Decarbonization Technologies in the National Energy Modeling System (NEMS)

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NEMS decarbonization technologies

- NEMS models numerous technologies related to decarbonization

- Technologies modeled in:
  - electric power sector module
  - end-use sector modules
  - fuel conversion modules

Electric power sector decarbonization technologies

- Gas and coal electricity generation with CCS
  - new and retrofit
  - 30% and 90% capture
- Renewable and low-carbon electricity generation
  - wind (2 types, including off-shore)
  - solar (3 types)
  - geothermal
  - conventional hydropower
  - Landfill gas from municipal solid waste
  - biomass (non gasification technology, no CCS)
- Grid-scale energy storage (4-hour batteries)
- Nuclear electricity generation
  - Conventional
  - Advanced light water reactor
  - Small modular reactor
- Participates in NEMS inter-module CO_2 market and CCUS

Industrial sector decarbonization technologies

- Steel: Increased Electric Arc Furnaces (EAF) capacity
  - Some price-driven choice between blast furnace and EAF
  - Direct Reduced Iron production completely exogenous

- Electrification of glass furnaces
  - Price-driven shift to electric furnaces

- Material substitution (lower clinker production) in the cement industry

Residential and Commercial sector decarbonization technologies

- Heat pumps
  - air-source and ground-source
- Electric boilers (commercial)
- Electric water heating
  - electric resistance and heat pump
- Electric cooking appliances
- Distributed generation
  - solar photovoltaic systems (residential and commercial)
  - small-scale wind technologies (residential and commercial)
- Combined heat and power
  - natural gas fuel cells (residential and commercial)
  - natural gas microturbines and traditional turbines (commercial)
  - natural gas and distillate fuel oil-fired reciprocating engines (commercial)

Transportation sector decarbonization technologies

- Hydrogen fuel cell vehicles
- Battery electric vehicles
- Hybrid electric vehicles
  - Conventional
  - Plug in

Fuel conversion module decarbonization technologies

- Coal-to-Liquids with CCS
- Steam methane reforming for H_2 production
  - No CCS available
- Ethanol (conventional, cellulosic), biodiesel, renewable diesel, and other advanced biofuels
  - No CCS available

Works in progress

- Electric power sector
  - Potential increase to near 100% carbon capture for gas and coal electricity generation with CCS
  - Hydrogen model
    - H_2 production via electrolysis as seasonal storage
    - Electricity generation from H_2 via combustion turbines and/or fuel cells

- Industrial sector
  - Electric boilers
  - Make electric arc furnaces deployment based on economics
  - Direct reduced iron