Macroeconomic Analysis (Task 5)

Presentation to the EIPC Stakeholder Steering Committee
Chicago, IL
July 15-16, 2010

EIPC Eastern Interconnection Planning Collaborative

CRA Charles River Associates

Presentation Outline

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

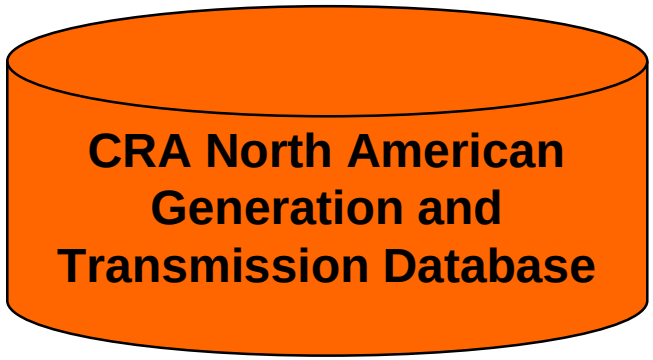
Objectives of this Presentation

- 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

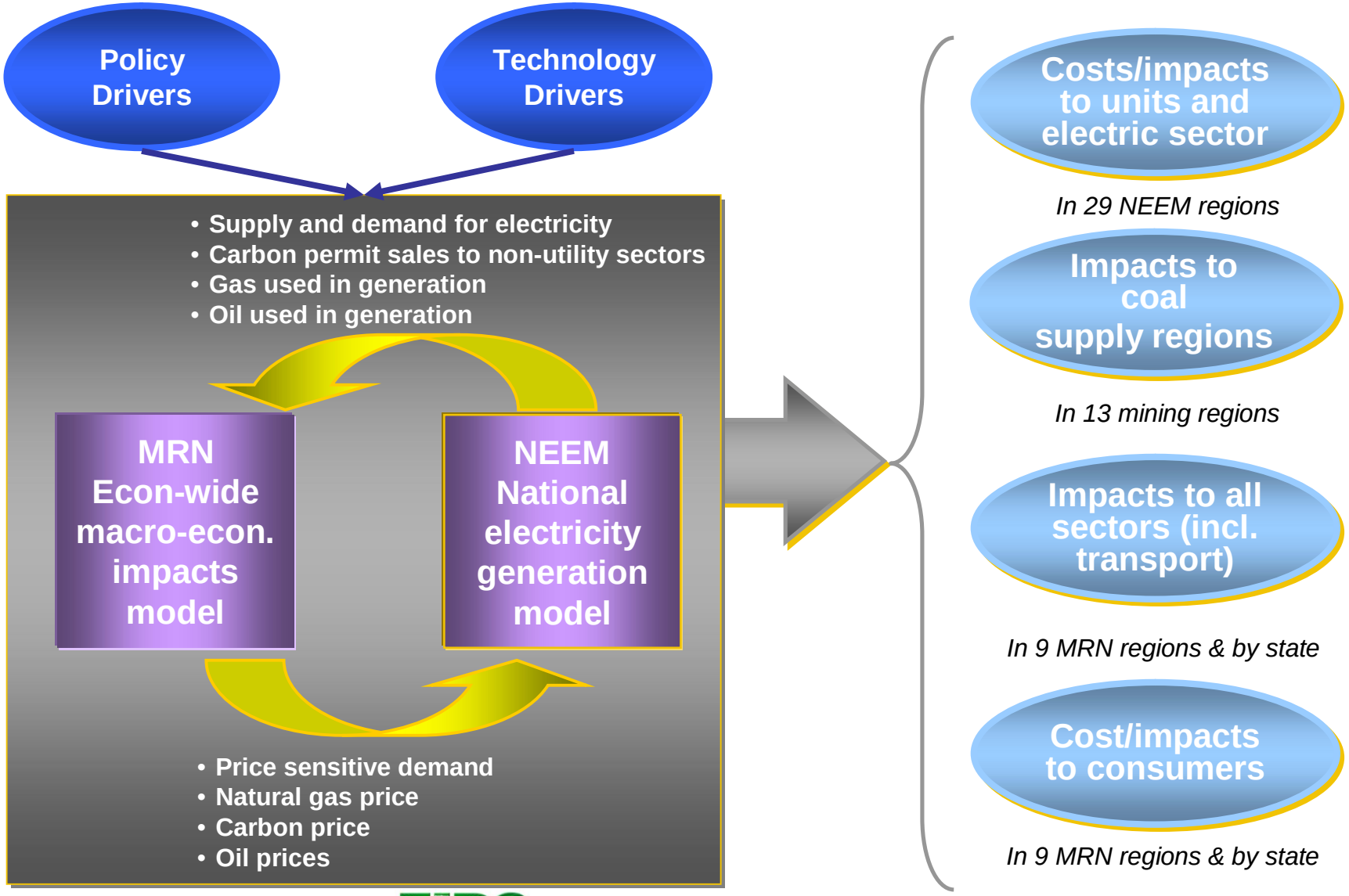
Chuck Trabandt Vice President	• CRA Officer-in-Charge, Project Manager
Alex Rudkevich Vice President	• Technical Director. Oversight of methodological integrity across all tasks. Technical lead on Tasks 3 and 9
Christopher Russo Principal	• Lead on macro-economic analysis of scenarios. CRA Technical 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



