

January 31, 2011

**To:** Stakeholder Steering Committee  
**From:** EIPC Modeling Working Group (MWG)  
**Subject:** BAU Future Modeling inputs - for February 7/8, 2011 SSC

The attached memo provides an update to the SSC regarding modeling updates to implement the Business-as-Usual (BAU) Future and approved sensitivities<sup>1</sup>. For each of the eight (8) MWG subteam areas, the memo indicates where subteam members have reached an initial consensus view, where decision points have been identified for SSC decision, and where additional data development is required (“holes”). In addition to the information provided in this memo, additional detailed backup information is provided for the Fuel & Emission and also the New Generation data recommendations (**available on the [MWG page of eipconline.com](#)**). While the MWG puts forth this update, it is recognized that due to time constraints, the MWG has not had the opportunity to fully vet the detail of all the subteam recommendations.

This memo references an “Inputs Template” document that includes the detail of the modeling inputs for the BAU and sensitivities in a series of tabs, and provides explicit references to the Inputs Template tables and exhibits. The Inputs Template is maintained in a centrally-accessible location<sup>2</sup>. The new NEEM region configuration, approved at the January 18<sup>th</sup> SSC meeting, is not yet reflected in the Inputs Template. CRA has recently provided information that reflects the new NEEM regions, and further data adjustments will be recommended by the MWG to reflect the new NEEM regions.

As this report indicates, there is a great breadth of modeling areas for review and development within an ambitious timeframe. The SSC will note that in some areas, the detailed data is still

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<sup>1</sup> The Modeling Working Group (MWG) is charged with developing an understanding of the capabilities, inputs and assumptions, and outputs for the CRA MRN/NEEM model, and for making recommendations for the values and assumptions to be used in the models to the SSC. To manage these responsibilities, the MWG divided into subteams to review the MRN-NEEM inputs and to consider alternative sources if necessary. Guiding principles for selecting data sources are based on the data being relevant (reflecting current market conditions *and projections* rather than academic or theoretical studies), public, and unbiased. The subteams are in-process of reviewing and proposing model inputs, with a focus first on those for the Business-as-Usual Future and sensitivities, with consideration of the full eight Futures.

<sup>2</sup><https://spreadsheets.google.com/pub?key=0AhPeRQUSZ9gDdG9mLVFzS3F0WIFTbmd4bWZEOUZWTVE&hl=en&output=html>

being formed, and in those areas this MWG report focuses on highlighting the proposed approaches that guide the detailed inputs development.

We would also like to acknowledge Stan Hadley and John Buechler for all their support through this effort. We look forward to continuing to develop the required modeling inputs for the EIPC effort. Should the SSC have any questions, please contact the MWG co-chairs, Erin Hogan and Mary Ellen Paravalos.

## **1. NEEM Regions and Transmission Subteam**

The NEEM Regions and Transmission subteam is focusing on the proposal for configuration of the NEEM regions, wheeling charges, hurdle rates, reserve margins, representation for Hydro Quebec and the Canadian Maritimes, and proposed approach to transmission transfer capacity adjustments.

### **Consensus Items:**

NEEM Regions:

- The new NEEM regions that have been identified by the PAs and CRA have received consensus agreement and accepted by the SSC. CRA has recently reflected the new NEEM regions in information provided to the MWG, and the MWG is making appropriate adjustments to the Inputs Template and their modeling.

Transmission from Hydro Quebec and the Maritime Provinces:

- For each of HQ-NY, HQ-NE, NB-NE, and HQ-Ontario, the MWG recommends that baseline infrastructure transmission be reflected in the modeling of energy transfers using fixed values for each load block. The energy transfers reflect baseline infrastructure and expected energy transfers. Additional potential energy resources in HQ and Maritimes will be modeled using 'pseudo-generator units' which reflect proxies for capacity cost, energy dispatch price, and transmission costs. Additionally, we will identify the amount of generation capacity from HQ and Maritimes that is appropriate to be counted toward New York and New England reserve margins.
- The energy transfer values are expected to be reflected in Table 25 (HQ and Maritimes Energy Transfers), and the "pseudo-generation unit" proxies will be reflected in the relevant New Generation inputs - Exhibit 9 (Capital Cost Detail), Exhibit 4 (Wind Shapes), Exhibit 11 (Wind Capacity Factor and Potential) and Exhibit 12 (New Resource Limits). These inputs are still being developed with assistance from the NE and NY PAs and the Canadian entities.

