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Dear Mr. Nelson, Ms. Pham, and Ms. Lintmeijer,

Thank you for the opportunity to provide comments on the Rhode Island Future of Gas Technical Analysis Draft Results distributed to the Stakeholder Committee on February 6th. Acadia Center submits the following recommendations in response.

The Draft Results Found the "Hybrid Delivered Fuels Scenario" with "Managed Transition Sensitivity" to Have the Lowest Economy-wide Costs of any Scenario/Sensitivity Combination Analyzed and This Finding Should be More Prominently Highlighted in the Report

As articulated on slide 64 of the Technical Analysis Draft Results presentation ("Draft Results presentation"), this Future of Gas technical analysis evaluated six decarbonization pathway scenarios ("scenarios") and applied five sensitivities to all scenarios[1], resulting in 30 unique model/sensitivity run combinations. Slide 64 also includes Low Bound and High Bound sensitivity model runs for each scenario (essentially combining multiple sensitivities), increasing the total number of unique scenario/sensitivity combinations analyzed to 42. **The outputs on slide 64 answer one of the most fundamental questions for this type of modeling analysis – *What is the economy-wide cost of each of these 64 unique decarbonization scenario/sensitivity combinations relative to a "business as usual" (or "reference") scenario?* The results of the table on slide 64 highlight that the Hybrid Delivered Fuels Backup Scenario with Managed Transition Sensitivity has an estimated incremental cost $12.7 billion, the lowest incremental cost of any of the 42 modeling runs by a margin $1.4 billion.** Also notable is that the Staged Electrification scenario with Managed Transition sensitivity has the second lowest cost at $14.1 billion. The below image represents how these findings are displayed on slide 64 of the Draft Results presentation, with highlights added to emphasize the Hybrid Delivered Fuels Scenario with Managed Transition Sensitivity finding.

[1] Acadia Center acknowledges that a sixth sensitivity ("Impact of Global Warming Potential and Biofuel Emissions" was also modeled for all scenarios, but this sensitivity only impacted the emissions reductions achieved under each scenario (as summarized on slide 30), not the economy-wide incremental cost of each scenario.

Economy-Wide Incremental Costs Across Seven Modeling Sensitivities Applied to Six Decarbonization Pathway Scenarios (Slide 64)

Sensitivity →
↓ Scenario

Incremental cost above Reference ($2023 billions cumulative NPV)							
	Low bound	Man. Trans.	High Heat Pump	High RECs	High Renew Fuel	High Net. GSHP	High bound
High Electrification	$16.4	$14.6	$19.1	$16.8	$16.8	$17.0	$20.3
Staged Electrification	$14.9	$14.1	$17.2	$15.2	$16.4	$14.9	$19.1
Alternative Heat Infrastructure	$16.7	$16.3	$18.6	$17.0	$18.7	$18.9	$23.1
Continued Use of Gas	$15.8	$15.8	$16.9	$15.9	$24.5	$15.8	$25.8
Hybrid Gas Backup	$14.5	$14.3	$16.5	$14.8	$16.9	$14.5	$19.3
Hybrid DF Backup	$14.6	$12.7	$16.6	$15.0	$17.5	$14.6	$19.8

This strikes Acadia Center as one of the key findings of the entire Technical Analysis Draft Results. From a communications perspective, it seems odd to relegate this finding to slide 64 of an 85-slide presentation. **The first comparison of economy-wide costs of the various scenarios analyzed appears on slide 17, and importantly does not include the economy-wide costs associated with the Managed Transition Sensitivity for each scenario.** A small footnote in the bottom right mentions the economy-wide costs are only shown for an "unmanaged transition" but the logic as to why is not made clear.

Economy-Wide Costs Across Seven Modeling Sensitivities Applied to Six Decarbonization Pathway Scenarios (Slide 17)

Evaluation Criteria	Key Metric	Detail on slide	High Electrification	Hybrid + Delivered Fuels Backup	Hybrid + Gas Backup	Staged Electrification	Alternative Heat Infrastructure	Continued Use of Gas
Economy-wide Costs	Cumulative NPV in $bln*	62-65	$16-20	$15-20	$14-19	$15-19	$17-23	$16-26

* Expressed as cumulative Net Present Value (NPV) between 2023-2050, incremental to a reference scenario. Costs shown for "unmanaged" transition.