- 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



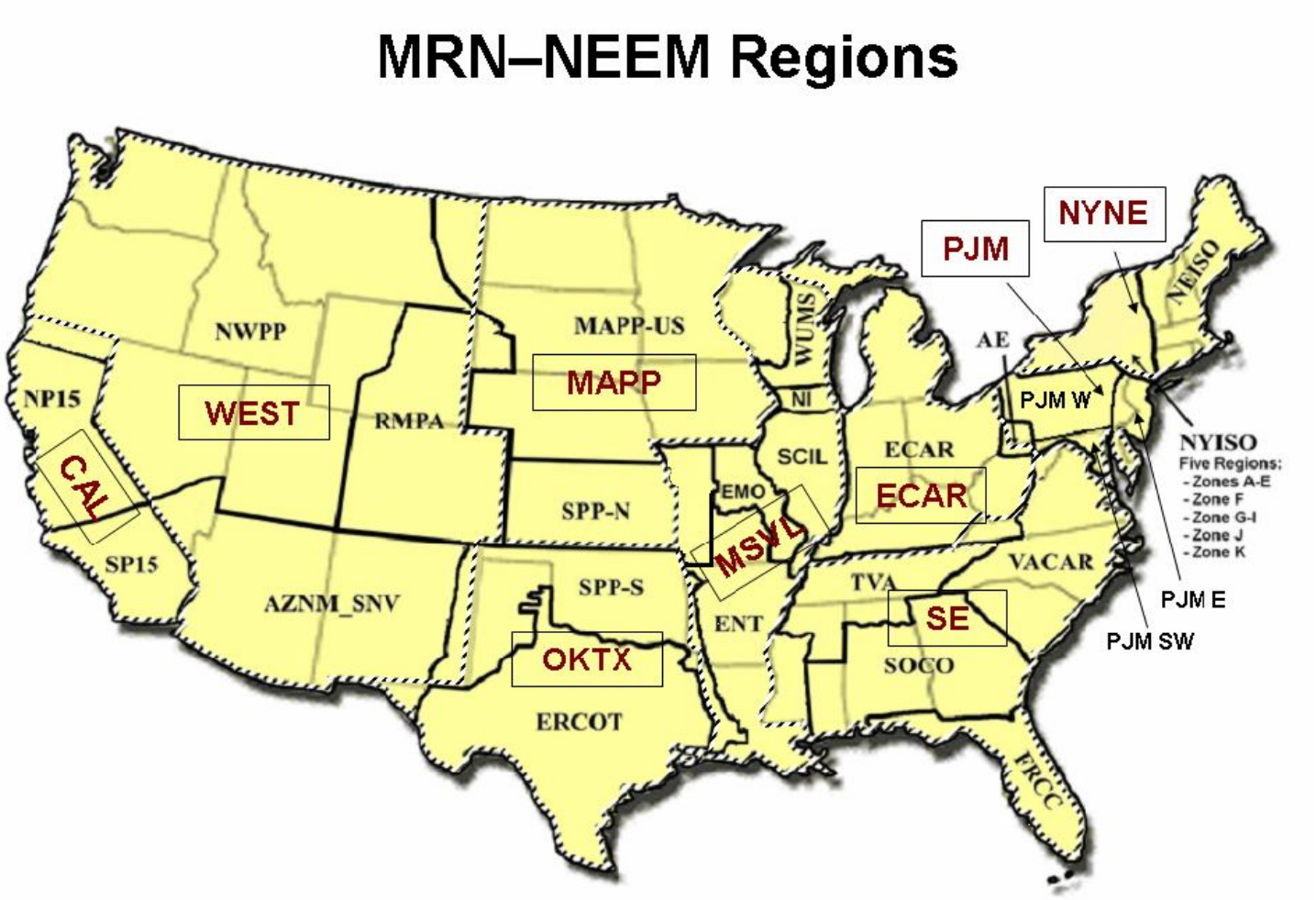
EIPC Eastern Interconnection Planning Collaborative

CRA Charles River Associates

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



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
  - SO_2/NO_X/Hg caps
  - CO_2 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 NOx, SOx 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, NOx, SOx 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

