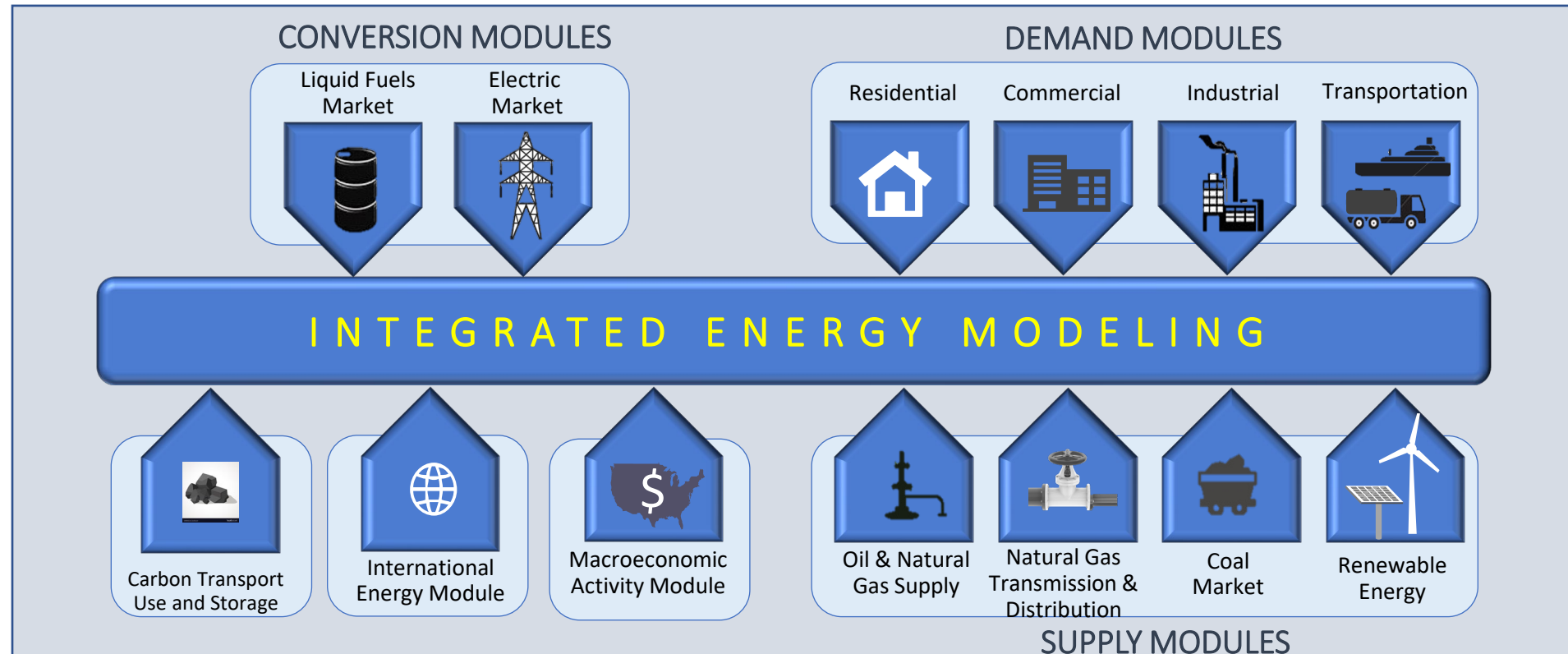


Hydrogen in the National Energy Modeling System (NEMS): Modeling Challenges

March 24, 2022



NEMS Architecture

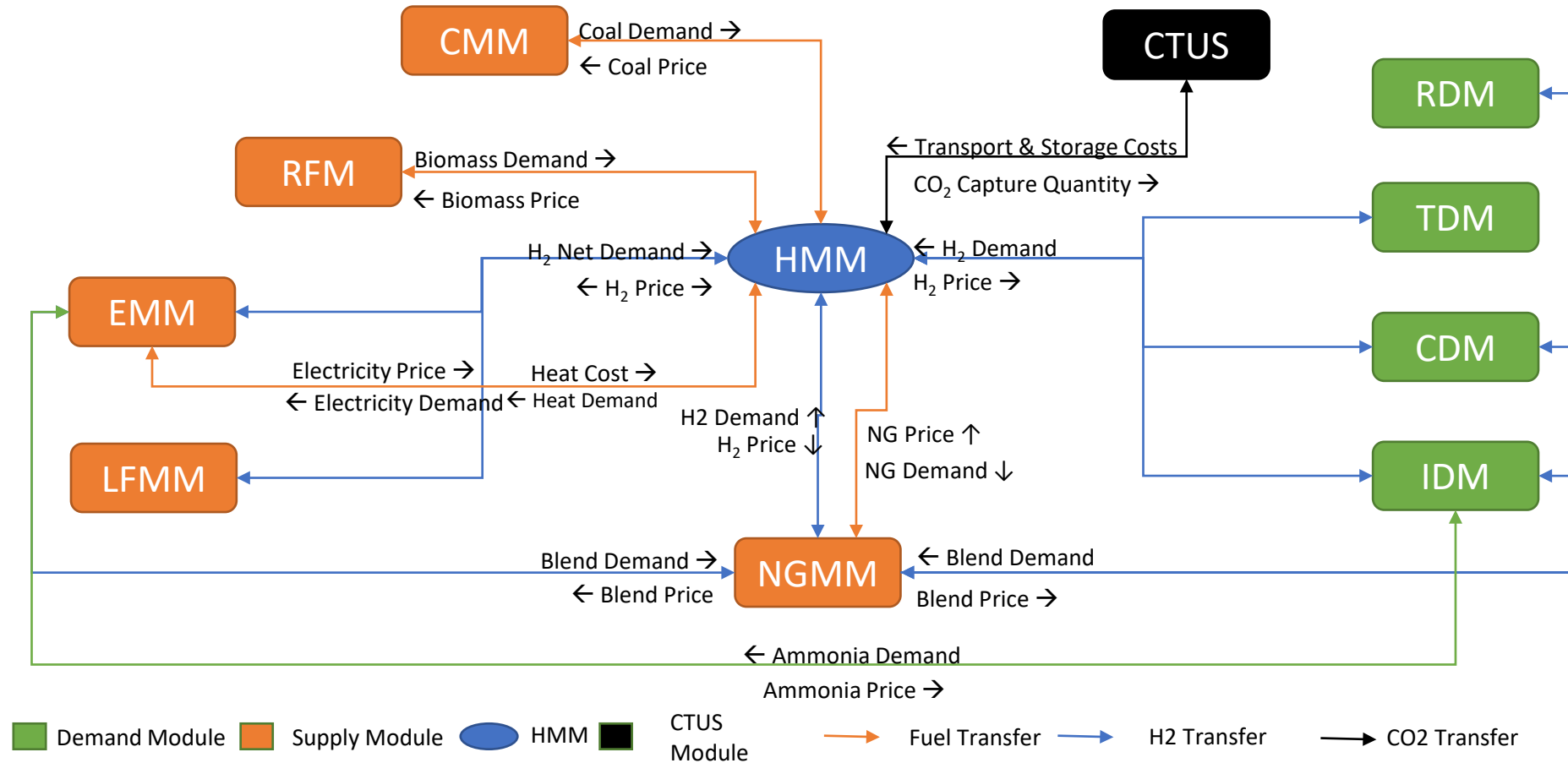


Overview of NEMS Hydrogen Model Enhancements

- (New Module) Hydrogen Market Module (HMM):
 - Production, transportation and storage of hydrogen
- Electricity Market Module (EMM):
 - Production of hydrogen through electrolysis, storage and combustion of hydrogen
- Natural Gas Market Module (NGMM):
 - Blended hydrogen
- End-Use
 - Transportation (TDM)– In particular, Heavy-Duty Vehicles
 - Industrial (IDM): Steel, chemical
 - Liquid Fuels Market Module (LFMM): Hydrogen for refining
 - Commercial (CDM): Niche Combined Heat and Power uses



Summary Chart of Interactions



HMM

- Constrained optimization program
 - Production, transportation storage of hydrogen
 - Multiple production technologies
 - Fossil fuel
 - Biofuel
 - Solar
 - Electrolysis
 - Dedicated transportation network (Region to region)
 - Large-scale storage



EMM - HMM Interactions

- Hydrogen production will be in both the EMM and HMM
 - EMM will have hydrogen from low-carbon sources
 - HMM will produce hydrogen from all technologies
 - Estimated load shape for electricity consumption
- Endogenous learning for joint technologies
- Potential for merchant hydrogen supply to EMM



Natural Gas Hydrogen Blends

- NGMM will use blended hydrogen and natural gas
- Blend level low enough that modeling new equipment not necessary
- Assume homogenous mixture throughout transportation and distribution system
- No modeling of separation of hydrogen and natural gas for demand usage



Self-Supply in Demand and Conversion Modules

- The self-production of hydrogen in the demand and conversion modules in NEMS will continue to occur
 - HMM to provide sector specific hydrogen pricing to the LFMM, TDM and IDM for both centralized production and distribution, and a regionally specific price of hydrogen for self-supply
 - HMM will compete with the hydrogen production in modules described below.

Refining (LFMM)	Hydrogen production with steam methane reforming (SMR) for use in the refining sector will continue to be included
Transportation (TDM)	Localized hydrogen production for transportation consumption may be modeled, however this may be in a reduced form rather than at the technology level
Electricity (EMM)	Hydrogen production for use with a seasonal storage component is under development at EIA. This initiative will be incorporated into the current project
Industrial (IDM)	Localized hydrogen production as an intermediate for industrial processes will continue to be modeled. This production is a closed source, being produced and consumed within the industrial module.
Commercial (CDM)	Niche market for Combined Heat and Power