The summary table on slide 17 includes the range of estimated economy-wide costs between the Low Bound and High Bound Sensitivities. These sensitivities test a range of assumptions regarding heat pumps, networked geothermal systems, alternative fuels, and the cost of renewable energy credits (RECs). However, these Low Bound and High Bound Sensitivities, and the economy-wide costs associated with them as presented on slide 17, don't represent the full range of sensitivities modeled. In the case of the Hybrid DF scenario, the Managed Transition sensitivity has an economy-wide cost ($12.7 billion) that is $1.9 billion lower than the Hybrid DF Scenario with the Low Bound sensitivity ($14.6 billion). This extremely important point is completely lost in the slide 17 summary table. **Acadia Center urges E3 to include the full range of economy-wide costs, across all sensitivities within a scenario, in any table summarizing the range of economy wide costs across scenarios and sensitivities. Further, Acadia Center urges E3 to elevate the finding that the Hybrid DF Scenario with Managed Transition Sensitivity was found to be the lowest cost of all 42 scenario/sensitivity combinations analyzed – this level of finding is appropriate for inclusion in the Summary and Key Findings section of the Draft Results presentation and the corresponding report.**

Effectively Communicating the Risk of Rising "Non-Migrating Customer" Energy Costs

Several slides in the Draft Results presentation focus total monthly energy costs for "non-migrating" customers. In the context of decarbonization scenarios that rely heavily on building electrification and entail significant departures of customers from the gas system, the term "non-migrating" customers refers to those customers that remain reliant on the gas distribution system for heating. The concern of monthly costs for these non-migrating customers is first addressed in the summary table on slide 17, and also addressed in more detail on slide 68. **While Acadia agrees that it is critical to flag the modeled, rapidly escalating monthly energy costs for non-migrating customers, we also have concerns with how this information is presented and the risk of incorrect interpretations of these findings by various audiences. In particular, these projections on non-migrating customers monthly energy costs assume no changes, either minor or major, to the status quo cost recovery approaches over the next 26 years and effectively communicating this point is critical.**

While this point may be crystal clear to those have been steeped in the technical analysis for months, it may be significantly less clear to those reading the findings of the Draft Results presentation for the first time or those less familiar with this type of scenario analysis. To Acadia Center, this is why framing and clear communication on this particular topic is critical. For example, one could imagine language on slide 68 stating, *"Projections of monthly energy costs on this slide assume cost recovery regulations remains unchanged between 2023 and 2050. Significant changes to regulatory designs that share gas system transition costs more broadly with those who benefit from the transition have the potential to fundamentally alter the migrating vs non-migrating customer monthly energy cost dynamic shown in the graph below."* This would prevent misinterpretations that the migrating vs. non-migrating energy cost dynamic is a "fixed outcome" of the decarbonization scenarios modeled by E3. The importance of this framing also applies to slide 17, where the concept of non-migrating customer costs in 2050 is first introduced in the presentation.

Other studies that have investigated this particular topic have come to the conclusion that the current cost recovery paradigm is not structured to handle the building decarbonization transition over the next 25+ years in a manner that equitably limits energy cost escalation for non-migrating gas customers. For example, the Massachusetts D.P.U. 20-80 Independent Consultants Report: Considerations and Alternatives for Regulatory Designs to Support Transition Plans considered some of the potential options to address this concern. The section of that report titled Evaluate Alternatives Approaches to Recover Transitions Costs states, *"There are two approaches that can be evaluated to mitigate cost recovery to remaining LDC (gas utility) customers while maintaining basic ratemaking principles: (a)* *cost recovery from customers leaving the gas system (migration charge), and more broadly (b) Massachusetts-wide cost recovery (transition charge)."* While Acadia Center does not advocate for a migration charge applied to electric heating customers departing the gas system, exploration of the wide array of potential state-wide cost recovery mechanisms warrants further investigation.

