Modeling Hydrogen in the Electric Power System

For

Hydrogen in the U.S. Energy System: Webcast Forum on Modeling Challenges

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By

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Overview

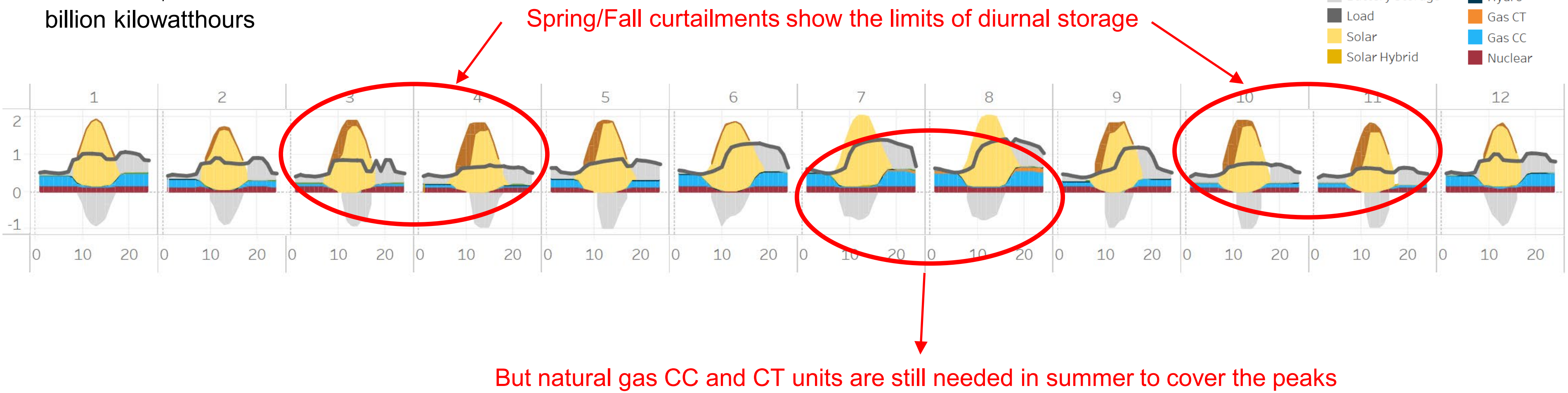
- Hydrogen has several potential uses in the electric power sector
  - Bulk power (i.e. use in a CC unit for load-following or baseload): pre-supposes availability of “externally” produced hydrogen (otherwise, its just storage…see below)
  - Reliability (i.e. use in a CT to provide peaking or just to meet reserve margin)
  - As diurnal or seasonal storage: especially important if natural gas peakers are not available

- Current policy proposals look to decarbonize the electric power sector 10-15 years ahead of the rest of the economy
  - This suggests that broader hydrogen markets might not be formed by the time hydrogen would be most useful in the power sector
  - To the extent that hydrogen is an economically viable technology for electricity, the power sector may have to “bootstrap” its own industry

- EIA is currently developing a submodule within EMM to allow for hydrogen use within the model to provide seasonal storage and reliability

The case for seasonal storage is evident even with moderate renewable penetration

Hourly U.S. electricity generation and load by fuel type and month in 2050
Midcontinent ISO/South
AEO2022 $35 Carbon Fee case
billion kilowatthours



