

# MWG Recommendations

SSC Meeting  
March 28 & 29, 2011

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## Overview

- Recommendations are grouped into the following categories for each Future:
  - **Consensus Recommendations on Key Base Case Assumptions**
  - **Transfer Limits Sensitivities**
  - **Consensus Recommendations on Remaining Sensitivities**
  - **Recommended Options for Non-Consensus Items**
- Some Futures include “Previously Approved Assumptions” as noted
- Some assumptions apply to multiple Futures
  - Most of cross-cutting issues are noted within each of the relevant Futures

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## Selected Model Inputs Previously Approved by SSC

- Load Growth High/Low +/- 1%/year
  - High: F1S3, F2S3, F3S3, F4S2, F5S3, F6S2, F7S3
  - Low: F1S4, F2S4, F5S4, F6S3, F7S2
- Natural Gas Price
  - High Composite AEO 2010/2011
    - F1S5, F2S5, F3S3, F4S3, F5S5, F6S5
  - Low \$4.50/MMBtu (2010\$) for all years
    - F2S6, F3S4, F4S8, F5S6, F6S6
- Capital Costs Adjustments Increments +/- 20%
  - Increase: F5S8, F6S7, F7S6
  - Decrease: F1S8, F1S8, F5S7, F6S6, F7B

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## Generation Capital Cost Transmission Adder

- No additional information on the level of interconnection costs included in AEO generation capacity costs
- **Recommendation:** Apply \$21.92/kW transmission adder to all generation capacity costs

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## Future 1: BAU

### Consensus Recommendations on Remaining Sensitivities

- **Sensitivity 9: Environmental Regulatory Curtailment (ERC) 1**
  - Delay new EPA regulations by 20 years
- **Sensitivity 10: ERC 2 - Reduced RPS and EE/DR Requirements**
  - State RPS reduced by 5 % from target end date
  - For states with a solar carve-out, the solar carve out will reduced 1 percentage point or reduced to 0 if solar carve out is less than 1%. Rest of RPS will be reduced the remaining amount so that the overall reduction is 5%
  - EE requirements reduced by 5% from 2030 target end date
  - DR requirements reduced by 5% from 2030 target end date
- **Sensitivity 11: ERC 3 - Less Aggressive EPA Regulations**
  - Delay new EPA regulations by 5 years.
- **Sensitivity 12: ERC 4 - Even Less Aggressive EPA Regulations**
  - Delay new EPA regulations by 10 years.

*See page 2 of MWG Recommendations Memo for complete list of sensitivities. S1-S8 previously approved.*

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## Future 1: BAU

### Consensus Recommendations on Remaining Sensitivities (cont'd)

- **Sensitivity 13: Free Market (FM) 1 - No Policies/Regulations Past Expiration/Sunset Date and RPS Requirements Removed**
  - PTC not modeled (sunsets in 2013); ITC modeled at 10% only for solar (30% tax credit for solar and other technologies sunsets in 2016; 10% credit for solar does not sunset)
  - RPS requirements removed
- **Sensitivity 14: FM 2 - FM1 and All Fuel Subsidies Removed**
  - FM 1 specifications; and gas price of \$4.00/MMBtu (2010\$) for all years
- **Sensitivity 15: FM 3 - FM1 and High Load Growth**
  - FM 1 specifications; and 1% per year increase over reference case load forecast

*See page 2 of MWG Recommendations Memo for complete list of sensitivities. S1-S8 previously approved.*

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## **Future 1: BAU**

Recommended Options for Non-Consensus Item

### **Transfer limits for remaining BAU sensitivities (S3-S15)**

- **Option A** – Base Case transfer capability
- **Option B** – Revised transfer capability with overload charges 75% of average shadow price
- **Option C** – Where applicable, revised transfer capability with overload charges of 25% of average shadow prices

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## **Future 2: Federal Carbon Constraint, Nat'l Imp.**

Base Case Assumptions previously approved

- Full Compliance with the Clean Air Act and Clean Water Act
- 42% CO<sub>2</sub> reduction from 2005 levels by 2030 economy-wide
- 80% CO<sub>2</sub> reduction from 2005 levels by 2050 economy-wide

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## Future 2: Federal Carbon Constraint, Nat'l Imp.

### Consensus Recommendations for Key Base Case Assumptions

- **Carbon Constraint**
  - Carbon Tax
  - Initial Level \$30 in 2015 and increase \$7/year
  - CRA Use Sensitivities 7 & 8 to adjust price to achieve goal
  - Carbon Tax adjustment run iteratively with transmission sensitivities
  - Carbon tax recycled to the economy
  - **Nuclear**
  - Eliminate Capacity Constraints except NYISO Zones J-K
  - BAU Capital Costs
- **CCS Capacity Addition Limits**
  - Increase Capacity additions limits by 50%
  - No CCS for combined Cycle

*See page 4 in MWG Recommendations Memo*

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## Future 2: Federal Carbon Constraint, Nat'l Imp.

### Consensus Recommendations for Remaining Sensitivities

- **Sensitivity 7: Increased Carbon Tax**

Sensitivity to be used by CRA iteratively to determine appropriate Carbon Tax level to reach 42% reduction in Carbon emissions by 2030
- **Sensitivity 8: Decreased Carbon Tax**

Sensitivity to be used by CRA iteratively to determine appropriate Carbon Tax level to reach 42% reduction in Carbon emissions by 2030

*See page 5 of MWG Recommendations Memo for complete list of sensitivities. S1-S6 discussed elsewhere and/or previously approved.*

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## Future 2: Federal Carbon Constraint, Nat'l Imp. Transfer Limits Sensitivities

- **F2S1: Revised transfer capability**
- **F2S2: Revised transfer capability**
  - Must select desired % of weighted average shadow price

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## Future 2: Federal Carbon Constraint, Nat'l Imp. Recommended Options for Non-consensus Item

### Modeling of DC Lines

- **Option A:** No explicit modeling of DC lines in Phase 1 of the EIPC process. During Phase 2, DC lines could be selected in deciding the appropriate transmission overlay
  - Modeling DC lines will be difficult and will involve substantial judgment calls
  - Appropriate arena for deciding transmission technology is in Phase 2 of the process
- **Option B:** In Futures 2, 5 and 8 the model would have a limited option of selecting DC lines based on the pseudo-generator methodology used for modeling Hydro Quebec transfers
  - Modeling DC lines only in Phase 2 would hamper the selection of the most economic generation
    - Utilizing DC lines would allow intermittent generators to avoid intermittent generation limits that would not be operationally constraining given DC lines
  - Judgment calls on placement of DC lines could be minimized by basing placement on previous studies (e.g. EWITS)

*See page 19 in MWG Recommendations Memo*

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## Future 2: Federal Carbon Constraint, Nat'l Imp.

