

Macroeconomic Analysis (Task 5)

Presentation to the EIPC Stakeholder Steering Committee
Chicago, IL
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Eastern Interconnection Planning Collaborative



Presentation Outline

- Objectives of this presentation
- Overview of the CRA Modeling Suite
- SSC Inputs for Task 5

Objectives of this Presentation

- Introduce the CRA team and its role in Task 5
- Highlight the inputs from SSC on Task 5
- Provide an overview of the modeling suite CRA will use in Task 5
- Answer questions

CRA EIPC Project Team

Chuck Trabandt
Vice President

- CRA Officer-in-Charge, Project Manager

Alex Rudkevich
Vice President

- Technical Director. Oversight of methodological integrity across all tasks. Technical lead on Tasks 3 and 9

Christopher Russo
Principal

- Lead on macro-economic analysis of scenarios. CRA Technical Liaison on Tasks 4 and 5

Scott Niemann
Principal

- Technical Lead on Task 5

Ralph Luciani
Vice President

- CRA Liaison with SSC

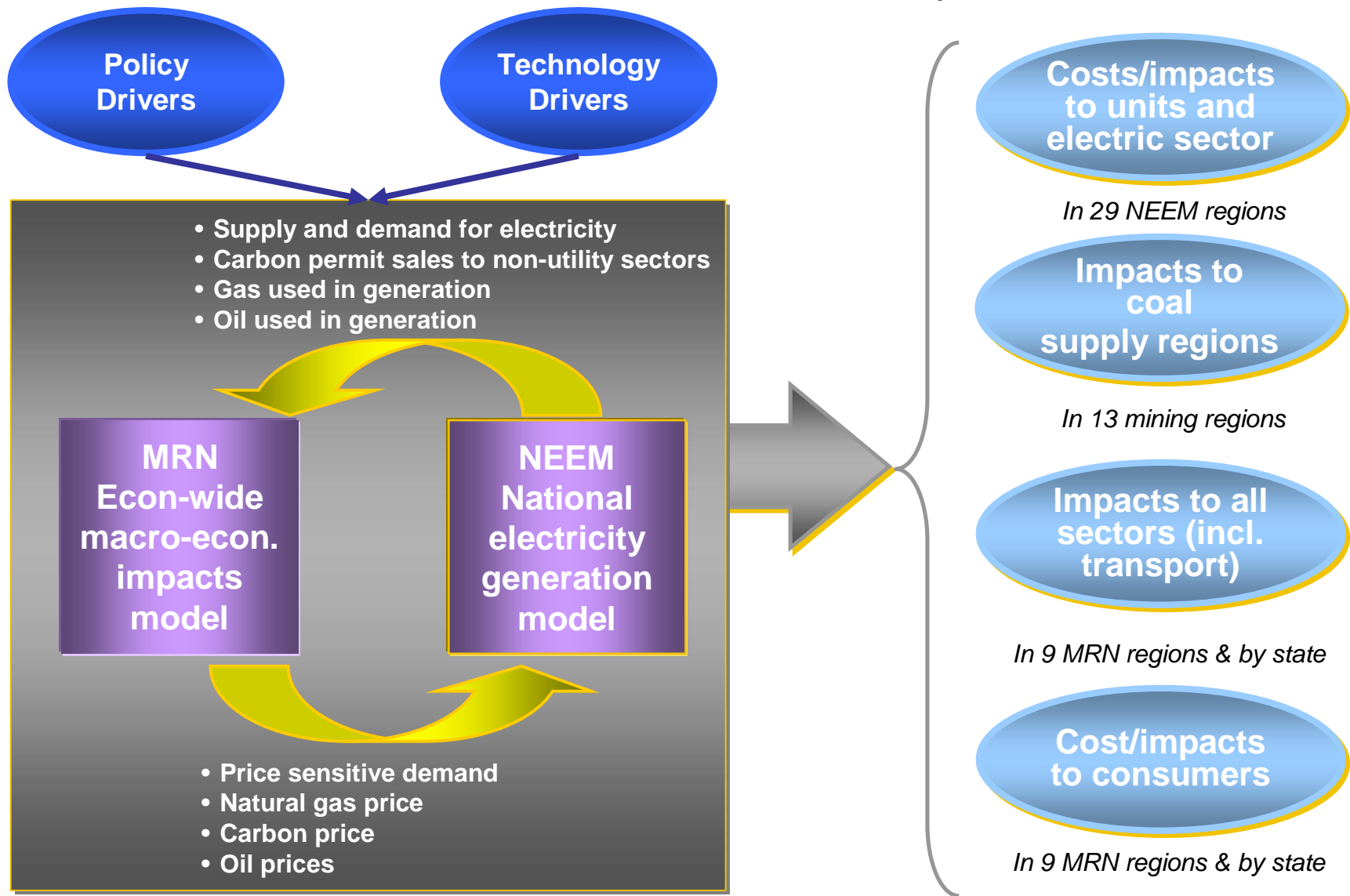
CRA's Principal Analytical Tools for Task 5

