Analyzing Transportation Policies using the National Energy Modeling System (NEMS)

April 30, 2019

Tracy Terry
Outline

• Overview of NEMS
• Transportation Model Overview
• Regional Representation
• Light-Duty Vehicles
• Freight Trucks
• Transit
• Key Policies
• Key Assumptions and Inputs
• Key NEMS Outputs
Overview of NEMS

• The National Energy Modeling System (NEMS) is an integrated energy model that includes energy supply and production by fuel type, energy consumption by end-use sector, and energy conversion (electricity production & refining)

• NEMS was developed by the Energy Information Administration (EIA) – an independent agency within DOE
  – Used by EIA for its Annual Energy Outlook projections, as well as Congressional and other agency requests
  – Also used extensively outside of EIA (NGOs, private sector, etc.)

• Provides annual results through 2050 with significant detail by fuel and sector

• Modular structure allows each sector to be represented by methodology and data that fit it best
NEMS Schematic

CONVERSION MODULES

- Liquid Fuels Market
- Electric Market

DEMAND MODULES

- Residential
- Commercial
- Industrial
- Transportation

SUPPLY MODULES

- International Energy Demand Module
- Macroeconomic Activity Module
- Oil & Natural Gas Supply
- Natural Gas Transmission & Distribution
- Coal Market
- Renewable Energy

INTEGRATED ENERGY MODELING
Transportation Model Overview

• Energy use is modeled by transportation mode: light-duty vehicles, freight, aviation, bus, rail, etc.

• Transportation model uses a variety of inputs from other modules within NEMS to determine vehicle shares, fuel consumption, VMT, etc.
  – GDP; sales of new cars and trucks; disposable income; population; industrial output; fuel prices

• Calculates transportation energy demand by fuel and feeds it back to the overall NEMS system

• Greatest detail for light-duty vehicles (LDVs) and freight trucks
Regional Representation

- NEMS models the transportation sector at a regional level using the 9 Census divisions
- OnLocation will modify NEMS to split the South Atlantic into 2 regions: states that are participating in TCI (DE, MD, VA, DC) and all other states in the region
Transportation Categories

- Light-Duty Vehicles (LDVs) for personal use and fleets
  - Cars in 6 EPA size classes; Light trucks in 6 EPA size classes
- Freight Transport
  - Truck (light-, medium-heavy- and heavy-duty classes)
  - Rail Freight
  - Marine (domestic and international)
- Aviation
- Other Transport
  - Bus (commuter, intercity, and school buses)
  - Passenger Rail (commuter, intercity, and transit)
  - Recreational Boats
  - Military
Light-Duty Vehicles

• Significant technology detail for LDVs
  – Includes conventional/gasoline vehicles, hybrid and plug-in hybrid electric vehicles, CNG & LPG, fuel cell, and dedicated electric
• Market shares for vehicle types are calculated based on consumer preferences, vehicle costs, cost of driving, acceleration, range, etc.
• Model estimates new LDV fuel economy, price, horsepower, weight and range
  – Fuel economy is primarily driven by standards
• Vehicle Miles Traveled (VMT) is calculated based on the cost of driving (fuel & mpg), disposable income per capita, employment rate, number of vehicles per driver
• NEMS tracks the vehicle stock by technology and vintage and accounts for sales, retirements and transfers each year
Freight Trucks

• Truck sales are shared from the macroeconomic model forecast sales into subclasses for fuel economy classification purposes and two fleet types
• New truck fuel efficiency depends on the market penetration of specific fuel-saving technologies
  – Each of these have a variety of characteristics such as date of introduction, capital cost, fuel economy improvement, rate of base penetration, minimum and maximum penetration, and engineering notes
  – Technologies enter the market depending upon when they become available, and on the level of fuel prices
• Nine fuel options are represented: diesel, gasoline, CNG/LNG, LPG, Electric, PHEV diesel, PHEV gasoline, fuel cells
• Truck VMT is based on the growth in value of industrial output in 12 sectors and is shared to size classes, vintages, fuel type, and fleet type
• Total fuel consumption is calculated based on VMT and fuel economy
Key Policies NEMS Can Address

• Regional Transportation CO$_2$ Caps: CO$_2$ caps on highway gasoline and diesel fuel
  – Level of the emissions cap
  – Allowance banking
  – Cost containment

• Incentives for more efficient and/or alternative fuel vehicles (rebates, tax incentives, etc.) including both LDVs and freight trucks

• Impact of policies on VMT
  – NEMS has a limited ability to model detailed investment policies that would reduce VMT
  – OnLocation will work with Cambridge Systematics to incorporate their analyses into NEMS

• Policies to increase transit
Key Assumptions and Inputs

• The analysis will be based on EIA’s Annual Energy Outlook 2018, but assumptions in AEO 2018 can be changed
  – User assumptions can generally be changed easily (e.g., battery costs for EVs)
  – Inputs to the transportation model from other parts of NEMS (e.g., fuel prices) can be changed but some are more challenging than others
• Gasoline and diesel prices (calculated by NEMS based on world oil prices, U.S. oil production, refinery costs and inputs, demand)
• Battery costs for EVs as well as the balance of electric vehicle costs (non-battery costs)
• Baseline regional VMT growth
• Existing federal and state policies such as fuel economy standards for LDVs and commercial trucks, tax incentives for EVs, ZEV mandates, etc.
  – AEO 2018 includes existing federal policies at the time the projection was finalized.
Key NEMS Outputs

- CO$_2$ emissions by region and sector (including power sector CO$_2$ emissions)
- Price of CO$_2$ allowances and total revenue generated
- Annual energy consumption by fuel type, transportation mode, and region
  - Includes biofuels such as corn ethanol, cellulosic ethanol, biodiesel, biobutanol, and others
- Sales and stocks of LDVs by type (conventional gasoline, hybrids, PHEV, EV, etc)
- Fuel economy
- LDV and freight truck VMT