### Recommended Options for Non-consensus Item

#### Hydro Potential in Lower 48 States *(applies to Futures 2-8)*

- **Option A** - Use Preliminary Hydro Assessment Potential 10,400 MW in all futures
- **Option B** – Use preliminary hydro potential as one sensitivity in Futures 3 and 6 (depends on availability)
- **Option C** – Do not include hydro potential at all

*See page 18 in MWG Recommendations memo*

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## Future 2: Federal Carbon Constraint, Nat'l Imp.

### Recommended Options for Non-consensus Item

#### Variable Resource Penetration Limits, Intermittency Regions and Reserve Margin Contributions / Capacity Values *(applies to Futures 2, 3, 5, 6, 8)*

- **Option A: Uniform Approach for 2/3/5/6/8**
  - For Futures, use the same assumptions
  - Relative to BAU: only change intermittency regions
    - Use 6-region intermittency regions (same as super regions developed for regional futures)
  - Keep BAU values for penetration limits and reserve margin contributions
  - Justification:
    - 25% Penetration limit is already aggressive – further increase not needed.
    - Changes in transmission sensitivity implementation will lead to important differences between the regional and national futures - additional differentiation is not needed.

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## Future 2: Federal Carbon Constraint, Nat'l Imp. Recommended Options for Non-consensus Item (cont'd)

**Variable Resource Penetration Limits, Intermittency Regions and Reserve Margin Contributions / Capacity Values** *(applies to Futures 2, 3, 5, 6, 8)*

- **Option A: Uniform Approach**
  - For Futures, use the same assumptions
  - Relative to BAU: only change intermittency regions
    - Use 6-region intermittency regions (same as super regions developed for regional futures)
  - Keep BAU values for penetration limits and reserve margin contributions
- **Option B: Differentiated Approach**
  - Use increased wind/solar penetration limit (50%) for both national and regional implementation futures to reflect transmission expansion
  - Apply limits over larger intermittency regions (4 region framework consolidating SPP/South and PJM/MAPP/MISO)
  - Adjust reserve margin contribution (capacity value)

*See pages 21-23 of MWG Recommendations Memo for more details on this issue*

## Options A/B

### Summary of Consensus and Non Consensus Options

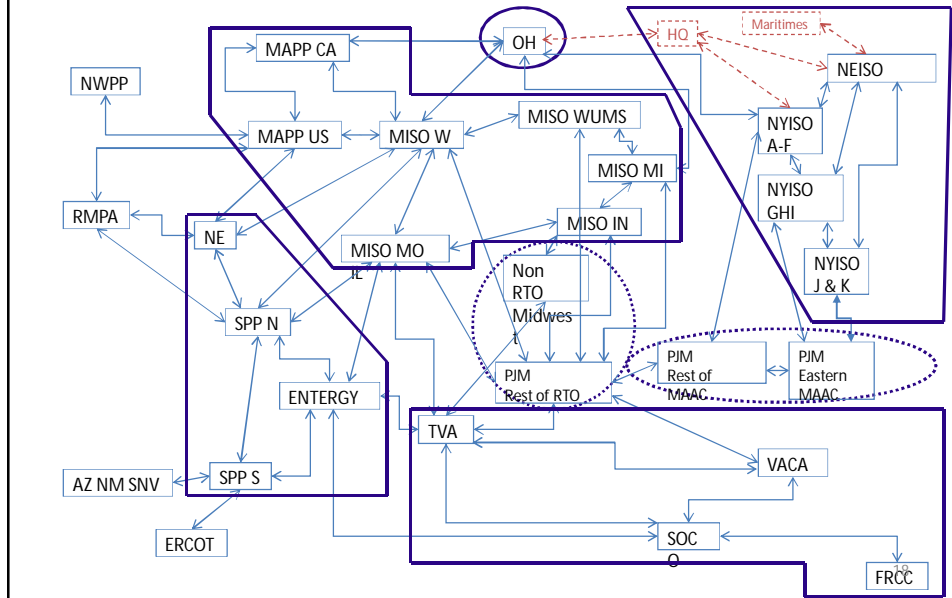
Future	Model Input	Option A	Option B
Futures 1/4/7	All Inputs	BAU values	
Regional Implementation Futures 3/6	Intermittency Regions	6 Region Framework (same as super regions)	
	Wind/Solar Contribution to Reserve Margin	BAU (Current Planning Practice)	
	Wind/Solar Penetration Limits (MWh)	BAU (25%)	50%
National Implementation Futures 2/5/8	Intermittency Regions	6 Region Framework (same as super regions)	4 Region Framework
	Wind/Solar Contribution to Reserve Margin	BAU (Current Planning Practice)	Adjusted to reflect inter-regional tx expansion
	Wind/Solar Penetration Limits (MWh)	BAU (25%)	50%

### Future 3: Federal Carbon Constraint: State/Reg'l Imp. Consensus Recommendations on Base Case

- Same as Future 2 except "Super-Regions" will be delineated to encourage selection of local resources first (see map on following slide)
- All Carbon Constraint assumptions the same as Future 2
- Heat Rate assumptions improved by 1.5 times the incremental HR improvement between 2010 and 2015

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### Future 3: Federal Carbon Constraint: State/Reg'l Imp. Consensus Recommendations on Super-Regions



### Future 3: Federal Carbon Constraint: State/Reg'l Imp. Transfer Limits Sensitivity

- **F3S1: Revised transfer capability**
  - Must select desired % of weighted average shadow price

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### Future 3: Federal Carbon Constraint: State/Reg'l Imp. Consensus Recommendations on Remaining Sensitivities

- **Sensitivity 5: Increased Carbon Tax** - Sensitivity to be used by CRA iteratively to determine appropriate Carbon Tax level to reach 42% reduction in Carbon emissions by 2030
- **Sensitivity 6: Decreased Carbon Tax** - Sensitivity to be used by CRA iteratively to determine appropriate Carbon Tax level to reach 42% reduction in Carbon emissions by 2030
- **Sensitivity 7: Limited New/Upgraded Nuclear** –20% increase in nuclear capital cost.
- **Sensitivity 8: Increased Imported Canadian Hydro**
  - HQ/Maritimes Hydro
    - Capacity factors for existing flows will be increased to 95%
      - Capacity factors for hydro pseudo-generators will be set at 75% (18 hours at full capacity, 6 hours at zero capacity).
    - Ontario and Manitoba Hydro
      - Capacity factors for existing and new hydro will be set at 75% (18 hours at full capacity, 6 hours at zero capacity).

