Scenario Analysis – Transmission & Distribution Conceptual Costs

ISO new england

Development of Transmission Cost Estimates

- Transmission requirements differ for the 7 scenarios
- Scenario exercise needs an appropriate high-level estimate of costs for transmission requirements appropriate to each supply-side scenario
- Given scenario assumptions, transmission cost estimates are broad, order-of-magnitude.
- Transmission costs are included in the analysis of scenario costs on an ex-post basis (after production cost modeling)
- Results of analyses (including transmission costs) will be presented so that user can mix and match transmission costs with the various scenarios

Process for Developing Generic, Order-of-Magnitude Transmission Cost Assumptions

- ISO worked with the Transmission Owners to prepare assumptions for the different scenarios.
- Transmission Owners provided input based on judgment and experience.
- Transmission cost assumptions reflect TO/ISO consensus only for the purposes of this Scenario Analysis, and do not represent the opinion of any individual Transmission Owner or ISO.

Transmission Cost Assumptions – Elements

- **High-level ("conceptual") electrical transmission needs appropriate to each supply-side scenario**
  - Estimate of miles of AC & HVDC Transmission
    - **HVDC also includes terminal costs**
    - **HVAC substation costs added to per mile cost**
  - Estimate of adder for non-linear routing
- **Estimate of range of costs for transmission**
  - Order-of-magnitude cost ranges based on # of miles of transmission for each Resource Scenario
  - Adder for integrating generating resources and transmission system via substation investment

Proposed Assumptions for the "Underlying Transmission System"

- **"The underlying transmission system" = the RSP expansion plan**
- **Team reviewed Scenarios and sensitivities to determine incremental transmission needs assuming:**
  - Forward Capacity Market and traditional siting issues will influence location of new resources
  - Transmission development will be heavily associated with the location of incremental resources
  - RSP transmission expansion plan is common to all cases:
    - **All supply side scenarios have incremental transmission identified beyond the RSP expansion case**
    - **By contrast DSM cases do not assume incremental transmission beyond RSP**

Assumptions for "Incremental" Transmission System for Supply Side Scenarios

- "Incremental Transmission" = expansion beyond the RSP
- Scenario exercise requires estimate of order-of-magnitude, conceptual, generic transmission system costs ranges for each scenario:
  - Import Scenario
    - **From Quebec/Labrador/New Brunswick**
    - **From NY and the West**
    - **From both**
  - Wind – proxies for both interconnection and transmission costs
    - **Off-shore (assume development at/near Cape Cod)**
    - **On-shore ("Inland") assume development at/near NW Maine Aroostook County)**
  - Queue / Nuclear / Coal scenarios located within NE
    - **Assumed existing nuclear locations for queue/nuclear/coal expansion**
  - Natural gas combined cycle
    - **Assumed siting of plants near existing electric and natural gas infrastructure**

Assumptions for "Incremental" Transmission System for Supply Side Scenarios

- Assume Worcester (Millbury) is the geographic load center of NE
- Estimated cost range/mile from supply points to Millbury
- Source to Millbury
  - **Quebec/Labrador/New Brunswick to Millbury**
  - **Niagara to Utica / Utica to Millbury**
  - **Vt. Yankee, Pilgrim, Seabrook and Millstone Nuclear sites to Millbury**
  - **NW Maine Aroostook County to Millbury**
  - **Cape Cod to Millbury**
- Estimates are for 1,500 MW Capacity Lines
- DC and/or AC facilities (and costs) used as appropriate
- Based on 2007 Costs

Calculating Order-of-Magnitude, Generic Estimates of Transmission Costs for Individual Scenarios

- Developed a matrix of combined transmission paths to be used for each scenario.
- Estimated a range of generic order of magnitude costs for indicated point to point routes.
  - "As the Crow Flies" plus 20% (for costs of routing lines)
- Determined $/mile order of magnitude cost estimates
- Presenting results to Stakeholders for Comment (today)
- Will include transmission costs as part of the total costs for various scenario

Basic Assumptions - AC Lines

Line Cost/mile: 1,500 MW 345kV Line

US	$1.5-3.0 M per mile for lines	Plus $1.0 M per mile for sub-station cost
CAN	$1.0-2.0 M per mile for lines	

Route distance

	Queue, Coal and nuclear	Gas CC case	Hydro
High	average "as the crow flies" distance from Vt. Yankee, Seabrook, Pilgrim and Millstone to Millbury plus 20% for routing	10 miles per unit plus 20% for routing	To NY Border/to Utica/to Niagara To Canadian Border to Labrador/New Brunswick border to Pt. Lepreau
Low	5 miles per internal source unit plus 20% for routing	5 miles per unit plus 20% for routing	•To Canadian Border/To New Brunswick Border •To NY Border

