include a more heterogeneous generation mix.
- *There is an economic value to the reduction in price volatility.*
- *It may be possible to capture this value in modeling RTOs.*

Reliability

- *FERC believes that the proposed RTO structure will increase system reliability.*
- *More reliable systems imply a lower loss of load potential.*
- *Several studies have been published that try to estimate the cost of lost load.*
- *If these are combined with some assessment of the probability of lost load with and without RTOs, a value could be assigned to the increase in reliability.*

Strategic Behavior

- *All existing cost benefit analyses have focused on marginal cost scenarios. In real life, prices rarely reflect true marginal cost, due in part to strategic behavior by players in the market.*
- *The formation of RTOs would, in general, tend to dilute markets, thus lowering the potential to exercise market power.*
- *A model that simulates strategic behavior could assess the price and production cost impact of an RTO on this facet of the market.*

Sensitivity Analysis

- The expected benefits in any analysis depend on the input assumptions. There is a range of benefits that can be defined by the inputs to the market simulation model.

- Sensitivity analyses can be used to define the range of benefits, as well as analyze the impact of each benefit driver. It is simplistic to assume that various drivers impact the results additively. They may, in fact, offset and/or enhance each other.

List of Potential Sensitivities

- *Potential sensitivities might include:*
  - Geographic scope
  - Membership and continuity of service area
  - Market design variables such as
    - congestion management systems
    - reserves sharing
    - ancillary services markets
    - export charges (levels and mechanisms)
    - loss charges
  - Demand levels
  - Hydro levels and fuel prices
  - Generation and transmission availability

Review of Studies

- *Review of three RTO cost-benefit studies:*
- *ICF report to FERC.*
- *TCA study of proposed RTO-West.*
- *NYISO/NEPOOL NERTO study.*

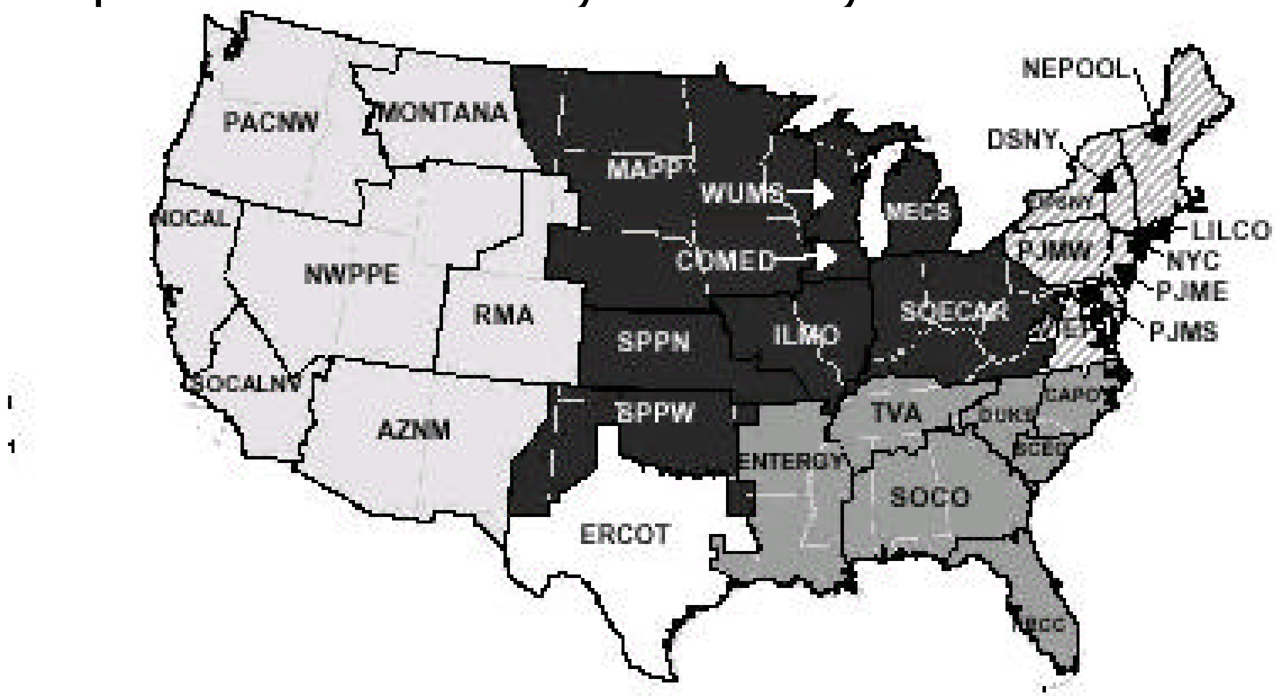
Review of Studies

- *Items of comparison:*
  - Scope of study
  - RTO costs estimated
  - Sources of benefit reviewed
  - Tools used in analysis
  - Overview of results
  - Sensitivities performed

- *List of additional metrics and analyses for future studies*
  - Quantifiable metrics, and possible tools to evaluate them
  - Non-quantifiable metrics

ICF FERC Study

- *Scope:*
  - Nationwide analysis, four RTOs + ERCOT.
  - Additional sensitivities for smaller and larger RTOs.
  - Net present value analysis of 20 year simulations.