*See page 7-8 of MWG Recommendations Memo for complete list of sensitivities. S1-S6 discussed elsewhere and/or previously approved.*

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**Future 3: Federal Carbon Constraint: State/Reg'l Imp.**  
Recommended Options on Non-Consensus Item

**Carbon Tax Revenue Recycling**

- **Option A:** Revenues recycled only to regional economy
  - Increases comparability between Future 2 and 3
  - Regions would have to “pick winners”
- **Option B:** Revenues partially recycled to support regionally preferred clean technology
  - Closer to likely policies
  - Explicitly called for in high-level future description

*See page 19 of MWG Recommendations Memo*

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**Future 3: Federal Carbon Constraint: State/Reg'l Imp.**  
Recommended Options on Non-Consensus Item

**Friction Charges** (*applies to Future 6*)

- **Option A:** Eliminate friction charges within a super-region as a base assumption of Futures 3 and 6
  - Decreased friction charges within a super-region would represent increased regional market integration that would be plausible given a regionally-focused future
- **Option B:** Friction Charges remain at BAU levels
  - Changing friction charges would reduce comparability between futures
  - Changing friction charges might not have a significant impact on the model
  - Complete elimination of friction charges represents an unrealistic level of regional market integration

*See page 19 in MWG Recommendations Memo*

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**Future 3: Federal Carbon Constraint, State/Reg'l Imp.  
Recommended Options for Non-consensus Item**

**Variable Resource Penetration Limits, Intermittency Regions and Reserve Margin Contributions / Capacity Values** *(applies to Futures 2, 3, 5, 6, 8)*

- **Option A: Uniform Approach for 2/3/5/6/8**
  - For Futures, use the same assumptions
  - Relative to BAU: only change intermittency regions
    - Use 6-region intermittency regions (same as super regions developed for regional futures)
  - Keep BAU values for penetration limits and reserve margin contributions
- **Option B: Differentiated Approach**
  - Use increased wind/solar penetration limit (50%) for both national and regional implementation futures to reflect transmission expansion
  - Apply limits over larger intermittency regions (4 region framework consolidating SPP/South and PJM/MAPP/MISO)
  - Adjust reserve margin contribution (capacity value)

*See pages 21-23 of MWG Recommendations Memo for more details on this issue*

**Options A/B**

**Summary of Consensus and Non Consensus Options**

Future	Model Input	Option A	Option B
Futures 1/4/7	All Inputs	BAU values	
Regional Implementation Futures 3/6	Intermittency Regions	6 Region Framework (same as super regions)	
	Wind/Solar Contribution to Reserve Margin	BAU (Current Planning Practice)	
	Wind/Solar Penetration Limits (MWh)	BAU (25%)	50%
National Implementation Futures 2/5/8	Intermittency Regions	6 Region Framework (same as super regions)	4 Region Framework
	Wind/Solar Contribution to Reserve Margin	BAU (Current Planning Practice)	Adjusted to reflect inter-regional tx expansion
	Wind/Solar Penetration Limits (MWh)	BAU (25%)	50%

**Future 3: Federal Carbon Constraint, State/Reg'l Imp.**  
 Recommended Options for Non-consensus Item

**Hydro Potential in Lower 48 States** (*applies to Futures 2-8*)

- **Option A** - Use Preliminary Hydro Assessment Potential 10,400 MW in all futures
- **Option B** – Use preliminary hydro potential as one sensitivity in Futures 3 and 6 (depends on availability)
- **Option C** – Do not include hydro potential at all

*See page 18 in MWG Recommendations memo*

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**Future 4: Aggressive EE/DR/DG/SG**  
 Previously approved assumptions for Base Case

- Peak and energy reduced 1%/yr
- Demand Response full level of participation defined in the FERC 2009 study.
  - First 7% DR modeled as pseudo generator with no energy
  - DR in excess of 7% modeled as reduction off the top two load blocks
- Dynamic pricing and full participation of advanced metering (Smart Grid)

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## Future 4: Aggressive EE/DR/DG/SG Consensus Recommendations for Base Case

- Economic Adjustments
  - Use BAU GDP and other macroeconomic assumptions to circumvent the MRN-NEEM load/GDP adjustments
- Increase non-renewable generation costs by 5% to limit centralized generation
- Variable resource penetration
  - Use BAU Values for all inputs (*also applies to Future 7*)
    - Wind/Solar Penetration Limits: 25%
    - Intermittency Regions: 14 regions
    - Wind/Solar Contributions to Reserve Margins (capacity value): Reflecting current planning practice
  - Justification: No significant transmission expansion relative to BAU is expected
    - See pages 21-23 of MWG Recommendations Memo, particularly pertaining to other Futures

*See page 9 of MWG Recommendations Memo*

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## Future 4: Aggressive EE/DR/DG/SG Consensus Recommendations for Remaining Sensitivities

- **Sensitivity 4: Lower EE Performance**
  - REMOVE/REPLACE. This will be evaluated off line, through post processing of mid-range EE/DR/smart grid/storage/DG costs. This sensitivity is freed up for use as one of the Clean Energy Standard sensitivities.
- **Sensitivity 5: Higher PHEV Levels**
  - 3x, 6x, 9x, 10x BAU base case for years 2015, 2020, 2025 and 2030 (See Decision Points)
  - Assumes smart charging: 14% of charging during peak hours
- **Sensitivity 6: Higher PHEV Peak**
  - 3x, 6x, 9x, 10x BAU base case for years 2015, 2020, 2025 and 2030 (See Decision Points)
  - Assumes 37% of charging during peak hours
- **Sensitivity 7: Increased Economy Activity**
  - REMOVE/REPLACE. The demand sub-team agrees this sensitivity is not needed since the GDP from the BAU is being used for the base case and NEEM/MRN is equilibrated only once for each future.
- **Sensitivity 9: Additional 1% mandated energy consumption reductions and comparable increase in DR.**
  - Both peak and energy demand forecasts are 2%/yr less than the BAU reference case.
  - DR is assumed to be at the full participation level in the FERC 2009 study, plus 1%/yr additional DR growth.