Basic Assumptions - DC Lines (for Hydro / Import cases)

Line Cost/mile:
1,500 MW
450 kV Line

US	$1.5-3.0 M per mile for lines	Plus $250 M for each con-verter station
CAN	$1.0-2.0 M per mile for lines	Plus $250 M for each con-verter station

Route distance

High	Hydro •To NY Border/to Utica/to Niagara •To Canadian Border to Labrador
Low	•To Canadian Border •To NY Border

Number of Transmission Lines (1500 MW) Assumed for various cases

	# of lines
Each scenario adding 5400 MW of supply-side resources	4
Each retirement case (assuming 8900 MW total added, including replacement of retired capacity)	6
Each additional 3,500 MW EE/DR sensitivity case (for net 2,900 MW of scenario technology resources added)	2
Wind cases: • Off shore, given 20% qualified mw • On shore, given 20% qualified mw	 2 2

Range of Cost Estimates for Transmission Elements

	Scenarios – Incremental 8,000 MW Note: all cases have the same 2,600 MW of resources reflecting proposals in the ISO-NE Queue as of 10/31/06	Common Assumptions		Replace 3,500 MW of the Scenario Technology with 1,750 MW of Energy Efficiency (EE) and 1,750 MW of Demand Response (DR)		Replace 2,700 MW of DR with 2,700 MW of EE[1]	Replace 2,700 MW of EE with 2,700 MW of DR[1]	Retire 3500 MW and replace with Scenario Technology		Decreased Imports of Low-Emission Resources (- 7 TWh)[1]	
		Total Low Mi & Low ($M)	Total High Mi & High ($M)	Total Low Mi & Low ($M)	Total High Mi & High ($M)			Total Low Mi & Low ($M)	Total High Mi & High ($M)	Total Low Mi & Low ($M)	Total High Mi & High ($M)
1	Mix of currently proposed resources (5400 MW blend reflecting the fuel mix exhibited recently by the market (i.e., "the Queue")	**60**	**1210**	**30**	**605**			**90**	**1814**	**60**	**1210**
2	Additional EE and DR with 2700 MW of DR and 2700 MW of EE	**0**	**0**	**0**	**0**	**X**	**X**	**0**	**0**	**0**	**0**
3	Nuclear – 5400 MW	**60**	**1210**	**30**	**605**			**90**	**1814**	**60**	**1210**
4	Advanced clean coal – 5400 MW Without Carbon Sequestration	**60**	**1210**	**30**	**605**			**90**	**1814**	**60**	**1210**
5	Natural Gas (Combined Cycle) – 5400 MW	**60**	**192**	**30**	**96**			**90**	**288**	**60**	**192**

Range of Cost Estimates for Transmission Elements

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6	Renewables – 5,400 MW (including a combo of wind (on/off shore), hydro, biomass, landfill gas, Combined Heat and Power, fuel cells, Photo Voltaics 1/8 each)	**570**	**2544**	**285**	**1272**			**855**	**3816**	**570**	**2544**

Range of Cost Estimates for Transmission Elements

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7	Increased Imports of Hydro and/or other Low Emission Resources (30 TWh of imports										
7a	Millbury- Canadian Border (AC)	3060	7200	1530	3600			4590	10800	3060	7200
7b	Millbury-Labrador (Source) (AC)	3060	20400	1530	10200			4590	30600	3060	20400
7c	Millbury- NY (Border) (AC)	1040	2448	520	1224			1561	3672	1040	2448
7d	Millbury- NY (Utica) (AC)	1591	3744	796	1872			2387	5616	1591	3744
7e	Millbury- NY (Niagara) (AC)	3366	7920	1683	3960			5049	11880	3366	7920
7f	Millbury - New Brunswick Border (AC)	3794	8928	1897	4464			5692	13392	3794	8928
7g	Millbury - St. Johns (AC)	4406	10368	2203	5184			6610	15552	4406	10368

