The National Energy Model: A Progress Report

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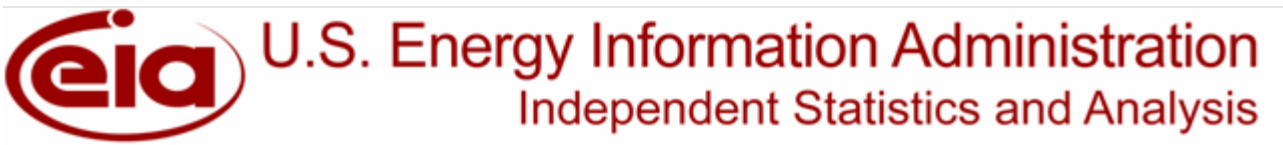

EIA continues a multi-year project to develop a National Energy Model (NEM)

- The **National Energy Model System (NEMS):**
  - Integrated regional energy-economy model of the United States
  - Projections to 2035 published in the *Annual Energy Outlook*
  - Applied for energy policy analysis (e.g. climate bills, CAFE standards)
  - Reflects continued model development spanning 18 years
  - Model and data assumptions are documented annually and customers are invited to working group meetings semiannually to be briefed on changes to the model and data assumptions.
- The **National Energy Model (NEM):**
  - The new name marks an evolution to a transformed model
  - Culmination of multi-year project to:
    - Refocus model development to areas of concern
    - Adopt stakeholder ideas
    - Improve policy-analysis capabilities

National Energy Model Origins

- NEMS attained adolescence at 15 years in 2006
- The former EIA administrator (Guy Caruso) initiated planning for a future NEMS
- An internal committee scoped out possibilities, solicited suggestions, prioritized recommendations:
  - Held meetings with interested parties in the Department of Energy
  - Letters sent to energy trade and research organizations
  - Inquiries sent to National Laboratories
  - Solicited input from the EIA modelers and users
  - Outlined development recommendations with priorities
- Development phased, subject to budget and other commitments

Top Twelve Challenges

1. Simplicity vs. complexity
   a. Level of detail required for policy analysis
   b. Tradeoff in terms of model execution time
   c. Reduced form models often suggested
2. Technology change and development
   a. Learning
   b. Economies of scale
   c. Technological optimism
   d. Link between R&D and technology advances
   e. Level playing field
3. Decisionmaking
   a. Capturing consumer and producer behavior
   b. Differences among the agents
   c. Foresight

More Challenges …

4. Increasing global interactions
   a. International markets are increasingly complex
   b. Technology development occurs in a global context
   c. Prospect of international carbon markets
5. Interactions between energy and the economy
   a. Economic implications of energy policy of increasing interest
   b. Potential for more feedback between the energy and economic modeling
   c. Investment
6. Infrastructure
   a. Siting issues for large, new installations, such as refineries and liquefied natural gas terminals
   b. Energy transportation of all types, particularly electricity and perhaps ethanol and hydrogen
   c. Water requirements and impacts on water supply

Yet More Challenges …

7. Environmental impacts
   a. Energy-related CO_2 emissions and sulfur dioxide, nitrogen oxides, and mercury emissions from the electric power sector
   b. Need to represent emission caps, fees, trading, and banking
   c. Representation of other greenhouse gases and abatement costs from the Environmental Protection Administration
   d. No representation of the carbon cycle, environmental damage, or climate change abatement/mitigation costs
8. Noneconomic policies and programs
   a. Deployment programs, mandates, etc.
   b. Changing consumer preferences

And Still More Challenges …

9. Regionality
    a. State impacts
    b. State programs
10. Time horizon
    a. Credibility an issue, particularly in a more detailed model
    b. New and emerging technologies
    c. Backstop technologies may not be a good option
11. Data availability underlies many challenges and is a challenge unto itself
12. Presentation of results
    a. Transparency
    b. Uncertainty analysis
    c. Diagnostics

NEMS is evolving into NEM

- Took an *Evolutionary* approach to initial NEM development:
  - Immediate benefits
  - Leverage existing investment: retain well-established, viable components
  - No firm plans for fundamental restructuring
  - Focus on a few overhauls where needed
  - Resources limited; commitments heavy
- Many NEM recommendations are now adopted in the current version of NEMS.
- Most other recommendations achievable within the existing NEMS structure without overhauling or re-inventing the whole model

Sampling of NEM Recommendations from outside EIA

- Extend the horizon to 2050 or later
- Treat technologies equitably and consistently (e.g., technological optimism)
- Add technology options and modeling flexibility
- Add representations of energy infrastructure
- Enhance integration of U.S. energy markets with the economy and world markets
- Expand regional detail
- Add uncertainty analysis and stochastic scenarios
- Outreach: more expert consultation/peer review; help users and interact on modeling plans
- Improve transparency/documentation and add automated diagnostics
- Reduce model execution time