*See page 9-10 of MWG Recommendations Memo for complete list of sensitivities. S1-S3 and S8 discussed elsewhere and/or previously approved.*

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## Future 4: Aggressive EE/DR/DG/SG

### Transfer Limits Sensitivity

- **F4S1: Revised transfer capability**
  - Must select desired % of weighted average shadow price

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## Future 4: Aggressive EE/DR/DG/SG

### Recommended options for Non-consensus Item

**Higher EV/PHEV Levels** (*applies to F1S7, F4S5, F4S6, Clean Energy Standard*)

- **Option A**
  - Use multipliers of 3x, 6x, 9x, 10x BAU base case vehicle levels, for years 2015, 2020, 2025 and 2030, respectively, for all High PHEV levels sensitivities, for all Futures
- **Option B**
  - Keep BAU high EV/PHEV sensitivity as is, but use the 3x, 6x, 9x, 10x BAU base case vehicle levels for other High PHEV sensitivities
- **Option C**
  - Only Clean Energy Standard sensitivities use 3x, 6x, 9x, 10x BAU base case vehicle levels

*See page 18 in MWG Recommendations Memo*

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## Future 4: Aggressive EE/DR/DG/SG

Recommended Options for Non-Consensus Item

### Incentives for Offshore Wind

Future 4 high level future description: "Preference for local resources. May include offshore wind"

- **Option A:** No incentive for offshore wind
  - Focus of future is on demand-side resources (EE, DR, DG, etc.)
- **Option B:** Offshore wind capital costs decreased by 20%

*See page 20 of MWG Recommendations Memo*

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## Future 4: Aggressive EE/DR/DG/SG

Recommended Options for Non-Consensus Item

### Hydro Potential in Lower 48 States *(applies to Futures 2-8)*

- **Option A** - Use Preliminary Hydro Assessment Potential 10,400 MW in all futures
- **Option B** – Use preliminary hydro potential as one sensitivity in Futures 3 and 6 (depends on availability)
- **Option C** – Do not include hydro potential at all

*See page 18 in MWG Recommendations memo*

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## Future 5: National RPS, Top-Down Impl.

### Key Base Case Assumptions

- 30% Electricity from Renewable Resources by 2030  
(approved by SSC)
- Beginning in 2010, increase renewable energy targets by 1.5%/year until 2030 (approved by SSC)
  - Existing RPS policies will not be adjusted from their BAU values
- Qualifying resources include existing and new hydro, wind, biomass, solar, and landfill gas (approved by SSC)
- RPS can be met by acquiring RECS, but ACP is not available (Consensus of MWG)
- Production tax credits will be removed (Consensus of MWG)

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## Future 5: National RPS, Top-Down Imp.

### Consensus Recommendations on Remaining Sensitivities

- **Sensitivity 9: Increased deployment of flexible resources (DR, storage)**
  - Purpose of sensitivity was assumed to assess how DR and storage are used to enable further deployment of intermittent resources
  - Model cannot explicitly model DR and storage
  - Alternative is to increase the variable resource penetration limits by 15% in absolute terms relative to the base value in Future 5
- **Sensitivity 10: Modified load block shapes in recognition of increased PHEV levels**
  - It was interpreted that this sensitivity sought to understand the impacts of higher PHEV targets charging during peak hours
  - 3x, 6x, 9x, 10x BAU base case for years 2015, 2020, 2025 and 2030. (See Recommended Options)
  - Assumes 37% of charging during peak hours.

*See page 9-10 of MWG Recommendations Memo for complete list of sensitivities. S1-S8 discussed elsewhere and/or previously approved.*

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## Future 5: National RPS, Top-Down Imp.

### Transfer Limits Sensitivities

- **F5S1: Revised transfer capability**
- **F5S2: Revised transfer capability**
  - Must select desired % of weighted average shadow price

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## Future 5: National RPS, Top-Down Imp.

### Consensus Recommendations on Clean Energy Standard Sensitivities

- **Sensitivity X: Clean Energy Standard**
  - Clean Energy Standard modeling methodology identical to Federal RPS.
  - CES starts at 50% in 2020 and increases 10% every 5 years to 80% by 2035.
  - Qualifying resources include existing and new hydro, wind, biomass, solar, landfill gas and nuclear. Coal with Carbon Capture and Sequestration and Natural Gas partially qualify:
    - Coal with CCS is awarded a credit in proportion to the amount of Carbon Capture.
    - Natural Gas is awarded half a credit.
  - CES must be met by acquiring Clean Energy Credits (CECs). No ACP will be used for RPS compliance.
  - National RPS will not be modeled during this sensitivity but existing state RPS policies will not be adjusted from their BAU values.
- **Additional sensitivities on CES have not been specified**

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## Future 5: National RPS, Top-Down Imp.

### Recommendation on Non-consensus Item

#### Increased Deployment of Flexible Resources (DR, Storage) – F5S9 (also applies to F6S6<sup>c2</sup>)

- Future 5 Sensitivity 9 -- Purpose of sensitivity was assumed to assess how DR and storage are used to enable further deployment of intermittent resources
- Model cannot explicitly model DR and storage
  - Modeling DR as a load modifier does not enable more intermittent resources in the model (i.e., clipping the peak does not create need for intermittent resources)
  - Modeling storage as a load modifier (valley fill / peak shaving) would be difficult given that MRN-NEEM uses a seasonal load duration curve
  - **Option A**
    - Increase the variable resource penetration limits by 15% in absolute terms relative to the base value in Futures 5 and 6
    - However, there is concern with not increasing cost may give misleading results

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## Future 5: National RPS, Top-Down Imp.

### Recommended Options on Non-Consensus Item

#### RPS and Canadian Resources

- **Option A:** Canadian load covered by national RPS and all Canadian qualifying resources can be utilized to meet RPS obligations
  - Canadian resources currently being used to satisfy some state RPS targets
  - 30% RPS target agreement dependent upon Canadian resources being allowed to satisfy RPS
- **Option B:** Canadian regions not covered by RPS and some restrictions placed on the amount of Canadian resources that can be used to meet U.S. RPS targets
  - Interested stakeholders examining BAU results to see if restrictions might be necessary

*See page 20 of MWG Recommendations Memo*

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## Future 5: National RPS, Top-Down Imp.

### Recommended Options on Non-Consensus Item

#### Hydro Potential in Lower 48 States *(applies to Futures 2-8)*

- **Option A** - Use Preliminary Hydro Assessment Potential 10,400 MW in all futures
- **Option B** – Use preliminary hydro potential as one sensitivity in Futures 3 and 6 (depends on availability)
- **Option C** – Do not include hydro potential at all

*See page 18 in MWG Recommendations memo*

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## Future 5: National RPS, Top-Down Imp.