Regarding state-wide cost recovery options, the report goes on to state that *"The pathways analysis shows: (1) it is impractical to expect LDC customers to pay for all transition costs; and (2) the option better aligns the cost of the transition to those who benefit from the transition."* Well not clearly defined in the report, presumably "those who benefit from the transition" refers to anyone who benefits from the avoidance of the impacts of climate change in the state (i.e., every resident and business in the state). The footnote in that report, citing a Regulatory Assistance Project's Under Pressure: Gas Utility Regulation for a Time of Transition report, summarizes the situation well, stating, *"Policymakers may look to other sources of funding to ameliorate rate impacts on future gas customers. There is no silver bullet, as many sources come with significant complications … General funds and taxes could provide funding to assist with the gas transition. Direct funding from the state or federal government, as well as various forms of tax assistance, could be significant, although budgets are often constrained…"*[2]

Upcoming phases of this investigation will surely include a more nuanced discussion of potential policy levers to address customer affordability concerns, particularly for non-migrating customers that remain on the gas distribution system in scenarios that have significant levels of customer departures from the gas system. Acadia Center looks forward to engaging in those conversations, but, in the meantime, urges E3 to provide more nuanced context when presenting the findings of non-migrating customer affordability under various scenarios investigated in the technical analysis.

The Risk Posed by "Alternative Accounting Frameworks" On the Ability of Alternative Fuels to Reduce GHG Emissions Should be Elevated in Findings

There is a high degree of uncertainty surrounding lifecycle emissions from biofuels, and the lifecycle emissions from biofuels vary on a fuel-by-fuel basis dependent on production pathways. Currently, the RI GHG Inventory ignores this nuance and complexity and considers biogenic emissions from biofuels scope 3, thus not impacting reported state-level emissions. This assumption – which treats all forms of biofuels identically (zero emissions) from a GHG accounting perspective is not appropriate for properly weighing the GHG impacts of decarbonization scenarios that rely heavily on biofuels.

Slides 30 and 78 in the Draft Results presentation make an attempt to communicate this risk. For example, slide 30 shows that if biofuels are assumed to "yield not emissions benefits" that the Continued Use of Gas Scenario only achieves an 83% reduction in net emissions by 2050, opposed to a 100% reduction under the default modeling assumptions used by E3 that match the accounting structure. The results are even more alarming when one focuses strictly on the impact of 2050 building sector emissions when comparing the status quo and "no emissions benefits" biofuel emissions accounting methodologies. For example, the Continued Use of Gas Scenario appears to show

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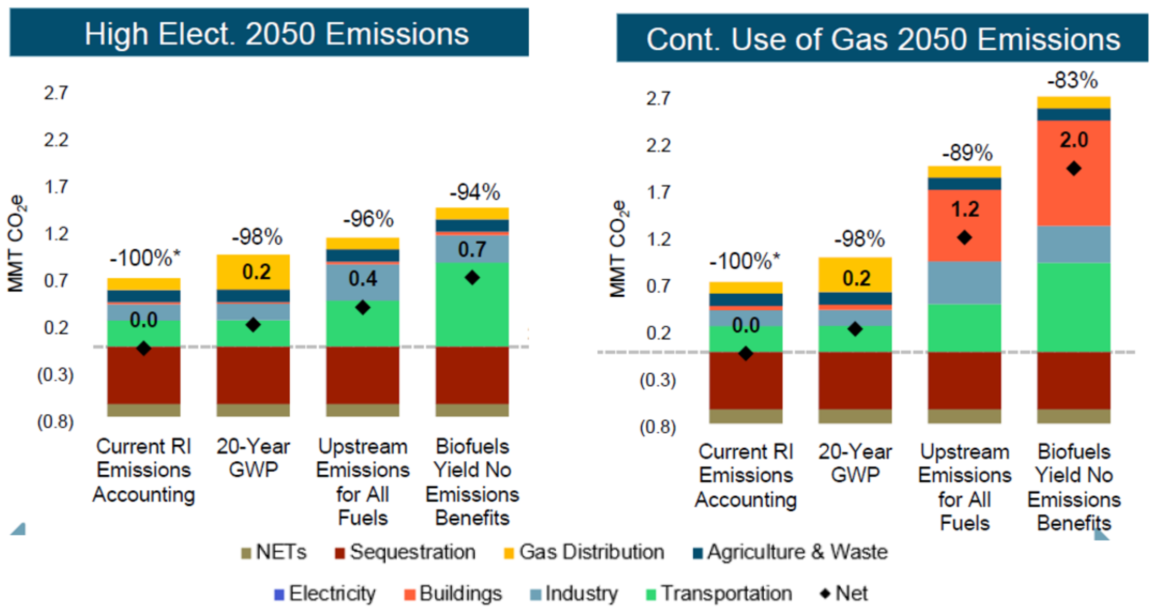
[2] Anderson, Megan., LeBel, Mark., & Dupuy, Max, 'Under pressure: Gas utility Regulation for a Time of Transition' (May 2021) (p. 16)