**MRN-NEEM & NEEM
CGE Macroeconomic model
and
Detailed Electricity Generation
Expansion, Coal Supply and
Environment Model**

**CRA North American
Generation and
Transmission Database**

- **NEEM/MRN**
 - Long-term optimal generation expansion model
 - Built around environmental and economic planning principles
 - “Pipe-and-bubble” transmission system
 - Simulation of fuel prices and emission credit prices
 - Representation and modeling of RPS requirements

MRN-NEEM includes a detailed electric sector fully integrated with all other sectors of the U.S. economy

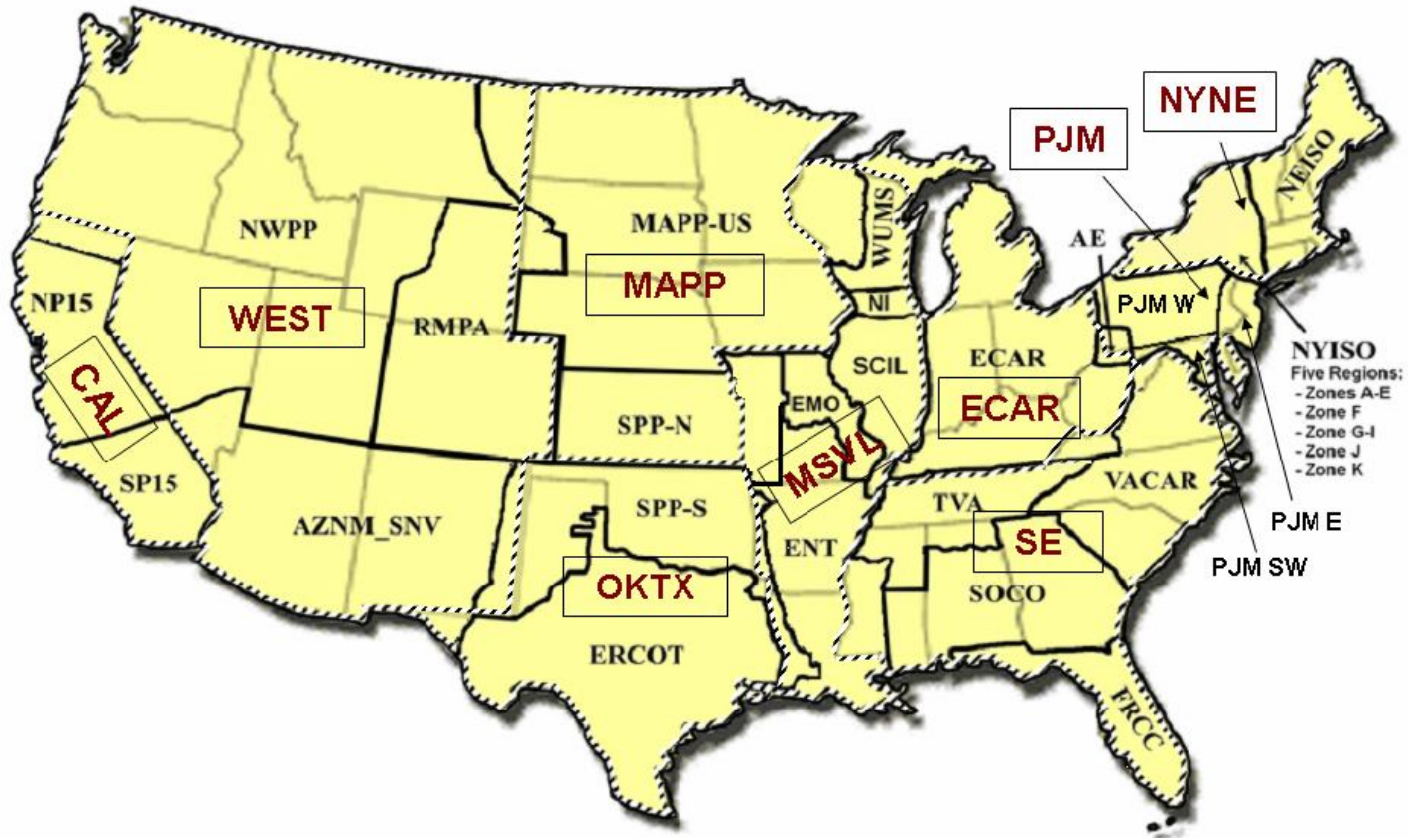


NEEM Simulates Optimal System Expansion

- Mix and timing of new generation additions
- Dispatching units to meet demand
- Operating, mothballing, or retiring units
- Retrofitting existing units with pollution control equipment
- Switching fuels (between types/grades of coal)
- NOx and SOx allowance sales and purchases
- Scheduling maintenance for generating units
- Inter-regional energy transactions
- NEEM has embedded coal supply and transportation model
 - Retrofitting units leads to coal switching
 - Carbon regulation affects coal-fired generation
 - Both factors influence coal production by region and prices