Range of Cost Estimates for Transmission Elements

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7	Increased Imports of Hydro and/or other Low Emission Resources (30 TWh of imports										
7a	Millbury- Canadian Border (DC)	**3860**	**8000**	**1930**	**4000**			**5790**	**12000**	**3860**	**8000**
7b	Millbury-Labrador (Source) (DC)	**5860**	**16930**	**2930**	**8465**			**8790**	**25395**	**5860**	**16930**
7c											
7d	Millbury- NY (Utica) (DC)	**2335**	**3080**	**1167**	**1540**			**3502**	**4620**	**2335**	**3080**
7e	Millbury- NY (Niagara) (DC)	**3414**	**6560**	**1707**	**3280**			**5120**	**9840**	**3414**	**6560**
7f	Millbury - New Brunswick Border (DC)	**0**	**0**	**0**	**0**			**0**	**0**	**0**	**0**
7g	Millbury - St. Johns (DC)	**0**	**0**	**0**	**0**			**0**	**0**	**0**	**0**

Method for Developing Distribution Cost Savings Due to EE and DR

- Estimate the distribution equipment capital investment savings over the 13-year period (2007-2020), assuming 5400 MW of EE and DR were added
  - Assume an average annual load reduction of 415 MW per year (5400MW / 13 years)
  - Develop a $ / MW value for distribution equipment investment
  - Estimate a low and high % of distribution equipment that would need to be installed, considering the lumpiness of equipment additions and the sensitivity of the load change to impact expansion plans
  - Multiply the (percentage) x ($ / MW cost) x (5400 MW) to calculated the estimated capital saved

Method for Developing Distribution Costs Savings due to EE and DR - Detail

- Estimated distribution capital cost required to serve 415 MW of load = $100K/MW
  - Based on a various distribution substation configurations (single transformer, dual transformer, addition of second transformer)
  - Increased by 10% to account for line equipment
- Estimated low & high percentage values were 20% & 60%, based on:
  - Estimate of 1500 - 2500 individual main line distribution circuits and 500- 1500 distribution substations in NE
  - Load reduction/ circuit would be only 0.2 MW if reduction spread equally over each circuit and 0.4 MW per substation
  - Not all growth in load requires distribution investment (e.g., if a circuit / distribution substation is 70 % loaded and load growth increased loading to 90%, no capital investment would be needed. If the circuit were loaded to 85% and load growth would increase loading to 105%, capital saving would be needed).
  - Independent of load growth, distribution investment would still be required for some situations, e.g.:
    - equipment needed for storm related damage
    - connecting new customers or serving fast growing areas
    - replacement of equipment that must be moved (road work)
    - replacing outdated equipment
    - additions required for power quality, protection and reliability issues
  - Distribution capital to meet the extreme summer and winter peak loading by circuit. All circuits do not peak at the time of the system peak so EE and DR would have to be controlled circuit by circuit.
- Calculated investment savings Range
  - $100K/MW x .2 x 5400MW ~ $100M
  - $100K/MW x .6 x 5400MW ~ $325M

Range of Distribution Credit Adjustments

		A		D		E	F	G		H		I	
	Scenarios – Incremental 8,000 MW Note: all cases have the same 2,600 MW of resources reflecting proposals in the ISO-NE Queue as of 10/31/06	Common Assumptions		Replace 3,500 MW of the Scenario Technology with 1,750 MW of Energy Efficiency (EE) and 1,750 MW of Demand Response (DR)		Replace 2,700 MW of DR with 2,700 MW of EE[1]	Replace 2,700 MW of EE with 2,700 MW of DR[1]	Retire 3500 MW and replace with Scenario Technology		High Carbon Allowance Prices[1]		Low Carbon Allowance Prices[1]	
		Total Low ($M)	Total High ($M)	Total Low ($M)	Total High ($M)	Total Low ($M)	Total High ($M)	Total Low ($M)	Total High ($M)	Total Low ($M)	Total High ($M)	Total Low ($M)	Total High ($M)
1	Mix of currently proposed resources (5400 MW blend reflecting the fuel mix exhibited recently by the market (i.e., "the Queue")			**-65**	**-211**								
2	Additional EE and DR with 2700 MW of DR and 2700 MW of EE	**-100**	**-325**			**-100**	**-325**	**-165**	**-536**	**-100**	**-325**	**-100**	**-325**
3	Nuclear – 5400 MW			**-65**	**-211**								
4	Advanced clean coal – 5400 MW Without Carbon Sequestration			**-65**	**-211**								
5	Natural Gas (Combined Cycle) – 5400 MW			**-65**	**-211**								
6	Renewables – 5,400 MW (including a combo of wind (on/off shore), hydro, biomass, landfill gas, Combined Heat and Power, fuel cells, Photo Voltaics 1/8 each)			**-65**	**-211**								
7	Increased Imports of Hydro and/or other Low Emission Resources (30 TWh of imports			**-65**	**-211**								