approximately a 17x increase in building sector emissions. Conversely, the High Electrification Scenario only shows an approximate 2x increase.[3]

Impacts of Different Accounting Frameworks for Alternative Fuels on 2050 Emissions: High Electrification Scenario vs. Continued Use of Gas Scenario (Slide 30)



Given the high level of uncertainty regarding appropriate lifecycle emissions accounting and the high level or risk that future GHG accounting changes could make it impossible for all of the modeled scenarios (particularly those more reliant on biofuels) to comply with the Act on Climate GHG reduction targets, Acadia Center urges the findings from slide 30 and slide 78 to be elevated to the "Summary and Key Findings" section of the Draft Results presentation and the corresponding report.

The Risk Posed by Methane Leaks from the Gas Distribution System Should be More Effectively Communicated

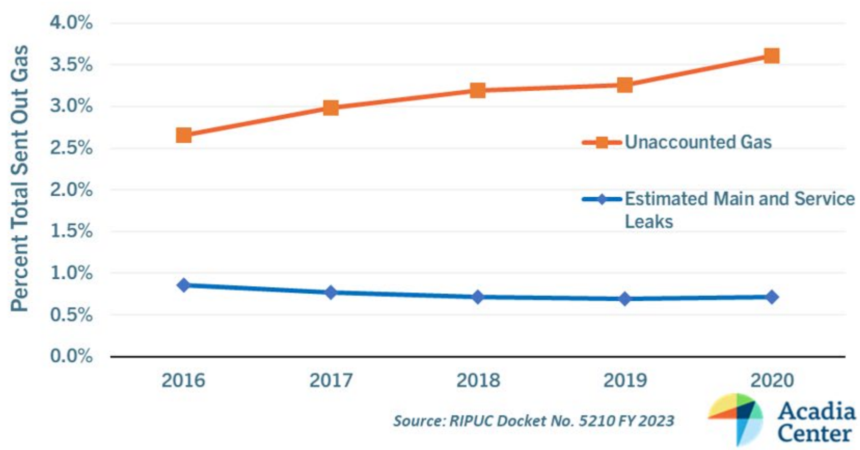
Acadia Center has significant concerns that the GHG emissions risks posed by gas distribution system and behind-the-meter leaks are not being adequately communicated in the Draft Results presentation. While we acknowledge that it is challenging to quantify the exact magnitude of methane leaks from the gas distribution system and behind-the-meter, there is a high likelihood, based on mounting scientific evidence, that the RI GHG Inventory significantly underestimates these methane leaks and the resulting GHG emissions. It's critical that this risk is properly communicated to various audiences that will be reviewing the results of the technical analysis. **The risk of RI GHG Inventory's underestimating the level of methane leaks from the gas distribution system and behind the meter is not addressed anywhere in the 85-slide Draft Results presentation and is a significant oversight in Acadia Center's view.**

[3] Note: Increase in building sector emissions under various accounting methodologies estimated by Acadia Center based on graph measurements since underlying graph data not provided to stakeholders.

How significant is the risk of underestimating gas system and behind-the-meter methane leaks? A long-term study by Harvard scientists (Sargent et al., 2021) found that six times more methane is leaking into the air within a 28-mile radius of downtown Boston than the Massachusetts GHG Inventory reported.[4] It's worth noting that the methodology for estimating gas system leaks in the MA GHG Inventory and RI GHG Inventory is identical. Additionally, the study observed no changes to the level of methane emissions in the greater Boston metro area over a period of eight years despite significant efforts to slow the rate of leaks from the gas system, primarily through gas main replacements. While the greater Boston metro area gas system and the Rhode Island gas system are not entirely analogous, the systems share enough similarities for the findings from the Sargent et al., 2021 study to help frame the potential risk of gas system leaks in the context of Rhode Island.