My Personal Near-Term Goals of NEM Development

- Upgrade Modules to Better Reflect Market Behavior
  - Electricity Market Module
  - Liquid Fuels Market Module
  - CO_2/EOR
  - Biomass Supply Module (Polysis)
  - Transportation Module
  - Industrial Module
- Improve Model Usability
  - Test a single NEMS module conversion from FORTRAN into a modeling specific language (GAMS, AIMMS).
  - Improve transparency to other groups using NEM.
  - More easily train junior analysts to make model changes to test and evaluate alternative formulations.
  - Extend model time horizon for use by others

NEM Development Achievements—Transportation

- New attribute-based CAFE standards based on vehicle footprint
- Disaggregated vehicle manufacturers from 4 to 9 to capture their varying vehicle attributes and sales
- Incorporated new vehicle types
  - 2 electric vehicles (100-mile range and 200-mile range)
  - 2 plug-in hybrids (10-mile and 40-mile all-electric range)
- Improved battery technology modeling:
  - Lithium-ion cost falls with cumulative production, time
  - Battery size reflects R&D-based improvements in maximum depth-of-discharge (time based)
- Adopted regional travel demand model (9 Census divisions)
- Regionalized bus and transit modeling with fuel, mode breakouts
- Developed 13 region world air model:
  - Regional travel demand and aircraft sales projections (econometric)
  - Model flow of aircraft between regions to satisfy demand
  - Tracks movements of parked and active aircraft, (passenger & freight)

NEM Development In Progress—Transportation

- **Heavy duty truck modeling:**
  - Update and develop technology assumptions for fuel efficiency, emission control
  - Improve demand drivers: disaggregate industrial shipments classification
  - Market segmentation for fuel economy standards:
    - Review sales, travel, and vehicle attribute data
    - Develop new vehicle classes that represent vehicles with similar duty cycles, travel behavior, and vehicle attributes
    - Final fuel economy/GHG standards will determine size class groupings
- **Off-Road freight modeling**
  - Regionalization: Develop representation of regional freight flows for rail and marine modes of travel, stocks by vintage, and fuel efficiency and fuel use characteristics
  - Develop advanced technology assumptions for fuel efficiency, emission control
  - Improve demand drivers: disaggregate industrial shipments classification
    - 10 to 32 for marine travel
    - 10 to 15 for rail travel
  - Market Segmentation:
    - Marine: 14 vessel types disaggregated by 3 engine sizes
    - Rail: segmentation to be determined by car/commodity type

NEM Development Achievements—Buildings

- Distributed generation module, enhancements (AEO2007 and AEO2008)
- Personal computer module
- Residential televisions and related equipment (AEO2007)
- Incorporated residential shell technology database for new construction
- Expansion of choice methodology to allow for integration of heating, ventilation, and air-conditioning choices with shell technologies for new residential construction
- Improved representation of commercial building shell efficiency (AEO2009, AEO2011, AEO2012)
- Detailed trend projections for several categories of miscellaneous electricity use, such as coffee makers, ceiling fans, rechargers, transformers, medical imaging equipment (AEO2007)

Other Recent/Ongoing NEM Development Initiatives

- Developing a Liquid Fuels Market Module (AEO2012) (next slide)
- Expanded the regions in the Electricity Market Module from 13 to 22 (AEO2011)
- Conducted study and review of hardware and software options for implementing NEM
- Developing endogenous biomass supply representation to meet demands from the electricity and liquid fuels sectors (AEO2012)
- Incorporated explicit CO_2 flows and market structures for enhanced oil recovery (AEO2011)
- Reviewing and incorporating cost/performance factors affecting retrofits of carbon capture and storage in coal plants
- Representing impacts of "Smart Grid" policy efforts (AEO2012 and 2013)
- Reviewing the macroeconomic activity module and a redesign could follow (AEO2012 or later)

NEM Focus: A new Liquid Fuels Market Module

- Replaces the Petroleum Market Module and biofuels modeling extensions
- Process/Plan:
  - Stakeholder workshops held
  - Component design report written (merging two independent proposals), reviewed, then published on EIA web site
  - Prototype/Test-bed version under development (single representative refinery from PADD 3)
  - Phase II: full development (6/2011)
- Improvements:
  - Greater regional breakouts (7 domestic regions, 1 off-shore)
  - Capacity planning/foresight standardized and streamlined
  - New non-petroleum fuel market module
  - International component with better light/heavy demand interaction and price differentials
  - Competitive technology adoption algorithm for alternative fuels
  - GAMS Optimization modeling package used

