Mitigation Working Group (MWG)
Buildings Ad Hoc Group
Topic: Maryland Building Decarbonization Pathways

July 13, 2021

The meeting included a presentation by E3 on preliminary results for Maryland's buildings study. Participants were encouraged to provide feedback and participate in the discussion.

<u>Public Comments</u>

- Donald Goldberg: Should the state have mid-point goals? So we can make sure to meet goals?
- Thomas Marston: having trouble improving decarbonizing as it is. Looking at the importance of attention on an existing housing, which is significantly energy efficient, and hard to scrub gas out of it because of individual conditions. So we need to focus on existing buildings
- Paul Berman: E3 report doesn't focus adequately on environmental justice concerns. Focusing on existing housing stock is a way to remedy that.
- David Smedick: Really need to dig into solutions for allotting resources on whole-home retrofits (not just whack a mole). MWG has done work, but more needs to be done. Also: as potential federal action is taking place, could we get clarification on how that will help states?
- Christopher Russell: There needs to be a conversation on the means of deploying decarbonization.

<u>Presentation:</u>

- In May, E3 had workshop with building ad hoc group to get feedback on three scenarios
    - Since then, been working with MDE, USCA, and the Nature Conservancy on finalizing scenario design. We have finished preliminary analysis.
- Today's presentation focuses on EARLY results on three scenarios. We want feedback.
- Objective: building decarbonization by 2050
    - Currently 13% total MD emissions
    - 90% of statewide electric load
        - 30% of total GHG emissions (including electricity use)
    - Key questions: potential pathways, and costs and benefits to producers and consumers
- Three scenarios:
    - High electrification
        - Almost all buildings switched to ASHPs and GSHPs. Heating supplied by electricity throughout year
        - High efficiency through building retrofits
    - Electrification with gas back-up
        - Existing buildings keep using fuels and heating, supplied with heat pump with existing furnace/boiler that serves as a backup in coldest
        - All electric for new construction
    - High decarbonized methane
        - Buildings keep using fuels for heating, but fossil fuels gradually replaced by low-carbon renewable fuels

        - Biomethane, synthetic natural gas
        - Hydrogen blend
        - High efficiency w building retrofits
- All three scenarios get zero direct building emissions by 2045
    - But still indirect emissions from upstream electricity generation by 2045 (PJM imports)
        - 4.8-5 MMt CO_2e per year
        - Indirect emissions only with electricity generations
- Key findings
    - Net zero requires tech commercialization and accelerated implementation
    - Decarbonized methane requires large quantities of zero-carbon fuels, resulting in high incremental fuel costs with significant cost uncertainty
    - High electrification causes a summer to winter peak shift and significant increase in peak electricity demand, meaning high incremental electricity system costs
    - Electrification with fuel backup has 80% less electricity system cost compared to High Electrification scenario, lowest cost overall compared to other two scenarios
    - Cost of fuel increase in all scenarios as result of zero-carbon fuels and higher delivery cost (lower consumption), emphasis on mitigating energy burden with customers "staying behind" is important
- Questions:
    - Del. Dana Stein: What energy input are you expecting from PJM imports?
        - Consistent with 2030 GGRA plan, assumed that Maryland is currently getting 25% state load from PJM, breaking PJM into RGGI states and non-RGGI states. Assuming will be half clean electricity, half gas overall.
- Energy consumption:
    - Heat pumps become major space heating equipment in high-electrification (HE) scenario
    - Dual-fuel heat pumps added to most retrofit buildings in electrification with fuel backup (EFB), pairing with existing fuel-based systems.
    - Electric resistance currently accounts for 20% space heating devices.
- Electricity demand in all scenarios lower than reference due to efficiency gains
    - Demand increases in all scenarios due to more households, but net decrease overall,
- Natural gas demand declines in all scenarios.
    - In buildings expected to decline due to efficiency gains offsetting growth in household, accelerated in scenarios w significant building electrification.
- RNG (renewable natural gas) has 2 scenarios for supply (conservative and optimistic)
    - $70 for 1 MMBtu for conservative, half that for optimistic
    - Assumptions:
        - Conservative scenario has two constraints: feedstocks only with MD in-state supply. Assumes competitive (most cost-effectively used to produce liquid fuels e.g. transport or jet fuel).
        - Optimistic: access to population-weighted share of national feedstocks. And also NO competition for other end-uses. Assumes hydrogen is 7% of energy content available (7% can work in existing pipelines, but no more than that).
- Gas composition transitions to renewable natural gas (RNG)
    - By 2045, all building scenarios have 100% blend of RNG in remaining gas demand.
    - In conservative scenario where biomass limited, synthetic natural gas (SNG) is main source of low-carbon gas in all scenarios.
    - In optimistic, biomethane becomes main source of low-carbon gas.