Rhode Island-specific data on the levels of unaccounted gas in the state's gas distribution system also raise alarm bells. There is a significant disconnect between the levels of unaccounted gas reported by Rhode Island Energy (RIE) and the estimated gas main and service leak rates assumed in the RI GHG Inventory. For example, in 2020, the measure level of unaccounted gas according to RIE was 5.1x higher than the estimated rate of gas main and service leaks in the RI GHG Inventory, as depicted in the graph below.

Rhode Island Unaccounted for Gas vs. GHG Inventory Estimated Gas Main and Service Leaks
+ Gas Main Replacements by Material Type



Material	% Change Main Miles: 2016-2020
Cast Iron	-12.6%
Unprotected Steel	-24.0%
Plastic	+15.9%

Furthermore, while the Rhode Island GHG Inventory methodology assumes that replacing cast iron and unprotected steel gas mains with plastic gas mains significantly reduces the level of leaks, the level of unaccounted gas according to RIE steadily increased during the 2016-2020 time period despite 13% and 24% reductions, respectively, in miles of cast iron and unprotected steel mains over that same time period. It's also worth noting that neither the unaccounted for gas figures provided by RIE nor the RI GHG Inventory methodology for estimating gas main and service leaks account for behind-the-meter gas leaks. The Sargent et al., 2021 study flags behind-the-meter gas leaks as potential significant contributor to overall methane leak rates. T**he extreme levels of uncertainty regarding gas leaks in Rhode Island, and the limitations of the state's current accounting approach for gas system leaks, are core to the framing of the technical analysis and should be elevated to the Summary and Key Findings sector of the Draft Results presentation and the ensuing report.**

[4] https://www.pnas.org/doi/10.1073/pnas.2105804118

The Role of Propane or Propane Equivalent Alternative Fuels is Not Clear

Throughout the Stakeholder Committee and Technical Working Group process, several stakeholders have urged E3 to incorporate the option of natural gas heating system to hybrid electric/propane heating system conversions into the modeling (particularly in the case of the Hybrid Delivered Fuels Scenario) as a potential alternative to natural gas heating system to hybrid electric/oil heating system conversions. As discussed in Building Decarbonization Coalition's Future of Gas In New York State report[5], these gas to hybrid electric/propane conversions may be more cost-effective than gas to hybrid electric/oil conversions because adjustments to natural gas heating furnace/boiler burner tips to accommodate propane are lower cost than wholesale replacement of natural gas furnaces/boilers with oil furnaces/boilers. This point seems particularly relevant in scenarios, where, for example, the gas system on a street is being strategically decommissioned but multiple homes have recently installed high efficiency gas furnaces or boilers.

However, it's not clear, despite multiple requests from stakeholders, if E3 has actually incorporated these gas to hybrid electric/propane conversions into their modeling. The term "propane" is mentioned zero times in the Draft Results presentation and the term "LPG" is mentioned once on slide 29, but only in the context of remaining economy-wide emissions by fuel. On slide 33, the graph of Residential Housing Heating Equipment Adoption in the Hybrid Delivered Fuels Scenario appears to indicate that approximately 25% of residential heating devices are "oil heating" in 2023 and by 2050, about 62% of residential heating devices are "Hybrid Electric/Fuel Oil Heating". "Hybrid Electric/Propane" is not included as a category. This appears to suggest that a large number of gas heating customers in 2023 are converting to hybrid electric/fuel oil heating from 2024-2050. It's not clear if the conversion of these customers to hybrid electric/propane heating was considered as an option in E3's modeling. The same dynamic and questions apply to the commercial sector heating equipment adoption presented on slide 35. **If conversions to electric/propane hybrid heating were not considered for any buildings, this modeling decision could have the impact of significantly overestimating the costs associated with the Hybrid Delivered Fuels Scenario. Acadia Center requests that E3 clarify the assumptions regarding hybrid electric/propane heating in the technical analysis.**