## Decision Points:

### 1. BAU Sensitivity 1 Transmission Approach:

- The SSC needs to decide whether to use the EIPC/CRA soft-constraint approach for use in implementing Sensitivity #1 of the BAU Future. It is desirable for the SSC to decide whether to use the EIPC/CRA soft-constraint approach on Feb 7/8 to accommodate time for CRA to perform the necessary model-coding. The MWG recommends that the EIPC/CRA soft-constraint approach is generally appropriate to be used to implement Sensitivity #1 of the BAU Future. The MWG recommends that, for the BAU Sensitivity #1, the soft-constraint approach setting the Overload charge to one standard deviation below shadow prices, with a floor set at \$2/MWh. The MWG is not, at this time, suggesting *how* the results of Sensitivity #1 may be applied to the other BAU sensitivities. For instance, the MWG discussed the option of taking the results of Sensitivity #1 and reflecting those specific fixed transfer limits to the remaining BAU sensitivities, should the SSC decide to do so. However, the MWG recommends that the SSC wait until the results of Sensitivity #1 can be reviewed before deciding on specifically how to proceed. This is to allow for additional assurance that the Sensitivity #1 results are according to expectations, given the newness of the soft-constraint approach.

### 2. Sensitivity #2 Interregional fees/dispatch barriers reduced

- The SSC asked the MWG and SWG to consider how Sensitivity #2 may interact with Sensitivity #1, considering hurdle rates, transmission service charges, and other charges. We have developed the following 3 options for the SSC to consider, and MWG would like to emphasize that it does not view any of these options as precedents for other Futures.

## Option A

### BAU Sensitivity 2

- SSC to decide for the remaining sensitivities of the BAU whether to use:
  - o 1) Baseline Infrastructure Transmission Constraints; or
  - o 2) Sensitivity 1 Transmission Constraints
    - Transmission Constraints for each pipe would be set to reflect the usage over each pipe in Sensitivity 1 [see Decision Point 3 below]
    - Soft Constraints would be removed so that transmission cannot be expanded in the remaining sensitivities
  - o Note: EIPC has indicated they will not be able to provide transmission cost estimates for the increased transfer limit before the SSC needs to decide whether to use the Baseline Infrastructure Transmission Constraint or Sensitivity 1 Transmission Constraint approach for the remaining sensitivities.
- BAU Sensitivity 2
  - o Run Sensitivity 2 based on Transmission constraints determined by SSC choice from above with **removed** Hurdle Rates and Wheeling Charges

- Sensitivity 2 would result in increased use of the transmission system, but would not allow flow on any pipe to exceed the maximum level identified in Sensitivity 1 for that pipe.

## Option B

### **BAU Sensitivity 2**

- SSC to decide for the remaining sensitivities of the BAU whether to use:
  - 1) Baseline Infrastructure Transmission Constraints; or
  - 2) Sensitivity 1 Transmission Constraints
    - Transmission Constraints for each pipe would be set to reflect the usage over each pipe in Sensitivity 1 [see Decision Point 3 below]
    - Soft Constraints would be removed so that transmission cannot be expanded in the remaining sensitivities
  - Note: EIPC has indicated they will not be able to provide transmission cost estimates for the increased transfer limit before the SSC needs to decide whether to use the Baseline Infrastructure Transmission Constraint or Sensitivity 1 Transmission Constraint approach for the remaining sensitivities.
- Sensitivity 2
  - Run Sensitivity 2 based on Transmission constraints determined by SSC choice from above with Hurdle Rates and Wheeling Charges **reduced by 50%**
    - Sensitivity 2 would result in increased use of the transmission system, but would not allow flow on any pipe to exceed the maximum level identified in Sensitivity 1 for that pipe.

## Option C

### **BAU Sensitivity 2**

- Run Sensitivity 2 using the Soft Constraint Approach. Reduce or remove Hurdle Rates and Wheeling Rates
  - Sensitivity 2 would allow the flows on each pipe to exceed the maximum level identified in Sensitivity 1 for that pipe
  - SSC decision required to on whether to reduce or remove wheeling rates and hurdle rates

### **BAU Sensitivity 3 through the remaining BAU sensitivities**

- SSC to decide for the remaining sensitivities of the BAU whether to use:
  - 1) Baseline Infrastructure Transmission Constraints
  - 2) Sensitivity 1 Transmission Constraints

- Transmission Constraints for each pipe would be set to reflect the usage over each pipe in Sensitivity 1 [see Decision Point 3 below]
  - Soft Constraints would be removed so that transmission cannot be expanded in the remaining sensitivities
- 3) Sensitivity 2 Transmission Constraints
  - Transmission Constraints for each pipe would be set to reflect the usage over each pipe in Sensitivity 1 [see Decision Point 3 below]
  - Soft Constraints would be removed so that transmission cannot be expanded in the remaining sensitivities
- Note: EIPC has indicated they will not be able to provide transmission cost estimates for the increased transfer limit before the SSC needs to decide whether to use the Baseline Infrastructure Transmission Constraint, Sensitivity 1 Transmission Constraint, or Sensitivity 2 Transmission Constraint approach for the remaining sensitivities.