MRN-NEEM region map

MRN-NEEM Regions



NEEM regions are user-defined. Different Macroeconomic Futures will likely lead to differently defined regions

Key inputs

- Existing unit-level information
 - Capacity
 - Fuel type
 - Heat rate
 - Emission rates
 - Pollution control equipment
 - Fixed and variable O&M costs
- New generation options
 - Generation type/fuel type
 - Heat rate (for thermal)
 - Availability profiles for renewables
 - System integration costs for renewables
 - Emission rates
 - Capital, fixed and variable O&M costs
 - Capital charge rates
 - Timing on availability
 - Regional potential
- Transmission representation
 - NEEM regions and transfer limits between them
- Environmental regulations
 - SO₂/NO_x/Hg caps
 - CO₂ prices
 - Renewable portfolio standards
- Fuels
 - Coal supply curves
 - Seasonal delivered natural gas prices
 - Uranium, biomass and fuel oil prices
- Electricity Demand
 - Regional peak demand
 - Regional annual demand by load block
- Resource Adequacy
 - Regional reserve margin requirements

Key outputs

- Electric sector results (national and regional)
 - New capacity additions and retirements
 - Wholesale electricity prices by region, year & load block
 - Environmental allowance prices (for NO_x, SO_x and Hg)
 - Capacity prices
 - Coal prices by coal type
 - Environmental retrofits
 - Power interchange between power regions
 - High level transmission congestion
 - REC prices (for RPS)
- Unit-level results
 - Generation and capacity factor
 - Emissions and emission rates (CO₂, NO_x, SO_x and Hg)
 - Fuel consumption
 - Energy and capacity revenues
 - Costs (fuel, VOM/FOM, allowance costs, depreciation on new capital)

CRA's Role in EIPC Macroeconomic Tasks

Task 4 Macroeconomic Futures Definition

- Provide technical assistance to SSC in its formulation of Macroeconomic Futures and sensitivities for Task 5
- Inform SSC on modeling feasibility of macroeconomic futures
- Formalize specifications for modeling inputs representing alternative macroeconomic futures

Task 5 Macroeconomic Analysis

- Macroeconomic analysis of up to 8 Futures, up to 9 sensitivities for each future defined in Task 4
- Quantify impact on the electric power supply and other sectors of the US economy
- Will use:
 - CRA NEEM and MRN-NEEM models
 - High level transmission analysis provided by Planning Authorities engineers

SSC Inputs on Task 5

Tasks	SSC	CRA
<i>Issue identification</i>	<p>Primary SSC identifies key issues</p>	<p>Advisory CRA participates in meetings to inform how issues are addressed or could be addressed through modeling that appropriate model outputs and metrics corresponding to the issue are produced and analyzed</p>
<i>Driver identification</i>	<p>Primary SSC is responsible for identifying key drivers of macroeconomic futures, selecting independent drivers</p>	<p>Advisory CRA's role is to assist SSC in determining the dependency structure among drivers consistent with CRA modeling structure</p>
<i>Uncertainties definition</i>	<p>Primary SSC identifies uncertainty ranges for independent drivers</p>	<p>Advisory CRA provides feedback on the feasibility of modeling identified uncertainty ranges</p>