Specific Comments and Questions on Individual Slides in Technical Analysis Draft Results Presentation

The above section summarized high-level concerns with the analysis approach and the presentation of modeling results. The following list of primarily consists of more specific comments and questions that pertain to individual slides in the Technical Analysis Draft Results

- **Slide 4 Comment:** The term "managed transition" is only used once on this slide in the context of the Staged Electrification Scenario "research question" and gives the impression that the "managed transition" approach can not also be applied to the five other scenarios presented on the slide. However, as described on slide 6, the Managed Transition Sensitivity was applied to all six scenarios presented on slide 4. Acadia Center suggests avoiding the term "managed transition" in the context of the Staged Electrification Scenario research question to avoid confusion.

[5] See page 49 of report

- **Slide 5 Comment:** For those that have not been following the technical analysis in depth, it would be helpful to articulate that the "Low-Carbon Fuels" column is referring to the Low/Medium/High use of low-carbon fuels across the entire economy, not strictly the buildings sector, or, as the gas pump icon suggests, the transportation sector.
- **Slide 10 Comment:** It would be helpful to highlight the gross emissions level achieve in 2050 on this graph. It's not currently possible to decipher accurately and is highly relevant to the content/focus of the slide.
- **Slide 11 Comment:** It would be helpful to address if heat pump to heat pump replacements are included in these annual sales totals. For example, is a heat pump sold in 2050 to replace a heat pump sold in 2035 considered a "2050 heat pump sale?" This distinction would add helpful context for interpreting the heat pump peak sales in 2040 and subsequent decline in sales shown in 2050.
- **Slide 11 Comment:** Does the term "high-efficiency gas furnaces" on this slide intend to refer to "high-efficiency gas furnaces and high-efficiency gas boilers"? If so, Acadia Center would suggest changing the wording to reflect the intended meaning, particularly given the prevalence of hydronic heating systems in Rhode Island. This comment is also applicable to slide 26 and slide 34 of the presentation.
- **Slide 11 Comment:** The yellow and blue dots on this graph both represent single scenarios, while the green dots represent four distinct scenarios. Even acknowledging the footnote in the bottom right providing context of the definition of "heat pump" in this context, it seems surprising that all four of the scenarios represented by the green dots would see identical levels of heat pump sales across years. It would be helpful if this point was clarified. Do the green dots represent an average number of heat pump sales across those four scenarios?
- **Slide 12 Comment:** It would be helpful to provide some explanation of what "renewable fuel blending" means in the context of this slide. For example, one can imagine some people viewing this slide would not be clear if this refers to renewable fuel blending in the gas system, in both gaseous and delivered fuels in the buildings sector, or on an economy-wide basis (i.e., transportation sector, power generation sector, etc.).
- **Slide 12 Comment:** Minor comment, but the placement of the blue dot on the far left High Electrification scenario graph is confusing. The dot is on the portion of the graph representing electricity consumption, but the text makes reference to levels of renewable fuels.
- **Slide 13 Comment:** It appears that median peak load from heating in the High Electrification scenario is declining approximately 15% from 2040 to 2050. This is the only scenario showing a decline in peak heating load over that time period and it would be helpful to highlight what is driving that decline, opposed to the increase in, for example, the Hybrid Delivered Fuels and Staged Electrification scenarios.
- **Slide 13 Comment:** Does the analysis assume that 100% of hybrid heating systems, in both the residential and commercial sectors, are relying on their back-up combustion system during winter peak load events? This information is relevant for thinking about the "optimal" balance for hybrid versus fully electric heating systems, particularly in the residential sector.