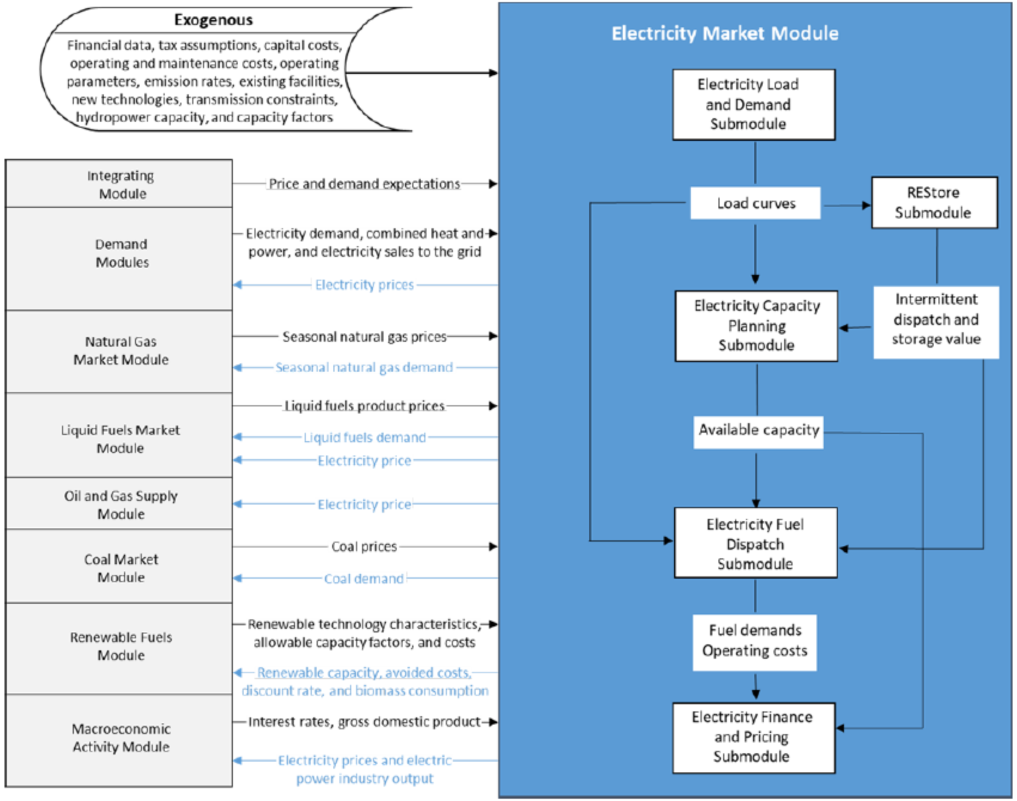
The case for modeling seasonal (H_2) storage within the EMM

- Hydrogen offers a conceptually different economic proposition than diurnal storage (batteries, pumped hydro)
  - With diurnal storage, not possible to decouple charging capacity from discharging capacity
  - For example, if curtailments are generally 1 to 5 GW, spread over 8 months, but peaking needs are 25 GW, you would need to build a 25 GW battery that was only ever recharged at 20% of its maximum capability
  - If existing CTs can be converted to H_2 at a low enough cost, charging capacity (electrolyzers) can be optimally sized for efficient recharge, without needing to carry excess discharge capacity