### Recommended Options on Non-Consensus Item

#### Variable Resource Penetration Limits, Intermittency Regions and Reserve Margin Contributions / Capacity Values *(applies to Futures 2, 3, 5, 6, 8)*

- **Option A: Uniform Approach for 2/3/5/6/8**
  - For Futures, use the same assumptions
  - Relative to BAU: only change intermittency regions
    - Use 6-region intermittency regions (same as super regions developed for regional futures)
  - Keep BAU values for penetration limits and reserve margin contributions
- **Option B: Differentiated Approach**
  - Use increased wind/solar penetration limit (50%) for both national and regional implementation futures to reflect transmission expansion
  - Apply limits over larger intermittency regions (4 region framework consolidating SPP/South and PJM/MAPP/MISO)
  - Adjust reserve margin contribution (capacity value)

*See pages 21-23 of MWG Recommendations Memo for more details on this issue*

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### Options A/B

#### Summary of Consensus and Non Consensus Options

Future	Model Input	Option A	Option B
Futures 1/4/7	All Inputs	BAU values	
Regional Implementation Futures 3/6	Intermittency Regions	6 Region Framework (same as super regions)	
	Wind/Solar Contribution to Reserve Margin	BAU (Current Planning Practice)	
	Wind/Solar Penetration Limits (MWh)	BAU (25%)	50%
National Implementation Futures 2/5/8	Intermittency Regions	6 Region Framework (same as super regions)	4 Region Framework
	Wind/Solar Contribution to Reserve Margin	BAU (Current Planning Practice)	Adjusted to reflect inter-regional tx expansion
	Wind/Solar Penetration Limits (MWh)	BAU (25%)	50%

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- ### Future 6: National RPS, State/Reg'l Imp.
- Consensus Recommendations on Base Case Assumptions
- Future the same as Future 5 except
    - Super-Regions will be designated to encourage selection of local resources
      - National RPS limit 30%
    - RPS can be met by producing RECs within super-region or purchasing ACPs
      - ACPs not recycled back into a region's economy
- See page 13 of MWG Recommendations Memo*
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## Future 6: National RPS, State/Reg'l Imp.

### Transfer Limits Sensitivity

- **F6S1: Revised transfer capability**
  - Must select desired % of weighted average shadow price

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## Future 6: National RPS, State/Reg'l Imp.

### Consensus Recommendations on Remaining Sensitivities

- **Sensitivity 8: Increased deployment of flexible resources (DR, storage)**
  - Purpose of sensitivity was assumed to assess how DR and storage are used to enable further deployment of intermittent resources
  - Model cannot explicitly model DR and storage
  - Alternative is to increase the variable resource penetration limits by 15% in absolute terms relative to the base value in Future 6
- **Sensitivity 9: Increased Imported Canadian Hydro**
  - HQ/Maritimes Hydro
    - Capacity factors for existing flows will be increased to 95%.
    - Capacity factors for hydro pseudo-generators will be set at 75% (18 hours at full capacity, 6 hours at zero capacity).
  - Ontario and Manitoba Hydro
    - Capacity factors for existing and new hydro will be set at 75% (18 hours at full capacity, 6 hours at zero capacity).
- **Sensitivity 10: Modified load block shapes in recognition of increased EV/PHEV levels**
  - It was interpreted that this sensitivity sought to understand the impacts of higher PHEV targets charging during peak hours.
  - 3x, 6x, 9x, 10x BAU base case for years 2015, 2020, 2025 and 2030 (See Recommended Options, No. 4).
  - Assumes 37% of charging during peak hours.

*See page 9-10 of MWG Recommendations Memo for complete list of sensitivities. S1-S7 discussed elsewhere and/or previously approved.*

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## Future 6: National RPS, State/Reg'l Imp.

### Recommended Options on Non-consensus Item

#### RPS ACP

- **Option A:** Set ACP for all super-region RPS at \$100/MWh
  - Value represents highest existing state RPS ACP (not including solar carve-outs)
  - ACP is high enough to provide a significant incentive to build renewables while still maintaining some element of cost control
- **Option B:** Set ACP for all super-regions at \$200/MWh
  - Value represents AEO levelized cost for solar PV
  - Value implicitly assumes that regions would meet the target with distributed solar

*See page 20 of MWG Recommendations Memo*

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## Future 6: National RPS, State/Reg'l Imp.

### Recommended Options on Non-consensus Item

#### Hydro Potential in Lower 48 States *(applies to Futures 2-8)*

- **Option A** - Use Preliminary Hydro Assessment Potential 10,400 MW in all futures
- **Option B** – Use preliminary hydro potential as one sensitivity in Futures 3 and 6 (depends on availability)
- **Option C** – Do not include hydro potential at all

*See page 18 in MWG Recommendations memo*

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## Future 6: National RPS, State/Reg'l Imp. Recommended Options on Non-consensus Item

### Friction Charges *(also applies to Future 3)*

- **Option A:** Eliminate friction charges within a super-region as a base assumption of Futures 3 and 6
  - Decreased friction charges within a super-region would represent increased regional market integration that would be plausible given a regionally-focused future
- **Option B:** Friction Charges remain at BAU levels
  - Changing friction charges would reduce comparability between futures
  - Changing friction charges might not have a significant impact on the model
  - Complete elimination of friction charges represents an unrealistic level of regional market integration

*See page 19 in MWG Recommendations Memo*

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## Future 6: National RPS, State/Reg'l Imp. Recommended Options on Non-Consensus Item

### Variable Resource Penetration Limits, Intermittency Regions and Reserve Margin Contributions / Capacity Values *(applies to Futures 2, 3, 5, 6, 8)*

- **Option A: Uniform Approach for 2/3/5/6/8**
  - For Futures, use the same assumptions
  - Relative to BAU: only change intermittency regions
    - Use 6-region intermittency regions (same as super regions developed for regional futures)
  - Keep BAU values for penetration limits and reserve margin contributions
- **Option B: Differentiated Approach**
  - Use increased wind/solar penetration limit (50%) for both national and regional implementation futures to reflect transmission expansion
  - Apply limits over larger intermittency regions (4 region framework consolidating SPP/South and PJM/MAPP/MISO)
  - Adjust reserve margin contribution (capacity value)

*See pages 21-23 of MWG Recommendations Memo for more details on this issue*

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### Options A/B

#### Summary of Consensus and Non Consensus Options

Future	Model Input	Option A	Option B
Futures 1/4/7	All Inputs	BAU values	
Regional Implementation Futures 3/6	Intermittency Regions	6 Region Framework (same as super regions)	
	Wind/Solar Contribution to Reserve Margin	BAU (Current Planning Practice)	
	Wind/Solar Penetration Limits (MWh)	BAU (25%)	50%
National Implementation Futures 2/5/8	Intermittency Regions	6 Region Framework (same as super regions)	4 Region Framework
	Wind/Solar Contribution to Reserve Margin	BAU (Current Planning Practice)	Adjusted to reflect inter-regional tx expansion
	Wind/Solar Penetration Limits (MWh)	BAU (25%)	50%