### **3. Determination of Fixed transfer limits derived from Soft-Constraint Approach**

- Option 1 – Transfer limits would be set to the maximum value of the flows over each pipe in the relevant Sensitivity.
- Option 2 – Transfer limits would be set to a level of average usage over each pipe in the relevant Sensitivity based on a specific methodology to be determined.

#### **Holes:**

- Reserve Margins, Hurdle Rates and Wheeling Charges
  - The PAs are currently reviewing the CRA-provided reserve margins, hurdle rates, and wheeling charges, and which need to reflect the new NEEM regions. The MWG has not yet received the PA-reviewed data for its review. These values will be updated in Table 15 (Reserve Margins) and Exhibit 18 (Wheeling Charges and Hurdle Rates).
  - Sensitivity 1 envisions that the SSC may decide to apply the results of Sensitivity #1 to the other BAU sensitivities. Once the results of Sensitivity #1 are reviewed, and the SSC decides on any application to the remaining Sensitivities, additional modeling assumptions will need to be reviewed (eg specific fixed transfer limits).
  - Sensitivity 2 as currently proposed envisions that interregional barriers, such as hurdle rates and wheeling charges, be reduced. Once Sensitivity 2 is approved by the SSC then we will need to adjust the modeling inputs accordingly.

- Transmission from Hydro Quebec and the Maritime Provinces
  - Energy transfers using fixed values for each load block for each of HQ-NY, HQ-NE, NB-NE, and HQ-OH (Table 25)
  - 'pseudo-generator units' modeled which reflect proxies for capacity cost, energy dispatch price, and transmission costs (Exhibits 4, 9, 11 and 12)

## 2. Environmental Policies Subteam

The Environmental Policy subteam is focusing on the data inputs reflecting the environmental policies to be modeled, including state RPS programs, EPA regulations, RGGI and renewable resource incentives.

### Consensus Items:

- The sub-team has reached consensus on RGGI modeling (see Table 22 – RGGI Modeling);
- The sub-team has reached consensus on modeling EPA regulations (Table 27 – EPA Regulations). Regarding Sensitivity #9 (No new non-CO2 EPA Regulations), the sub-team reached consensus regarding stipulations for modeling the Transport Rule, Utility MACT Rule, Cooling Water Intake Rule and the Coal Combustion Residuals Rule not to be put into place.

### Decision Points:

- Policy Sunsets:
  - The Federal Production Tax Credit provides a production incentive (~\$22/MWh) to wind and other forms of renewable energy for a period of 10 years that are placed into service before 2013. The Federal Investment Tax Credit provides a tax credit for 30% of the capital cost of solar energy systems and other forms of renewable energy (excluding large wind) for systems placed into service before 2017. CRA currently does not model either tax credit due to their early sunsets. See Table 29 (ITC/PTC Sunsets).
  - The SSC needs to decide for both the Production Tax Credit (PTC) and the Investment Tax Credit (ITC) whether or not they should be allowed to sunset as currently legislated or whether they should be assumed to be renewed. If the SSC decides to renew the policies, the subteam recommends the policies expire by 2025.

- Voluntary RPS Targets
  - CRA does not model voluntary state RPS goals/objectives. The Sub-team has assembled basic data on these voluntary RPS programs that can be expanded as necessary should the SSC decide to explicitly reflect these programs in the NEEM model (See Table 26020 – Appendix C State RPS State Detail).
  - The SSC needs to decide whether or not to model Voluntary RPSs. Not modeling the Voluntary RPSs will be an acknowledgement of the fundamental differences between mandatory and voluntary RPS. In addition, it would reduce the risk of double-counting renewable resources as some resources used to satisfy voluntary RPS goals are also being used to satisfy mandatory RPS targets. However, some members of the subteam believe that the voluntary RPS goals are creating incentives for renewables development and are on their way to being satisfied. As such they believe the model should recognize this reality.
  - If the SSC chooses to model Voluntary RPS, the sub-team recommends they be modeled at 60% of their full value with an Alternative Compliance Payment set equivalent to the lowest ACP of the mandatory RPS (Table 26).