ICF FERC Study

- *Costs:*
  - Approximate estimates cost of RTO formation, based on an extrapolation of the cost of forming four existing RTO/ISO bodies : CAISO, NEPOOL, NYISO, PJM.
  - Extrapolations made on various bases, including per MW capacity, per customer served, per GWh supplied etc., and combined into range of possible costs.

ICF FERC Study

- *Benefits:*
  - Key metric is saving in production costs resulting from the formation of RTOs as compared to the current structure (which is a 32-zone representation of the country, roughly along control area lines).
  - Three levels of implementation of FERC Order 2000 are considered:
    - Transmission changes (removal of hurdle rates, capacity and reserve sharing, enhanced inter-regional transfer capability).
    - Additional improvements to generator efficiency.
    - Additional demand response: 3.5% of peak.

ICF FERC Study

- *Tools used in analysis:*
  - ICF's IPM simulation framework, simulating generation on a unit-by-unit basis, including fuel and environmental costs.
- *Results:*
  - The study lists changes in the following for each incremental RTO implementation:
    - Generation by unit type
    - Capacity additions
    - Energy prices at each of 32 zones
    - Production costs
    - Energy transfer between regions

ICF FERC Study

- *Results:*
  - For example in the 2010-2020 timeframe, system level annualized production costs were estimated to decrease by 0.9%, 5%, and 6.9% respectively, in each of the incremental RTO implementation scenarios.
  - Similarly, prices were seen to drop in most parts of the country, but by differing amounts. This would suggest that more analysis could reveal which zones/areas would be the greater beneficiaries from RTO formation, although the ICF study does not draw these conclusions.

ICF FERC Study

- *Sensitivities:*
  - One sensitivity study was performed, testing the effect of changing the size of RTOs.
  - Larger RTOs (2 + ERCOT) and smaller RTOs (9 + ERCOT) were simulated.
  - Both simulations suggested that, other things being equal, larger RTOs could create greater gains in efficiency.

TCA RTO West Study

- *Scope:*
  - Analysis of the entire Western Interconnect, to test the impact of the formation of proposed RTO West.
  - Several sensitivity runs to test the relative impact of various market drivers.
  - Single year analysis for 2004.
  - Assessment of both social welfare and production cost changes.

TCA RTO West Study

- *Costs:*
  - Startup costs estimated based on extrapolations of startup costs of other ISOs in US and Canada.
  - Operating costs estimated based on annual reports and other published documents from various ISOs.
  - No attempt to compare operating costs of the RTO with current operating costs of entities it might replace.
  - Costs of providing secondary transmission exchange functionality estimated based on an original survey of members of Association of Power Exchanges.
  - Costs of providing scheduling coordinator services estimated based on an original survey of QSEs in California and ERCOT.

TCA RTO West Study

- *Benefits:*
  - Two key metrics of energy price impact analysis:
    - Production cost savings in the RTO and the whole WSCC.
    - Social welfare benefits – consumer and producer surplus.
  - In addition TCA assessed, qualitatively or quantitatively:
    - Reduced potential for loss of load.
    - Greater potential for information exchange.
    - Consolidation of functionality in the RTO.
    - New relationships made possible by the RTO.
    - The independent nature of an RTO.
    - Market concentration and changes in concentration resulting from formation of the proposed RTO.

TCA RTO West Study

- *Tools used in analysis:*
  - GE MAPS software, applied separately to cases with and without the RTO in place.
- *Results:*
  - The study lists changes resulting from RTO formation, in each of the following:
    - Energy and ancillary service payments by load
    - Generator production cost
    - Energy and ancillary service revenues to generators
    - Total social welfare
  - In addition, change in generation between regions of the WSCC is listed.