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- ### Future 7: Nuclear Resurgence
- Consensus Recommendations on Base Case
- 12 nuclear plants with 23,144 MW
  - Existing nuclear units uprated by 8.7% at \$2,600/kW
  - Nuclear capital costs reduced by 20%
  - Remove capacity addition limits everywhere in EI except NYISO J&K
  - Economic builds allowed in 2020
  - Variable resource penetration
    - Use BAU Values for all inputs (*also applies to Future 4*)
    - See pages 21-23 of MWG Recommendations Memo for more details on this issue, particularly pertaining to other Futures
- See page 15 in MWG Recommendations Memo.*
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## Future 7: Nuclear Resurgence

### Transfer Limits Sensitivity

- **F7S1: Revised transfer capability**
  - Must select desired % of weighted average shadow price

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## Future 7: Nuclear Resurgence

### Consensus Recommendations on Remaining Sensitivities

- **Sensitivity 4: Low Coal Prices and Low Gas Prices**
  - Natural gas price at \$4.50/MMBtu (2010\$) for all years; coal prices are endogenously determined in NEEMS. To the extent that coal competes against low natural gas prices, coal prices are also depressed as a result.
- **Sensitivity 5: EPA Carbon Limitation (electric sector only)**
  - A Carbon Tax will be utilized on the electric sector only set equivalent to 50% of the final Carbon Tax levels used in Future 2.
- **Sensitivity 6: High Uranium and Disposal Costs and High Capital Costs**
  - Increase in nuclear capital cost relative to the Future 7 base case. Because the Future 7 base case uses reduced capital costs for nuclear relative to the BAU, the nuclear capital costs used in this sensitivity will be the same as those used in the BAU base. This constitutes a roughly 20% increase in nuclear capital costs relative to other runs in Future 7.
- **Sensitivity 7: Include Only Nuclear Plants with Loan Guarantees**
  - This sensitivity includes only the nuclear units from the BAU currently under construction or with nuclear loan guarantees. Only 2 nuclear plants have loan guarantees with a capacity of 3,404 MW. Consequently, this sensitivity includes a total of 10 plants or 16 units (19,720 MW) less than this future base case and 1 plants or 2 units (2,330 MW) less than the BAU.

*See page 15-16 of MWG Recommendations Memo for complete list of sensitivities. S1-S3 discussed elsewhere and/or previously approved.*

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## Future 7: Nuclear Resurgence

### Recommended Options on Non-consensus Item

#### Hydro Potential in Lower 48 States *(applies to Futures 2-8)*

- **Option A** - Use Preliminary Hydro Assessment Potential 10,400 MW in all futures
- **Option B** – Use preliminary hydro potential as one sensitivity in Futures 3 and 6 (depends on availability)
- **Option C** – Do not include hydro potential at all

*See page 18 in MWG Recommendations memo*

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## Future 8: Combined Federal Climate and Energy Policy

### Consensus Recommendations on Base Case Assumptions

- 50% CO<sub>2</sub> reduction by 2030 and 80% by 2050 from 2005 levels *(previously approved)*
- Carbon Constraint
  - Carbon Tax level from Future 2
  - Carbon tax recycled into the economy
- Beginning in 2010, increase renewable energy targets by 1.5%/year until 2030
  - Existing state RPS policies will not be adjusted from their BAU values

*See page 17 of MWG Recommendations Memo.*

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## **Future 8: Combined Federal Climate and Energy Policy**

### **Consensus Recommendations on Remaining Sensitivities**

- **Sensitivity 3: Increased economic activity with Change in Relationship between GDP and Load Growth**
  - This sensitivity would require MRN-NEEM to re-equilibrated. Therefore, this is a free sensitivity since MRN-NEEM can be run only once for each future.
- **Sensitivity 4: Increase RPS to 40% or Lower Gas Prices**
  - Not perfect substitutes, MWG has no recommendation
  - Option A increase RPS to 40%
  - Option B Lower Gas Price

*See page 17 of MWG Recommendations Memo for complete list of sensitivities. S1-S2 discussed elsewhere and/or previously approved.*

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## **Future 8: Combined Federal Climate and Energy Policy**

### **Transfer Limits Sensitivities**

- **F8S1: Revised transfer capability**
- **F8S2: Revised transfer capability**
  - Must select desired % of weighted average shadow price

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## Future 8: Combined Federal Climate and Energy Policy Recommended Options on Non-Consensus Item

### Hydro Potential in Lower 48 States *(applies to Futures 2-8)*

- **Option A** - Use Preliminary Hydro Assessment Potential 10,400 MW in all futures
- **Option B** – Use preliminary hydro potential as one sensitivity in Futures 3 and 6 (depends on availability)
- **Option C** – Do not include hydro potential at all

*See page 18 in MWG Recommendations memo*

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## Future 8: Combined Federal Climate and Energy Policy Recommended Options on Non-Consensus Item

### Variable Resource Penetration Limits, Intermittency Regions and Reserve Margin Contributions / Capacity Values *(applies to Futures 2, 3, 5, 6, 8)*

- **Option A: Uniform Approach for 2/3/5/6/8**
  - For Futures, use the same assumptions
  - Relative to BAU: only change intermittency regions
    - Use 6-region intermittency regions (same as super regions developed for regional futures)
  - Keep BAU values for penetration limits and reserve margin contributions
- **Option B: Differentiated Approach**
  - Use increased wind/solar penetration limit (50%) for both national and regional implementation futures to reflect transmission expansion
  - Apply limits over larger intermittency regions (4 region framework consolidating SPP/South and PJM/MAPP/MISO)
  - Adjust reserve margin contribution (capacity value)

*See pages 21-23 of MWG Recommendations Memo for more details on this issue*

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### Options A/B

#### Summary of Consensus and Non Consensus Options

Future	Model Input	Option A	Option B
Futures 1/4/7	All Inputs	BAU values	
Regional Implementation Futures 3/6	Intermittency Regions	6 Region Framework (same as super regions)	
	Wind/Solar Contribution to Reserve Margin	BAU (Current Planning Practice)	
	Wind/Solar Penetration Limits (MWh)	BAU (25%)	50%
National Implementation Futures 2/5/8	Intermittency Regions	6 Region Framework (same as super regions)	4 Region Framework
	Wind/Solar Contribution to Reserve Margin	BAU (Current Planning Practice)	Adjusted to reflect inter-regional tx expansion
	Wind/Solar Penetration Limits (MWh)	BAU (25%)	50%

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**VARIABLE RESOURCE PENETRATION LIMITS, INTERMITTENCY REGIONS AND RESERVE MARGIN CONTRIBUTIONS / CAPACITY VALUES**