**Holes:**

- State RPS
  - The Subteam has made preliminary recommendations on how state RPS should be modeled that are currently being reviewed by the relevant states (see Table 20 RPS - Appendix C RPS State Detail). The MWG may recommend further changes once the States review is completed. The preliminary recommendations are reflected in Table 20.

**3. Fuel & Emission Price Subteam**

The Fuel & Emissions Price subteam is focusing on natural gas and oil price prices; the NEEM model calculates the coal price endogenously. The subteam is also focused on CO<sub>2</sub> emission prices; the NEEM model calculates the SO<sub>2</sub> and NO<sub>x</sub> prices endogenously.

**Consensus Items**

- Oil prices:
  - The sub-team recommends using AEO 2011 oil prices.

- SO<sub>2</sub>, NO<sub>x</sub> and CO<sub>2</sub> :
  - The SO<sub>2</sub> and NO<sub>x</sub> prices are calculated endogenously in the NEEM model based on the currently proposed EPA regulations. Since the BAU assumed no Federal CO<sub>2</sub> policy over the planning horizon, the carbon price in MRN should be zero.

### Decision Points

- Gas Prices:
  - The subteam reviewed multiple sources including AEO 2011 and 2010, NYMEX Henry Hub futures (December 23, 2010), RGGI (November 2010), EPA (September 2010), and two proprietary sources. Attached is the graph that compares the price forecast from these various sources. The subteam also reviewed the AEO forecasts over the last ten years (AEO 2002 through AEO 2011) and found that the AEO 2010 forecast falls in the middle of the range. The subteam expressed concern about the volatility of natural gas prices and forecasts over the years. The MWG was unable to come to a consensus on the appropriate gas price approach; two options are presented below for SSC decision.
    - OPTION 1 - The subteam recommends using a composite of the AEO 2010 and AEO 2011 natural gas prices, with AEO 2011 being more representative of short term prices while AEO 2010 is probably more representative of natural gas prices longer term. The subteam proposes a Henry Hub natural gas price forecast that starts with the AEO 2011 forecast in year 2011, ramping up to the AEO 2010 forecast by year 2025 and staying on the AEO 2010 forecast for years after 2025. For the natural gas basis point mapping, the subteam recommends using the CRA NEEM data which is based on historical data.
    - OPTION 2 – Another option discussed at the MWG is to use the AEO 2011 natural gas prices. Using the AEO 2011 gas prices will result in use of the model using a single source for all fuel costs.
    - For the high natural gas price sensitivity, the subteam recommends using the ratio of the AEO 2010 high natural gas price case to the AEO 2010 reference case and apply that ratio to the natural gas price forecast, in either OPTION 1 or OPTION 2.

### Holes:

- The subteam is reviewing the BAU sensitivity #14 regarding fixed fuel price adjusted for forecast inflation.



#### **4. Demand, Energy Efficiency, Demand Response Subteam**

The Demand, EE, DR subteam is focusing on the appropriate load modeling, considering energy efficiency and demand response program modeling. The subteam originally focused on developing baseline forecasts without EE and DR using various sources including CRA, FERC 714, ISO/RTO, AEO 2010/2011, NERC Long Term Assessment. However, some planning area forecasts appear to have EE/DR embedded in their forecasts. Consequently, the subteam requested that the PAs provide baseline forecasts by January 12<sup>th</sup>; however this was not achievable given the PA's request to have the new NEEM region configuration first approved by the SSC. Additional time is required to assure that baseline forecasts do not have EE and DR measures embedded within them to assure there is not material 'double counting' of EE and DR measure in the modeling.

##### **Consensus Items**

- State energy efficiency resource standards (EERS)
  - The sub-team tabulated the states' energy efficiency resource standards (EERS), which were confirmed by the states
- Demand Response Potential (DR)
  - The sub-team drew upon the findings of the June 2009 FERC National Assessment of Demand Response Potential study to estimate the DR level for the BAU future
- Application of EERS and DR to baseline forecasts
  - The sub-team proposes to apply the EERS and DR to the baseline forecast to arrive at the BAU energy demand and peak demand forecasts. Until updated demand forecasts can be provided, the subteam proposes to proceed to use CRA's default values for energy demand and peak demand, which are based on RTO/ISO forecasts and FERC 714 utility filings for the first 10 years and thereafter growing at the implied growth rates in AEO 2011. The sub-team has recently received information from CRA that update the energy demand and peak demand consistent with the newly proposed NEEM regions. The sub-team will be reviewing that information and will remove all known EE and DR embedded in CRA's default values, based on any provided PA review, to establish the baseline forecast without EE or DR.
- The sub-team agrees with CRA's recommendation to use in the BAU the plug-in electric vehicle (PHEV) and battery electric vehicle (BEV) forecast from AEO 2011.