TCA RTO West Study

- *Results:*

Summary of Benefits ($M)- Difference Between With and Without RTO - Base Case								
	A	B	C	D	E	F	G	H
Sub-Region	Load Energy Payment	Uplift Payment	Spinning Reserve Payment	Total Load Payment A+B+C	Generation Cost	Generator Energy Revenue	Generator Net Revenue B+C+F-E	Net Impact G-D
ALBERTA	(53)	0	(1)	(54)	(8)	(51)	(44)	10
BRITCOL	(70)	(2)	(3)	(75)	(87)	(147)	(65)	10
CA ISO	(526)	13	(50)	(563)	(174)	(711)	(573)	(10)
Rocky Mtn	(266)	0	(77)	(343)	(58)	(253)	(272)	70
Rest of RTO West	(1,174)	1	(209)	(1,383)	124	(755)	(1,087)	295
W Connect	(426)	(1)	(111)	(539)	(37)	(429)	(504)	34
Total	(2,516)	11	(451)	(2,956)	(239)	(2,345)	(2,546)	410

TCA RTO West Study

- *Sensitivities:*
  - Precipitation: low water levels.
  - High gas prices.
  - New entry assumptions on a regional basis.
  - Fixed transmission line losses.
  - Different export fee regimes at the edges of the RTO.
  - Fixed path scheduling limits without wheeling charges.
  - Identical maintenance schedules.
  - Zero operating reserves.

NERTO Study

- *Scope:*
  - Analysis of NEPOOL, NYISO and PJM regions, with some representation of neighboring Canadian provinces.
  - 2005 and 2010 snapshots.
  - Assessment of a NEPOOL-NYISO combination, as well as a three-way RTO.
- *Costs:*
  - Operational and capital budgets for the RTO estimated in detail using recent data from NEPOOL and NYISO annual reports.
  - Includes analysis of costs due to setup of new RTO, as well as benefits accruing from the new RTO taking on functionality that is currently duplicated.

NERTO Study

- *Benefits:*
  - Major metric is the incremental change in wholesale power costs in each of the component ISOs.
  - Includes some analysis of changes in production cost.
  - Includes analysis of change in emissions, and the effect on emissions costs over the whole region.
- *Tools used in analysis:*
  - GE MAPS software, applied separately to cases with and without the RTO in place.

NERTO Study

- *Results:*
  - The study lists:
    - Changes in wholesale power costs for each component ISO.
    - Production cost savings across the system.
    - Changes in total power flowing between component ISOs.
    - Qualitative treatment of reliability benefits, resource adequacy and reserve sharing.
  - The study showed that the 3-way RTO did not make economic sense
  - NYISO consistently benefited from RTO creation.
  - NEPOOL initially lost out, but had small net benefits in 2010.

NERTO Study

- *Sensitivities:*
  - Increased trade with Canadian provinces.
  - Increased trade with Midwest.
  - High gas and oil prices.
  - Decreased capacity additions in NYISO and PJM.
  - Increased transfer capability on the paths between existing ISOs.

Case Study: RTO West

GE MAPS and WECC Modeling

- *Load forecast: based on most recent forecast as provided by RTO West*
- *Fuel price forecast: based on EIA forecast for natural gas*
- *Transmission system: based on load flow representation that includes all transmission upgrades*
- *Environmental Adders: include NOx and SOx emission costs*

Using MAPS to Determine Benefits

- *MAPS can model the market operation with and without an RTO*
- *The Without RTO market conditions involve:*
  - Pancaked transmission wheel-out rates (on company basis)
  - Pancaked loss wheel-out rates
  - Contract path flows
  - Carrying reserves on individual company's units and requirements on company's loads
  - Scheduling maintenance of generation unit according to individual company's loads
  - Input hourly hydro generation to reflect average historic output; scheduled pump storage and small hydro generation (outside PNW) against company's loads

Using MAPS to Determine Benefits (cont.)

- *The With RTO market conditions involve:*
  - No pancaked transmission or loss rates, only region-wide wheel out rate
  - No contract path flows
  - Carrying reserve on most efficient resource within the RTO West region; the reserve requirements are on the entire region's load
  - Optimize unit commitment and least-cost security-constrained dispatch on region-wide basis (all generation resources within the WECC)
  - Scheduling maintenance of generation unit according to regional load
  - Input hourly hydro generation to reflect average historic output; scheduled pump storage and small hydro generation (outside PNW) against regional load
- *The difference in production cost and producers' and consumers' surplus between the two cases represents the benefits of establishing the RTO*
- *Note that the first two changes are contractual and not determined by the engineering characteristics of power systems*

Quantification of Benefits

- *Quantification of benefits from the GE MAPS analysis is based on comparisons of:*
  - Generation production cost
  - Load payments (based on spot market purchases)
  - Generation revenues (based on spot market purchases)

- *The comparisons were made both across the system and on a regional basis.*

Case Study: Summary

- *The quantitative analysis shows there are economic efficiencies to be realized by regionalizing the operation of the electric power market and the benefits outweigh the costs*
- *The results are based on input assumptions that the stakeholder group considers reasonable expected conditions in 2004 (including the current RTO West proposal, fixed hydro schedules, economically efficient markets with marginal cost bidding, etc.)*
- *Most realistically, the benefits fall within a range, and these results show the expected value given the base case assumptions*

See complete report at TCA Web page: WWW.TCA-US.COM