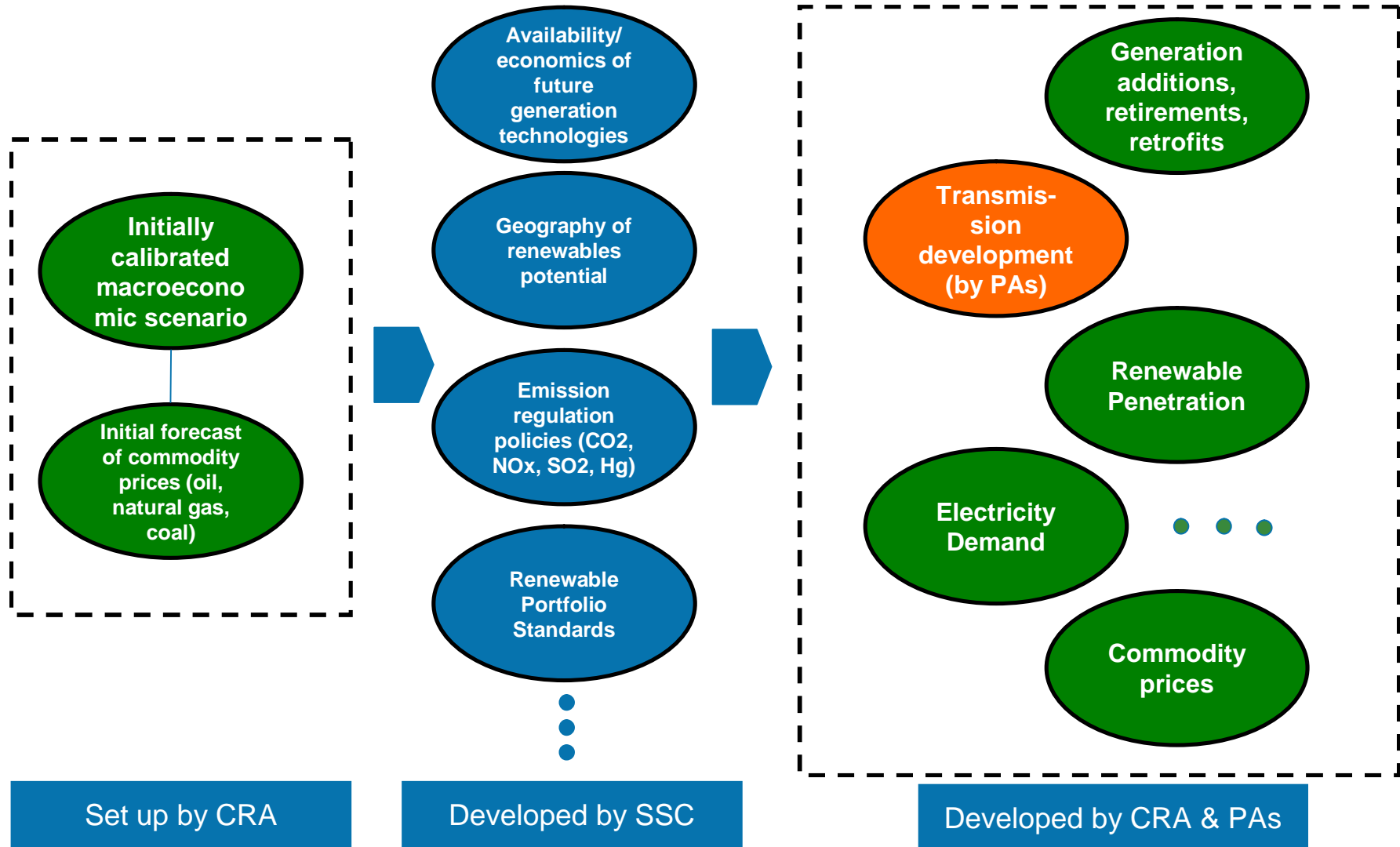
SSC Inputs on Task 5 (cont'd)

Tasks	SSC	CRA
<i>Macroeconomic Futures design</i>	<p>Design</p> <p>SSC develops internally consistent trajectories (values and timing) of primary drivers</p>	<p>Implementation</p> <p>CRA implements these trajectories as inputs to the model</p>
<i>Sensitivities</i>	<p>Design</p> <p>SSC identifies up to 9 sensitivities for each future by varying selected parameters of independent drivers within the uncertainty range</p>	<p>Implementation</p> <p>CRA implements these sensitivities by changing corresponding model inputs</p>
<i>Metrics definition</i>	<p>Support/Input</p> <p>SSC will provide recommendations and feedback on the list and definition of metrics developed by CRA</p>	<p>Design and implementation</p> <p>CRA will design output metrics, provide mathematical definition, economic interpretation and implement metrics as model post-processing</p>
<i>High Level Transmission Analysis</i>	<p>Guidance</p>	<p>Support</p> <p>CRA will provide support to PA Engineers on high level transmission analysis</p>

SSC Inputs on Task 5 (cont'd)

Primary Drivers (Model Inputs)

Dependent Drivers



Information Exchange for Task 5

Information flow from CRA to SSC

- Description of major drivers in CRA models. Primary and dependent drivers will be identified
- Electronic files for inputting information on primary drivers and sensitivities
- Proposed definition of metrics for evaluation of Macroeconomic Futures and sensitivities
- Technical comments on the implementability of SSC developed Macroeconomic Futures
- Results of macroeconomic analyses

Information flow from SSC to CRA

- Definition of Macroeconomic Futures in terms of combination of drivers and narratives on issues and themes
- Comments and suggestions on metrics for evaluation of Macroeconomic Futures and sensitivities
- Filled electronic files for inputting information on primary drivers and sensitivities

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