- All scenarios reduce total energy demand.
  - HE has lowest relative to reference, then EFP, then highly decarbonized methane (HDM)
- Questions:

  There's an assumption that no EmPOWER after 2023. But we most likely will have it after 2023 at least. How will that affect these projections?
    - Most relevant in HDM, because assuming no other incentives available. Only incentive left is EmPOWER. If we assume EmPOWER sticks around, air source HP would increase. In HE and EFB, other factors that drive heat pump production that are the prevailing incentive, so not much of a difference.
  - What about district heating?
    - Not considered within this study, that decision was made at discussion in May. but we do look at single family, multifamily, commercial?

Peak load:

- Maryland's current electric system peaks in the summer/
  - Building heat load peaks in the winter because heating is used instead of electricity/
- Maryland is expected to have little peak load growth in HDM scenario.
  - Growth is due to population.
  - Could have 3.5GW higher peak load in very cold winters.
- Winter peak loud expected to grow by 15 GW by 2045 in HE scenario.
  - Because electricity replaces gas heating.
  - By 2045, can be as much as 20 GW in peak cold winters.
- EFB has much smaller winter peak load growth.
  - Rare cold winters only have roughly 5GW more.
- Approach for system cost impact analysis has four cost components:
    - Electric system cost
      - Investment in transmission and distribution infrastructure.
      - Investment in additional generating capacity to meet peak electric demand.
      - Generation cost to meet additional electricity demand.
    - Gas system
      - Capital expenditure for reinvestment in gas system.
      - Operating cost to maintain gas system.
      - Gas commodity costs for RNG to replace natural gas.
    - Equipment
      - Investment tin efficient or electric appliances relative to reference.
      - Investment in building shell improvement.
    - Other fuels
      - Fuel commodity cost of biodiesel and other fuels.

Cost components:

- Meeting electric loads in HE scenario requires 203 billion of annual incremental system cost.
  - HE significantly increases electricity system cost.
  - Mainly from generating capacity, transmission, and distribution.
  - Pairing ASHPs with fuel systems can save more than 80% of incremental costs, mainly by avoiding T&D infrastructure and generating capacities.
  - With current installation practice, 3.2 billion. With high electrification improved system configuration, only 2 billion.

- Gas system cost in all scenarios show wide ranges because of large uncertainty with RNG commodity cost. HDM scenario can go from 4 billion to 12 billion per year while EFB 4 billion.
- Equipment cost:
    - Two book-end scenarios have high incremental equipment costs due to building shell improvement.
    - EFB lowest cost scenario because it doesn't include building shell improvement
- Residential Gas rates significantly increase across all scenarios.
    - HE w/ rapid rate increase driven by declining throughput despite lower total delivery and commodity costs.
    - HDM driven primarily by commodity cost for zero-carbon fuel.
    - EFB scenario higher gas rates than HDM due to lower throughput and resulting higher MMBtu delivery cost.
- HE scenario shows more rapid electric rate increase compared with EFB
    - EFB lower rate increase because it has smaller load factor and manages to avoid expensive peak capacity investment.
- Utility bill and customer impacts:
    - HE is a lot more, then EFB, then HDG.
- All electric design is expected to be less expensive for new construction.

Questions

- Ashita Gona: lot of pipelines would need to be updated. Are those upgrade costs included in modeling?
    - Yes. Applied different growth rates for different components.
- T&D cost for HE: cost of new infrastructure vs existing?
    - Not specified in study.
    - It would be good to know this, because if you'd have to invest in new transmission lines, that's something people would like to know versus upgrading existing.
- Difference between E3 analysis on critical question of peak demand season
    - Overall pretty confident in seeing that electrifying means peak increase in winter is 10GW.
    - But we don't consider changes in weather because of climate change. What's the impact of climate change on peaks? We don't know entirely.
- Erin Appel (Geothermal Association): there's cost considerations around geothermal installations, but we do have carveout for geothermal within tier 1.
    - This is something we were aware of, and we'll look into it to see how it'll affect study
- Delegate Stein: We heard about home retrofits and new home construction. What about commercial buildings?
    - We did a similar cost analysis, and we expect commercial would have similar results.
- Conclusions:
    - All scenarios technically feasible to net zero by 2045, but it would require extensive deployment and commercialization measures.
    - HDM requires high demand for zero-carbon fuels, meaning high incremental costs with significant cost uncertainty.
    - HE pathway results in shift from summer peak to winter peak (space heating loads in winter).
    - EFP lowest overall cost, also reducing reliance on tech that has not been widely commercialized or uncertain in scalability.

- Each scenario presents its own equity and affordability challenges.
    - Average cost of gas service likely to increase in electrification scenario as customers leave the system and infrastructure costs are spread over smaller customer base.

There should be an emphasis on mitigating energy burden of customers "staying behind."

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