- The sub-team agrees with EISPC's recommendation to add 1%/yr to the BAU forecasted growth rate for the high load sensitivity and to subtract 1%/yr from the BAU forecasted growth rate for the low load sensitivity.

### **Decision Points**

- The SSC will need to decide whether it is acceptable to use the baseline forecasts based on CRA's default values with known embedded EE and DR removed, if sufficient PA information cannot be provided to ensure no material 'double counting' in a time period needed to meet the EIPC project schedule.

### **Holes**

- Subteam proposal for high PHEV sensitivity

## **5. MRN Economic Subteam**

The MRN Economic subteam is focusing on the review of the factors that influence the MRN model including initial tax representation, elasticity assumptions, value shares of inputs, baseline energy prices, and growth rate assumptions. The initial tax representation and elasticity assumptions influence the model the most. The subteam concluded that the CRA approach seems reasonable given limitations of the model. For example, the MRN assumes a balanced Federal budget over the planning horizon by adjusting the tax rate. For the purposes of this project, assessing and proposing adjustments to government spending rather than raising taxes does not seem practical given the project schedule.

There are some items the subteam discussed and would like to highlight, but makes no recommendations. One item is the scaling factor MRN uses for technological progress to reflect autonomous energy efficiency improvements. This factor is an exogenous scaling parameter that decreases energy use per dollar of output overtime. For the BAU case there may be minor double counting of efficiency in states that have aggressive energy efficiency goals in the short term until the sunset date of those policies. For Futures with aggressive energy efficiency this factor may result in more significant double-counting. The MRN will work with the Demand/EE/DR subteam to minimize such double-counting.

Further, the subteam has two concerns regarding the Autonomous Energy Efficiency Improvement (AEEI) scaling factor 1) for Sensitivity 6, Increase High EE/RPS, there could be double counting and 2) AEEI lowers energy consumption which MRN interprets as though the economy is contracting rather than becoming more efficient. This issue may not be able to be resolved, but EISPC/SSC should be aware of the implications to the results which would indicate a lower economic growth than would be expected.

### **Consensus Items**

- Initial Tax Representation, Elasticity Assumptions, Value Shares of Inputs, Baseline Energy Prices, fixed charge rates, and Growth Rate Assumptions.

**Decision Points** – None identified

**Holes** – None identified

## **6. Existing Generation Subteam**

The Existing Generation Subteam is focusing on unit aggregation, their characteristics, operations and maintenance. Additionally, the subteam is focused on renewable characteristics, installed capacity by region, forced new builds and planned retirements, and retrofit costs.

The subteam has requested more information such as the meaning of installed capacity versus reserve capacity and sources of wind data. Additionally, the subteam members with a Ventyx license have reviewed the detailed data and unit aggregation process on a sample basis. The Subteam continues to review its respective tables based on the revised NEEM regions, as provided by CRA on 1-25, and awaits some information yet to be supplied. Additionally, EPA will be providing retrofit costs for the subteam's review. The subteam has prepared recommendations on the setup of the sensitivity cases for the BAU case.

### **Consensus Items**

- The subteam reached consensus on the CRA default data on Exhibits 4, 6, 8, 14 and Tables 4, 6, pending satisfactory followup information and action by CRA in each instance. Note for Table 4 that CRA is to develop a typical \$/MWh adder to coal VOM to represent \$15/ton coal ash, which it is believe might be roughly on the order of \$0.63/MWh. Unit specific data is derived from Ventyx's Energy Velocity data base and is acceptable as a data source.
- The subteam reached consensus on the following for BAU SENSITIVITIES 1-9
  - 1, 2, 3, 4, 6, 7 - No changes from the base case for Existing Generation.
  - 5 – High Gas Cost – Natural gas fuel prices (and any interrelated fuels) for existing generation increase similarly as to such prices for new generation and as specified by Fuels/Emissions Subteam input.
  - 8 – Increased Generation Costs – The capital portion of retrofit costs in Tables 8-11 increase similarly as to the capital portion of new generation costs and as specified by the New Generation Subteam input.
  - 9 – No new non-CO2 EPA regulations – CRA to revise and document retirement/retrofit logic as appropriate, including removal of compliance requirements specified by the Environmental Policies group for the new proposed rules (Transport, Utility MACT, Section 316(b)/Cooling Water Intake

Structures, and Coal Combustion Residuals, including the coal ash cost adder to VOM). In their place, CRA should then include compliance logic for CAIR as it is a finalized EPA Rule that remains in effect until replaced by the court-ordered "Transport Rule"; but the CAMR rule would not be included as it has been removed by the courts.