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### Options A/B

#### Summary of Consensus and Non Consensus Options

Future	Model Input	Option A	Option B
Futures 1/4/7	All Inputs	BAU values	
Regional Implementation Futures 3/6	Intermittency Regions	6 Region Framework (same as super regions)	
	Wind/Solar Contribution to Reserve Margin	BAU (Current Planning Practice)	
	Wind/Solar Penetration Limits (MWh)	BAU (25%)	50%
National Implementation Futures 2/5/8	Intermittency Regions	6 Region Framework (same as super regions)	4 Region Framework
	Wind/Solar Contribution to Reserve Margin	BAU (Current Planning Practice)	Adjusted to reflect inter-regional tx expansion
	Wind/Solar Penetration Limits (MWh)	BAU (25%)	50%

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- ### Consensus: Futures 1/4/7
- Use BAU Values for all inputs
    - Wind/Solar Penetration Limits: 25%
    - Intermittency Regions: 14 regions
    - Wind/Solar Contributions to Reserve Margins (capacity value): Reflecting current planning practice
  - Justification: No significant transmission expansion relative to BAU is expected
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## Futures 3/6 and 2/5/8 Option A: Uniform Approach

- For futures 2/3/5/6/8, use the same assumptions
- Relative to BAU: only change intermittency regions
  - Use 6-region intermittency regions (same as super regions developed for regional futures)
- Keep BAU values for penetration limits and reserve margin contributions
- Justification:
  - 25% Penetration limit is already aggressive – further increase not needed.
  - Changes in transmission sensitivity implementation will lead to important differences between the regional and national futures - additional differentiation is not needed.

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## Futures 3/6 and 2/5/8 Option B: Differentiated Approach

- Use increased wind/solar penetration limit (50%) for both national and regional implementation futures to reflect transmission expansion
- Apply limits over larger intermittency regions (4 region framework consolidating SPP/South and PJM/MAPP/MISO)
- Adjust reserve margin contribution (capacity value)
- Justification:
  - Is consistent with the intended purpose of the national implementation futures (2/5/8)
  - Reflects impact of inter-regional transmission expansion on system flexibility, regional diversity and variable resource integration

(see subsequent slides for further discussion)

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## Option B Justification: Intermittency Regions

- From the SPWG futures description:  
*"The main defining characteristic of this scenario is the deployment of significant amounts of renewable energy at the locations with the lowest cost renewable resources. ... There is also likely to be a need for significant enhancements to the nation's electric transmission system to achieve this scenario."*
- With a 25% wind/solar penetration limit, NEEM will in all likelihood build local renewables up to this limit. This is especially likely for regions with ample supply of low cost resources.
- With a 30% RPS, there will be no renewable power available for export between regions (and little "need for significant enhancements to the nation's electric transmission system").
- This would prevent NEEM from effectively deploying the least cost resources across the Eastern Interconnect for meeting RPSs and abatement targets.
- **This result is contrary the purpose of this future.**
- In order to promote effective deployment of least cost resources and to reflect the transmission build-out called for in the national implementation futures, the intermittency regions should be expanded relative to the regional implementation futures (see description of regions in summary slide at the end of this slide deck)

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## Option B Justification: Penetration Limits

- **Expanded Interregional transmission allows for a greater degree of generation/resource sharing, improved system flexibility, and better leveraging of geographic diversity. This means the system can integrate more variable resources at the same cost and therefore the maximum penetration level should be increased.**
  - Prior studies have shown transmission can facilitate very high Variable Energy Resource (VER) penetration rates (see subsequent slides)
  - Similarly, a number of studies in Europe have looked at very high wind penetrations, including some exceeding 50% of energy, and found them to be achievable on power systems that are less well-suited for wind integration than the U.S. power system is; these European power systems are smaller and have power plants that are less flexible than ours, and their wind resources have less diversity and more variability than ours.

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## Option B Justification: Penetration Limits

Prior studies have shown transmission can facilitate very high Variable Energy Resource (VER) penetration rates. In the U.S., the Eastern Wind Integration and Transmission Study, 30% wind (wind energy/total energy) was reliably accommodated across the Eastern U.S. Interconnect, with regions like SPP reliably accommodating much higher penetrations (see figure below)

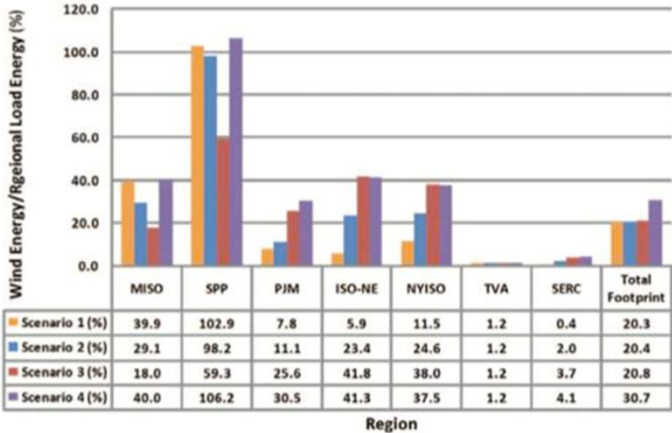


Figure 6-1. Wind energy penetration levels by region using 2004 hourly profiles

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## Option B Justification: Penetration Limits

The NREL-funded Nebraska wind integration study also found that 40% wind could be readily accommodated within the current SPP footprint at very low cost (<\$2/MWh of wind) without any negative impact on reliability.

The two central cases highlighted in the figure below from this study show that transmission expansion can result in substantially reduced curtailment for the same level of wind penetration

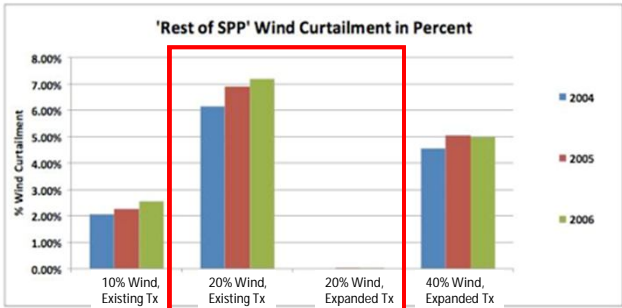


Figure 5: SPP Wind Generation Curtailment by Scenario (note: no curtailment in NPA)

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## Option B Justification: Penetration Limits

