US Multi-region MARKAL Modeling

Northeast 9-State Model

ETSAP Semi-annual Workshop
Annex X, 5th Workshop
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NE9 States Face Multiple Energy-Environment-Economy Policy Challenges

- CAA implementation (O3, PM, haze, CAIR, NSR)
- Mercury (CAMR, state Hg programs)
- Transportation planning (CA LEV GHG, feebates, diesel reduction initiatives)
- Climate (state action plans, RGGI, NEG/ECP goals, RPSs, low carbon fuels)
- Economic impact of changing energy markets and prices
**NE9/12 Data Development Process**

- EIA surveys, NEMS, eGRID
  - Regional base technology characterizations and end-use fuel shares

- EIA SEDS
  - 2002 State-level fuel consumption data

**Base year state-level system characterization**

- NEMS/DOE technology options
- AEO2006 demand projections
- AEO2006 fuel price projections
- State & regional policies

**Reference case evolution**

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**Model Representation**

- **Resource Supply**
  - Price taker, importing fuels at AEO2006 regional sector delivered prices
  - State-level biomass supply curves (ORNL)
  - State-level renewables potential (NREL and RGGI)

- **Power Sector**
  - Power plants above 25MW represented individually, others by fuel/missions control
  - Current inter-state/Canada+Other exchange options at current grid capacity, expandable
  - Six time slices currently, expanding to at least nine
### NE-9 Demand Sectors Representation

<table>
<thead>
<tr>
<th>Sector</th>
<th>Demand Sectors</th>
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<tbody>
<tr>
<td>Commercial</td>
<td>Space Heating, Cooling, Water Heating, Cooking, Ventilation, Refrigeration, Lighting, Office Equipment, Other</td>
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<tr>
<td>Industrial</td>
<td>Steam, Process Heat, Machine Drive, Electro-Chemical, Other, Feedstocks, Non-Energy, and captive CHP in each of Chemicals, Durables, Glass-Cement, Metals, Paper, Other</td>
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<tr>
<td>Transportation</td>
<td>Robust Light Duty Vehicles, expanding Heavy Duty Vehicles, Other</td>
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### NE9 RPS - Renewable Capacity

**Renewable Capacity - Reference Case**

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<thead>
<tr>
<th>Year</th>
<th>Solar PV</th>
<th>Biomass</th>
<th>Wind</th>
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**Renewable Capacity - 20% RPS Case**

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NE9/12 Next Steps

- Three additional states, with some refinements
- Additional regional policies (e.g., RGGI)
- Move power sector to more time-slices
- Integrated multi-pollutant policy analysis
- Breaking out individual state models for local use (e.g., NJ Master Plan, MA CHP, CT Carbon Cap, NH RPS)
- Expanding coverage to other states/regions (Ohio (and Midwest) integration)
- Imbedding state-level census region(s) within US9r multi-region national MARKAL model

Linkage with other planning tools

Multi-pollutant Policy Analysis Framework for the Northeast US
REMI-Energy: Mapping MARKAL Results to REMI Policy Variables

MARKAL Model Run

- Reference Demands for each Energy Service
- Demand Price Elasticities for each Energy Service (if available)
- Prices for Energy Resource, Imports and Exports
- Characterizations of Energy Conversion and End-use technologies

Annualed investment Cost for conversion, Process and end-use technologies

- Annual O&M cost in each conversion, Process and end-use technology
- Quantity of Energy carriers consumed by each conversion, Process and end-use technology
- Marginal Prices of Energy carriers
- Resource supply Levels and Revenue

Fuel cost for each conversion, Process and end-use technology

REMI Policy Variables and Other Inputs

GAMS Post-processor/VEDA-BE tables

REMI-Energy M2R Mapping Sheet