**Decision Points** – None identified at this point.

### **Holes**

- The subteam is waiting for review and possible alternative data from Joe Bryson-EPA and CRA on Exhibit 7, 13, and Tables 8, 9, 10, 11. Note on Tables 8-11, that Existing Generation agrees that CRA incorporate the Environmental Policies specifications on EPA Regulations relating to SCR Retrofits (Existing Reg) and the four proposed Rules of Transport, Utility MACT, Section 316(b)/Cooling Water Intake Structures, and Coal Combustion Residuals. Further that the NEEM model use the costs in Tables 8-11 (and other data as necessary) to make individual unit decisions on retrofit vs. retirement. The waiting is primarily for EPA review and comment on the cost values in Tables 8-11 and the associated data sources listed in Exhibit 13. In addition, one set of data needed for this environmental modeling yet to be developed is the identification of which units have once through cooling and intake structures that will be affected by 316(b)/cooling water intake structure rule. Also, CRA needs to produce Exhibit 7 yet based on Baseline Infrastructure.

### **7. New Generation Subteam**

The New Generation subteam is focusing on new build capital costs, operating costs, characteristics, learning parameters, regional cost multipliers, real fixed charge rates, new resource limits, wind resource limits and capacity factors, variable generation penetration limits, and capacity value of variable generation.

### **Consensus Items**

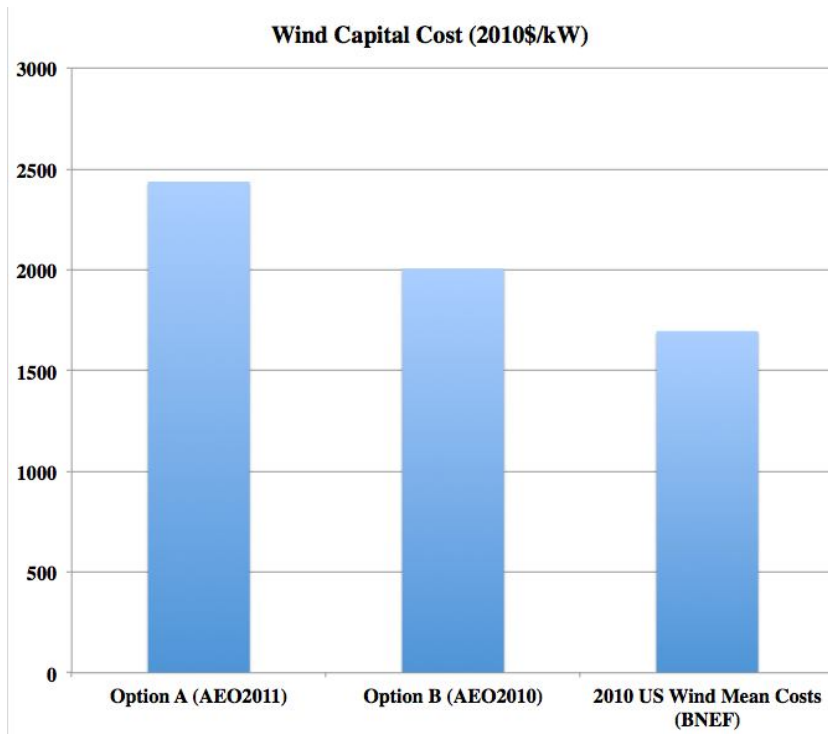
- Consensus has been reached on Wind Shapes (Exhibit 4) and Regional Cost Multipliers (Exhibit 10), subject to further review by the sub-team pending submittal of revised MRN-NEEM assumption document by CRA with modified NEEM region definitions. To the extent that data is available for relevant regions, the Sub-Team has reached consensus on the capacity value of variable generation (Table 5). Finally, for BAU sensitivity #8 (Increased Generation Cost), the Sub-Team has agreed to apply a uniform 25% increase to all 2011 base overnight capital costs in Exhibit 9/Table 7. No other BAU sensitivities are relevant to the inputs prepared by this Sub-Team.