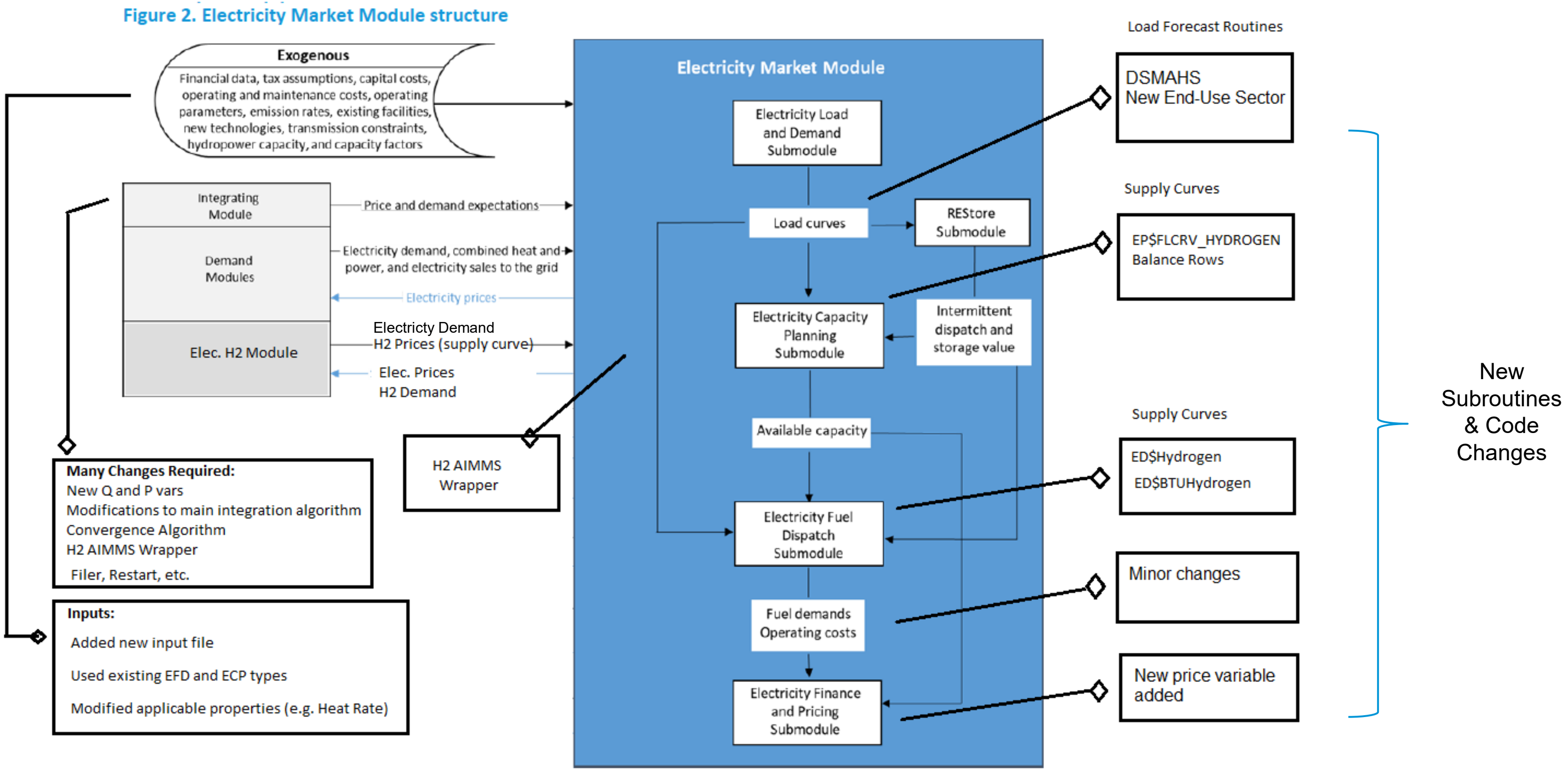
- Storage in general, and especially seasonal storage requires extensive communication with EMM and its REStore submodule
  - REStore provides a quasi-hourly dispatch (24 representative hours for each of 12 months)
  - It can co-optimize wind, solar, and storage dispatch for use in capacity planning and system dispatch modules

Current EMM structure

Figure 2. Electricity Market Module structure



Hydrogen structure under development



Electric Power Hydrogen for Reliability and Trans-seasonal Storage (EPHRTS) Model Status

- Base functionality demonstrated
  - AIMMS H_2 supply module will produce a supply curve for H_2 fuel produced from electrolysis based on electrolyzer costs, "hourly" marginal electricity prices, & storage costs.
  - ECP builds H_2 turbines and EFD dispatches them using H_2 fuel in sensitivities with very low electrolyzer costs
  - Difficult with current NEMS configuration to induce "demand-driven" builds
- Currently working / next steps:
  - Properly adding the electricity needed to produce H_2 to the total hourly electricity load curve
  - Adding H_2 turbines to REStore to determine hourly dispatch pattern
  - Edit all reporting/ model output files (debug files, ftab)
- Potential future additions:
  - Retrofit H_2 capability to existing CT (or CC) fleet
  - Blending with H_2 and natural gas

Questions?