- **Slide 17 Comment:** It's not entirely clear what "Number of targeted electrification customers" means in this table and the term would benefit from clarification. Does it mean "Number of gas customers converted to either fully electric or hybrid electric/delivered fuels"?
- **Slide 17 Comment:** The "2050 monthly total cost of ownership for migrating customer" row is confusing in the context of the Alternative Heat Infrastructure scenario and the Continued Use of Gas scenario. In the Alternative Heat Infrastructure, it appears "migrating" customers could either be converting from gas heating to air-source heat pump heating or networked geothermal heating. In the Continue Use of Gas scenario, it's not clear if there is a migration path being considered. Also, if monthly total cost of ownership data is presented in a summary table, it would be helpful to provide a more detailed graph or table on this topic to provide more context – slide 68 showcases monthly energy costs for migrating vs. non-migrating customers but our understanding is that those are distinct from monthly total ownership costs. Clarification on this topic would be helpful.
- **Slide 18 Comment:** It's not clear why both "Low" sensitivities for the High Electrification and Continued Use of Gas scenarios show an economy-wide cost in the "Natural Gas" category while both "High" sensitivities show no economy-wide cost in the "Natural Gas" category. Context on this point would be helpful.
- **Slide 23 Comment:** On the last bullet, it would be helpful to specify if the electricity rate increases shown are inflation adjusted. This comment is also applicable to slide 58 showing electricity rates by scenario in 2035 and 2050.
- **Slide 33 Comment:** The graph on this slide showing the number of heating devices by type for residential households in Rhode Island is helpful, but it would also be helpful to have more insight into the amount of fuel combusted by fuel type in the residential sector across time, both at an aggregated residential sector level and a per household level. No such graph currently exists in the presentation. For example, in the Hybrid Delivered Fuels scenario it appears that approximately 63% of homes in 2050 have a hybrid electric/fuel oil heating system in 2050, but the graph doesn't provide any insight into the volume of fuel the average home with this heating system is combusting in 2050. Is the average home with hybrid electric/fuel oil heating system using 5, 50, or 100 gallons of fuel in the typical winter in 2050? This information on amount of fuel combusted by type of fuel in the residential sector would be extremely useful for all scenarios, but particularly the scenarios that rely heavily on hybrid heating arrangements in the residential sector (Hybrid Delivered Fuels, Hybrid Gas).
- **Slide 33 Comment:** It appears that all scenarios have some levels of electric resistance heating equipment in 2050. It would be helpful to provide some context on what exactly this means. For example, does this mean that these homes rely on electric resistance heat as their primary heating source? Since the graph represents counts of heating equipment, what is considered "one electric resistance heating device" in this context?
- **Slide 35 Comment:** The comments related to slide 33 are applicable here as well, with the caveat that, in the commercial sector, aggregate commercial sector fuel consumption by fuel type in given year is more relevant/useful than "per business" or "per commercial building" consumption data (opposed to per household data in the residential sector).

- **Slide 56 Comment:** Based on graph on left, it appears that the installed capacity of "Existing Firm" resources remains relatively flat in the High Electrification scenario (~25 GW of installed capacity) from 2025-2050, but the graph on the right appears to show that these "Existing Firm" resources stop contributing to annual generation in the 2030s. It would be helpful to provide additional context on this "Existing Firm" vs. "New Firm" dynamic presented in the graph. For example, are the "Existing Firm" resources still utilized during peak events in 2050, but they are so rarely used that their annual generation appears nonexistent on the graph in the 2040-2050 range?
- **Slide 56 Comment:** It's not clear what the zebra white/gray pattern in the bottom right is referring to (not included in graph legend).
- **Slide 64 Comment:** In multiple scenarios (Staged Electrification, Alternative Heat Infrastructure, Hybrid Gas Backup, Hybrid DF Backup), the "Low Bound" sensitivity is not the lowest incremental cost scenario. In these four scenarios, the "Managed Transition" sensitivity has a lower incremental cost. Although the 6 sensitivities are explained at a high level on slide 6, I can see this table on slide 64 creating some confusion. For example, is the "Managed Transition" sensitivity applied as another "layer" of sensitivity onto the "Low Bound" sensitivity for each scenario?
- **Slide 65 Comment:** It's not clear why the "High" (conservative) residential water heating and commercial water heating cost parameters shows a lower low-end abatement cost range (-\$161/tCO_2e for residential, \$87/tCO_2e for commercial) than the "Low" (optimistic) cost parameters (-\$123/tCO_2e for residential, \$140/tCO_2e for commercial) and some additional context on this finding would be helpful.

Conclusion

Thank you for the opportunity to submit written comments. If you have any questions or concerns, please do not hesitate to reach out.

Sincerely,

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