**Decision Points** – The Sub-Team has not reached consensus on two central issues.

**1) Wind Capital Costs.** On the issue of new build costs and characteristics (Table 7 and Exhibit 9), the Sub-Team has agreed to use default learning assumptions from the Energy Information Administration (EIA) Annual Energy Outlook 2010 (AEO2010), default capital O&M costs from AEO2011. However, the Sub-Team has failed to reach consensus on the capital cost assumptions for wind in the BAU. The sub-team offers these two options below for the SSC to consider:

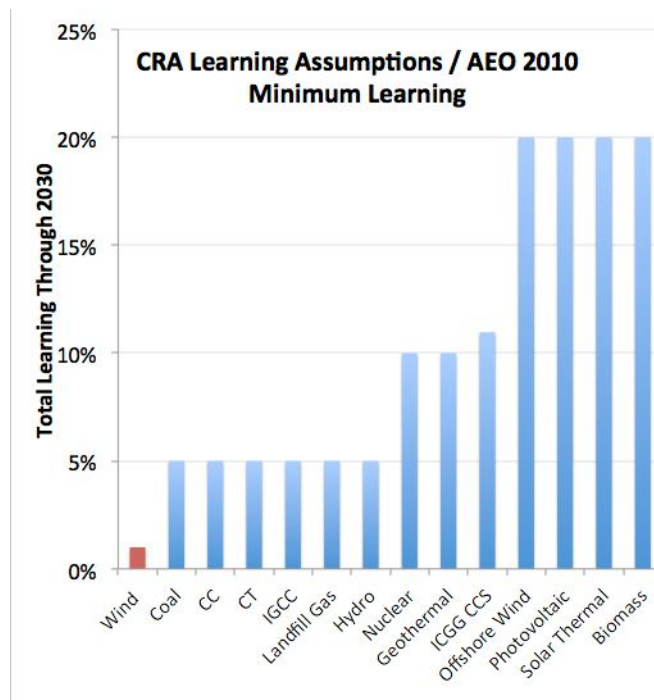
**Option A: Keep all costs and learning assumptions as listed by CRA: Wind Capital Cost \$2438/kW (AEO2011) and 1% learning through 2030 (AEO2010).** Several members of the New Generation Sub-Team prefer to use a single source for generating technologies capital costs, such as AEO 2011, rather than adjusting costs for specific generation type since a thorough and comparable review cannot be conducted for each technology given the time schedule.

**Option B: Use EIA AEO2010 installed capital cost for onshore wind (\$2007/kW) with 10% learning. This provides a good middle ground between matching near term declines and relying on AEO2011 wind capital costs that don't match near- and long-term market trends. Use of AEO2010 is consistent with other base assumptions in Exhibit 9.**



- Reported 2010 wind transactions are 14-17% below 2009 levels with further reductions expected in 2011.

- AEO 2011 Wind Capital Cost of \$2438/kW is the highest wind capital cost in the surveyed literature and 15% above the average cost published in the past two years.
- AEO2011 places cost reductions from technological learning for wind at 1%, well below those for more mature technologies like Coal, Hydro, and Natural Gas.
- A 10% learning rate places wind in the middle of the range between mature and emerging technologies. This is consistent with long term cost trends for wind found in the literature.<sup>3</sup>
- Since there is no BAU sensitivity for lower generation cost (only increased cost) there will be limited ability to adjust for high BAU wind costs in the sensitivities to this future.



<sup>3</sup> Median long term learning rates for wind ~10% per doubling of cumulative capacity, see Kahouli-Bahmi, S. 2008 Technological learning in energy–environment–economy modelling: A survey. Energy Policy 36, 138-162; Junginger, M., Faaij, A., Turkenburg, W., 2005. Global experience curves for wind farms. Energy Policy 33, 133–150.; Neij, L., 1999. Cost dynamics of wind power. Energy 24, 375–389.

## **2) Wind and Solar Generation Limits (Table 14) (fraction of annual MWh by CRA Intermittency Region)**

The amount of generation from wind and solar is limited in NEEM to a fixed fraction of annual generation (MWh). These limits are imposed on the basis of CRA Intermittency Region. The sub-team offers these two options below for the SSC to consider

### **Option A: Increase penetration limits (fraction of annual MWh by CRA Intermittency Region) to >40% or remove constraints altogether**

#### **Rationale:**

- Some areas already have more than 20% wind penetration (e.g. Iowa)
- Integration Studies (EWITS, NEWIS, NYISO) show 20%-30% is feasible and not an upper bound (note, these studies have not been designed to find an upper bound)
- Current trends that will facilitate integration of renewables (e.g. adoption of dynamic scheduling, balancing authority consolidation, direct load control) should be reflected in choice of renewable penetration limits. Choices for a 2030 model should not be limited to constraints imposed by current market structures and existing system topology.
- The model will already place significant constraints on import/export of wind by means of interregional transfer limits between NEEM regions and the limited ability to iteratively optimize those limits. Additional constraints are unnecessary.
- Penetration limits should reflect an upper bound of future structural constraints imposed by the system topology, not anticipated levels of wind/solar deployment in BAU or other futures