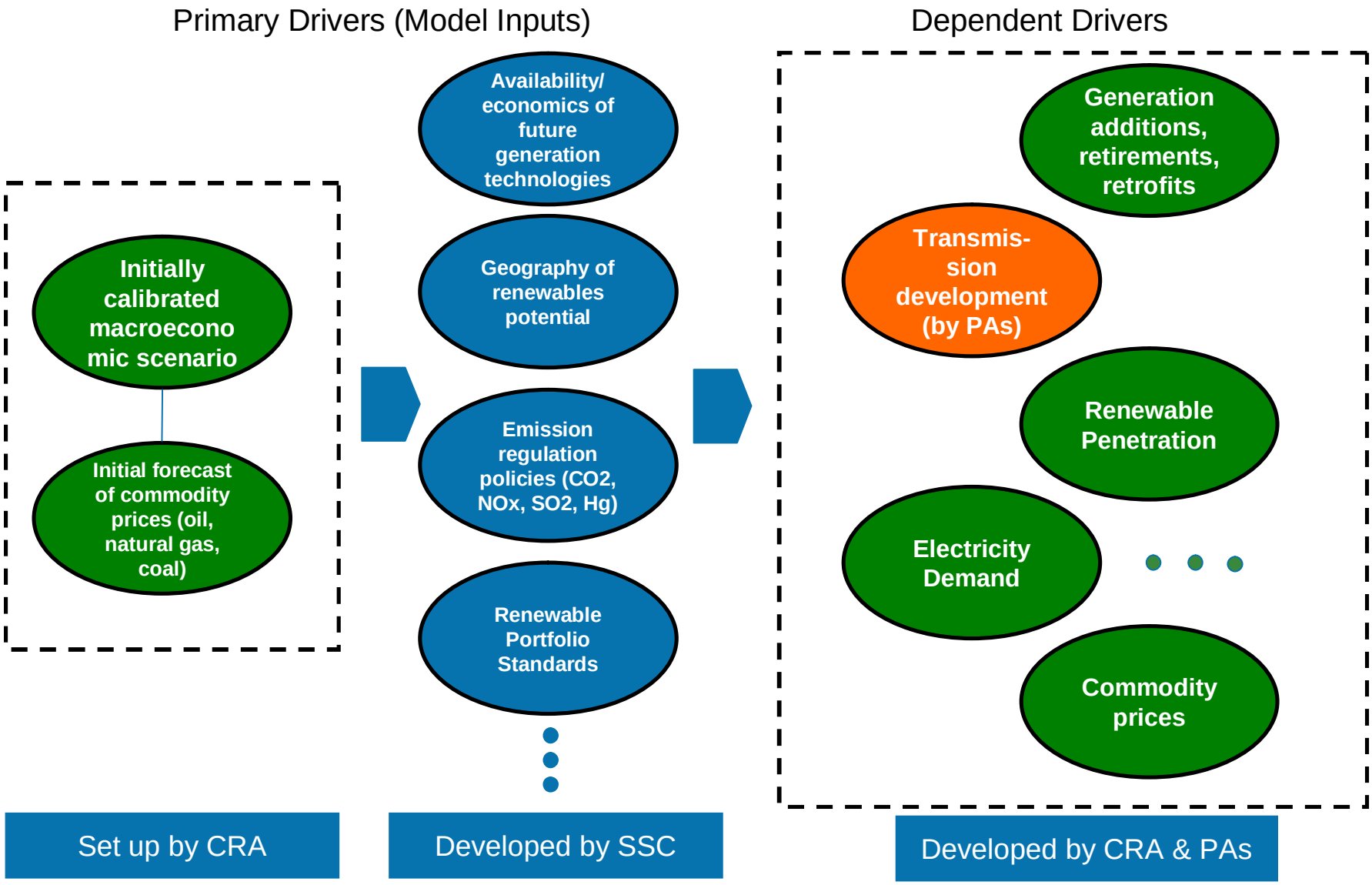
SSC Inputs on Task 5

Tasks	SSC	CRA
Issue identification	**Primary** SSC identifies key issues	**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
Driver identification	**Primary** SSC is responsible for identifying key drivers of macroeconomic futures, selecting independent drivers	**Advisory** CRA's role is to assist SSC in determining the dependency structure among drivers consistent with CRA modeling structure
Uncertainties definition	**Primary** SSC identifies uncertainty ranges for independent drivers	**Advisory** CRA provides feedback on the feasibility of modeling identified uncertainty ranges

SSC Inputs on Task 5 (cont'd)

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

SSC Inputs on Task 5 (cont'd)



EIPC Eastern Interconnection Planning Collaborative

CRA Charles River Associates

Information Exchange for Task 5

Information flow from CRA to SSC	Information flow from SSC to CRA
• 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	• 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

Alex Rudkevich, Chris Russo,
Chuck Trabandt

Charles River Associates

arudkevich@crai.com

crusso@crai.com

ctrabandt@crai.com