In Conclusion

- To paraphrase a quote from Winston Churchill,
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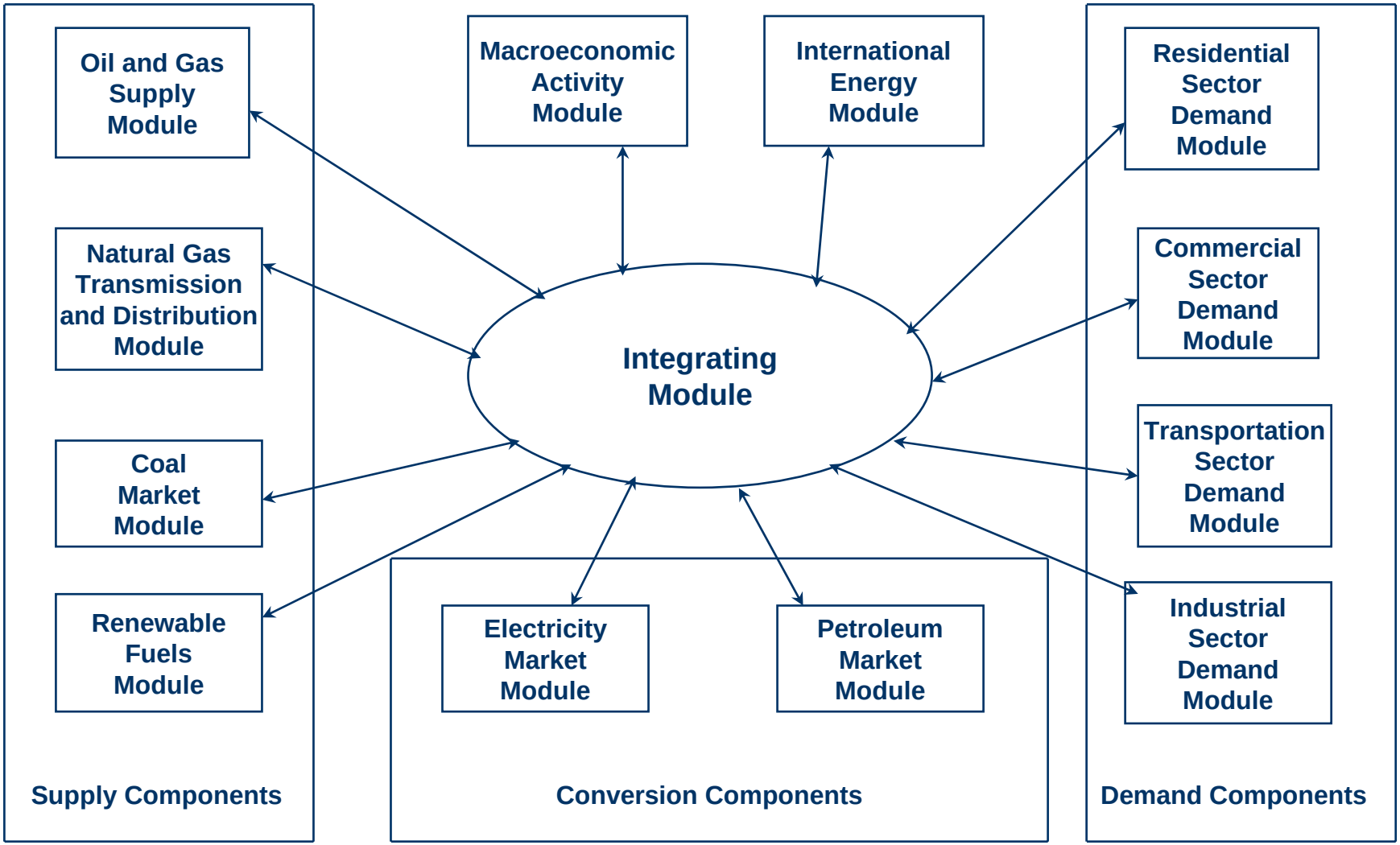
- "No one pretends that the *National Energy Modeling System* is perfect or all-wise. Indeed, it has been said that *NEMS* is the worst form of *energy model* except all those other forms that have been tried from time to time."

For more information

U.S. Energy Information Administration home page	www.eia.gov
Short-Term Energy Outlook	www.eia.gov/emeu/steo/pub/contents.html
Annual Energy Outlook	www.eia.gov/oiaf/aeo/index.html
International Energy Outlook	www.eia.gov/oiaf/ieo/index.html
Monthly Energy Review	www.eia.gov/emeu/mer/contents.html
National Energy Information Center	(202) 586-8800 Live expert from 9:00 AM – 5:00 p.m. EST Monday – Friday (excluding Federal holidays) email: InfoCtr@eia.doe.gov

Backup Slides

NEMS Structure



Strengths of NEMS

- Level of detail
- Technology
- Policy analysis capability
- Regional structure
- Expectations methodologies
- Modularity
  - Operational advantage
  - Methodology flexibility
  - Analysts responsibility
- FORTRAN

Weaknesses of NEMS

- Level of detail
- Data requirements
- Specification of new and emerging technologies – a weakness for all models
- Regional impacts for political divisions
- Linkages to world energy markets
- FORTRAN

NEMS Contacts

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Transportation Demand : John Maples - 202-586-1757 - john.maples@eia.gov Nicholas Chase - 202-586-8851 - nicholas.chase@eia.gov

New electricity regions
22 Sub-regions of the U.S. Power Grid (excludes AK and HI)