### **Option B: Increase BAU penetration limits (fraction of annual MWh by CRA Intermittency Region) to 25% across all regions**

#### **Rationale:**

- The higher penetration levels in some studies (e.g. EWITS: >40% MISO, ISO-NE, >100% SPP) require significant amounts of new transmission
- If wind, solar is driven by RPS values primarily, penetration levels are unlikely to exceed 20% in most regions.
- Some operational issues not well reflected in all integration studies (over-speed cutouts etc.)
- Lack of geographic diversity could further constrain the ability to reach high penetration levels

- Communications with PA's indicate that 25% is the penetration level with which they are comfortable

**Holes** – The Sub-Team is waiting for further guidance from CRA and NREL to inform their recommendation on wind resource limits (Exhibit 11 and Exhibit 12). NREL has provided an updated set of wind resource numbers currently used in NREL's ReEDS model. The Sub-Team is evaluating various methodologies to accurately capture wind resource potential down to class 3. If it is possible to specify two tiers of wind resources, Class 4+ and Class 3 wind resource could be modeled as separate technologies with appropriately adjusted wind shapes and mean capacity factors.

In addition, disaggregation of NEEM regions in MISO will require additional inputs from NREL to split the relevant regions as needed.

Additional inputs from CRA on forced builds (Exhibit 7) will also be needed to evaluate the inputs in Exhibit 12 that specify the capacity addition limits for all generation technologies.

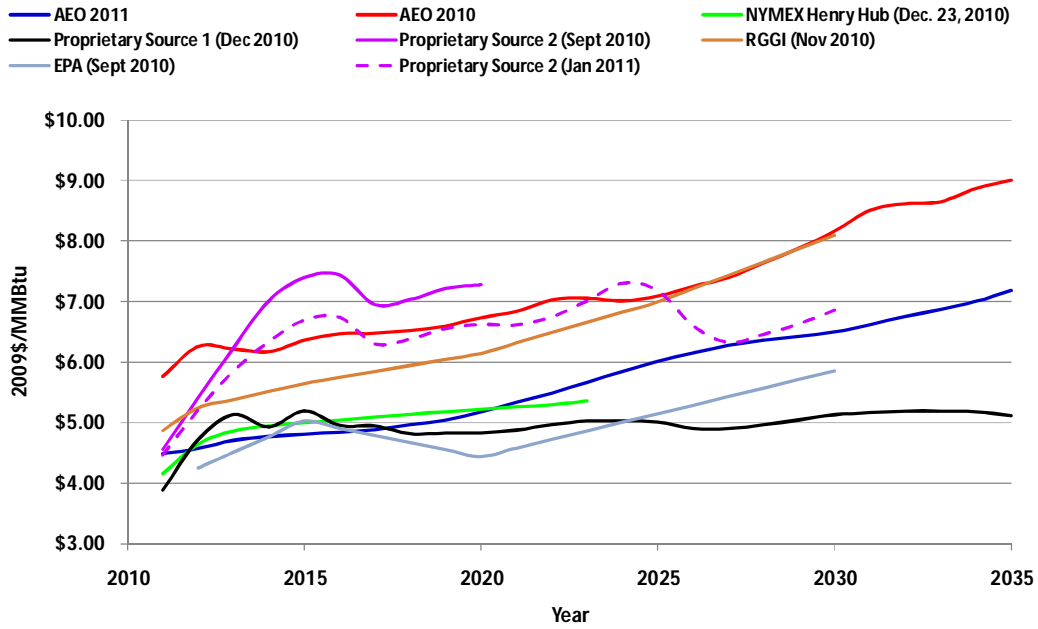
Planning authority guidance on "Intermittent Resource Contributions" (Table 5) is needed in NEISO and MAPP\_CA. If none is given, a default value of 15% will be assigned.

## **8. Canadian Modeling Subteam**

The Canadian economy is not explicitly modeled in MRN, and HQ and the Canadian Maritimes are not included as NEEM regions. The Canadian subteam has provided hydro potential in Ontario and the assumed capital costs for hydro, hourly forecast for off-shore wind farms in Ontario. The Canadian subteam is in the process of collecting additional information among other provinces. The Canadian modeling inputs are being included into the other subteam data inputs (eg new generation data, treatment of transmission and energy interchange).



### Fuel and Emission Prices Subteam Review of Natural Gas (Henry Hub) Price Forecasts



### Fuel and Emission Prices Subteam Review of Past AEO Forecasts of Electricity Sector Natural Gas Prices