- NONE of these wind integration studies attempt to establish an upper limit for variable resource penetration.
- Existing integration studies may provide a floor, but not a plausible upper bound for this limit.
- The proposed approach is to increase the penetration limit to 50% for both the regional and national implementation futures (2,3,5,6 and 8).
- These justifications are based on the central assumptions of the futures and should apply to all runs in these futures.
- Relegating such an adjustment to a single sensitivity is not an appropriate approach and inconsistent with the studies and data cited here

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## Option B Justification: Contribution to Reserve Margins

- **Transmission expansions allow the system to manage variability more effectively, and therefore the capacity value for variable resources should also be increased**
  - The “contribution to reserve margin” or “capacity value” of variable resources reflects their impact on system adequacy and reliability
  - Expanded transmission increases the deliverability of variable resources (reduced curtailment rates, balancing requirements, etc). This means that the capacity value of wind, measured, for example, by wind’s impact on system loss of load expectation (effective load carrying capability), is increased through transmission expansion. This impact should be reflected in the base runs for the national implementation futures where a large transmission build-out is expected.
  - The proposed approach is to increase the BAU contributions of variable resources by a factor of 1.4 for the national implementation futures (2, 5 and 8) where additional inter-regional transmission is expected based on the future narrative. This is consistent with data in the available literature.
  - In their feedback, EIPC planning authorities have indicated this is could be a valid approach for those futures where transmission expansion above that in the BAU is expected.

See subsequent slides for further data and summary of proposed values by region

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## Option B Justification: Contribution to Reserve Margins

- The Eastern Wind Integration and Transmission Study (EWITS) showed that capacity value of wind generators increases by a factor of 1.4 with the addition of inter-regional transmission.

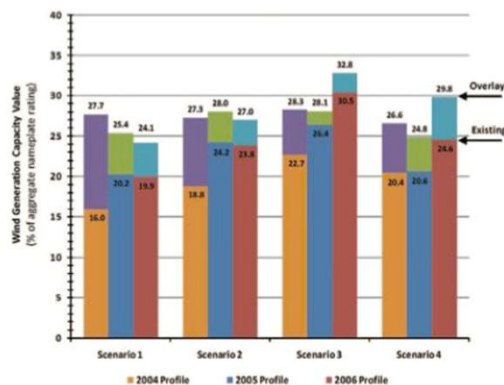


Figure 7-11. ELCC results for existing and overlay transmission

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## Option B Justification: A Differentiated Approach

- It is important to produce significant differentiation between the futures.
  - The value of these 8 futures for selecting the 3 final scenarios is greatly enhanced if they provide a set of substantially different outcomes
  - Producing only marginal differences between regions diminishes the value of having independent futures.
  - The national and regional futures are differentiated in other respects (heat rates, capacity addition limits, carbon revenue recycling, etc). Additional differentiation to reflect known impacts of transmission expansion on renewable integration is consistent with the approach pursued elsewhere in the futures
- Direct comparability between runs and the ability to attribute differences between runs to individual changes is not relevant to the development of the futures
  - The purpose of a sensitivity is to show the impact of varying a discrete variable or closely correlated set of variables. In this case comparability is an important concern
  - However the purpose of having different futures is to provide a substantially different scenarios with substantially different outcomes.
  - Direct comparability between futures should not be a driving consideration for model input development
  - Increased differentiation between futures will produce a greater diversity of data which the stakeholders will be able use to choose the final 3 build-out scenarios

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## Option B Intermittency Regions Summary

### Regions Futures (3,6)

Intermittency Region	NEEM Regions
SPP-ENT	SPP-S, SPP-N, NE, ENT
PJM	PJM_E, PJM_ROM, PJM_ROR, Non-RTO Midwest
MISO	MISO_W, MISO_MI, MISO_WUMS, MISO_IN, MISO_MO_IL, MAPP_CA, MAPP_US
Northeast	NYISO_A-F, NYISO_G-I, NYISO_J-K, NEISO, Maritimes, HQ imports to NY & NEISO
IESO	IESO, HQ imports to IESO
Southeast	TVA, VACAR, SOCO, FRCC

### National Futures (2,5,8)

Intermittency Region	NEEM Regions
South	SPP-S, SPP-N, NE, ENT, TVA, VACAR, SOCO, FRCC
PJM/MISO	PJM_E, PJM_SW, PJM_W, PJM_D, AE, NI, PJM_Midwest, MAPP_US, MAPP_CA, MISO_W, MISO_MI, MISO_WUMS, MISO_IN, MISO_MO_IL, Non-RTO Midwest
Northeast	NYISO_A-F, NYISO_G-I, NYISO_J-K, NEISO, Maritimes, HQ imports to NY & NEISO
IESO	IESO, HQ imports to IESO

### Futures 1, 4 and 7

Intermittency Region	NEEM Regions
SPP	SPP-S, SPP-N, NE
PJM	PJM_E, PJM_SW, PJM_W, PJM_D, AE, NI, PJM_Midwest
MAPP_CA	MAPP_CA
MAPP_US	MAPP_US
Rest of MISO	MISO_W, MISO_MI, MISO_WUMS, MISO_IN, MISO_MO_IL
Non-RTO Midwest	Non-RTO Midwest
New York	NYISO_A-F, NYISO_G-I, NYISO_J-K
NEISO	NEISO
ENT	ENT
TVA	TVA
VACAR	VACAR
SOCO	SOCO
FRCC	FRCC
IESO	IESO

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## Option B Variable Resource Reserve Margin Contribution Summary

Table 5 - Intermittent Resource Reserve Margin Contributions

NEEM Region	Technology	Futures 1,3,4,6,7	Futures 2,5,8	Basis for BAU Reserve Values
All Regions	Photovoltaic	30%	30%	CRA placeholder
All Regions	Offshore Wind	30%	30%	Based on EWITS ELCC for Isolated Regions Scenario (weighted average extrapolation) and GE integration studies for NY, New England
IESO	Wind	11%	15%	Current planning practice (input from S.Chui)
MAPP_CA	Wind	11%	15%	Input from planning authorities
New York	Wind	15%	21%	Based on NYISO input and consideration of September 2010 NYISO Wind Integration Study ( <a href="http://bit.ly/hP7bm3">http://bit.ly/hP7bm3</a> ) and wind data for subsequent years from the ISO
PJM	Wind	13%	18%	CRA placeholder (based on current planning practice)
SPP	Wind	6%	8%	CRA placeholder (based on current planning practice)
TVA	Wind	12%	17%	CRA placeholder (based on current planning practice and added in Jan 25 assumptions draft)
All Other Regions	Wind	15%	21%	Based on EWITS ELCC for All-Onshore (Scenario 1), isolated region analysis

\* Onshore wind increased in the high-transmission futures (EWITS Scenario 1 ELCC three year average, ratio of overlay to existing tx cases=1.38 )

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