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Technical comments on draft *Building Energy Transition Plan*

As a supplement to our comments on the September 18, 2021, draft *Building Energy Transition Plan*, the Office of People's Counsel provides these technical comments.

Earlier this year, OPC retained Synapse Energy Economics, Inc. to evaluate scenarios for the gas and electric systems in the context of Maryland's greenhouse gas reduction goals. We did so out of concern about the customer impacts flowing from the lack of a comprehensive future plan for the state's electric and gas utilities and, in particular, the gas utilities' accelerated investments in new and replacement gas infrastructure. Synapse's work is not yet complete.

Last week, we asked Synapse to perform a preliminary review of the E3 report. That review identifies serious problems with the E3 analysis and its directional results, which are reflected in the draft buildings plan. We believe Synapse's preliminary findings may be useful for MWG's and Commission's consideration and provide them below.

September 29, 2021

Memorandum

TO: MARYLAND OFFICE OF PEOPLE'S COUNSEL

FROM: ASA HOPKINS, PHD, KENJI TAKAHASHI, AND ALICE NAPOLEON

DATE: SEPTEMBER 29, 2021

RE: FINAL MEMO: BRIEF EVALUATION OF MARYLAND BUILDING ENERGY TRANSITION PLAN AND ASSOCIATED MARYLAND BUILDING DECARBONIZATION STUDY CONDUCTED BY E3

At the request of the Maryland Office of People's Counsel, we have briefly reviewed the *Maryland Building Energy Transition Plan* (the "Plan") and the associated *Maryland Building Decarbonization Study* conducted by E3 ("the E3 Study").

Background

The E3 Study evaluated three scenarios for the future of building energy and emissions in Maryland. These are summarized in the Plan as:

1) High Electrification – Almost all buildings adopt heat pumps and improve shell performance by 2045. All-electric new construction starting in 2025.

2) Electrification with Fuel Backup – Existing buildings adopt and use heat pumps for most of the annual heating load by 2045, but existing furnaces and boilers provide backup heating in the coldest hours of the year. Fossil fuels are replaced with low-carbon renewable fuels by 2045. All-electric new construction starting in 2025.

3) High Decarbonized Methane – Most buildings use fuel for heating and improve shell performance by 2045. Fossil fuels are replaced with low-carbon renewable fuels by 2045.[1]

As summarized by the Plan, the Study concluded that the Electrification with Fuel Backup case is both lowest cost and lowest risk among the three scenarios.[2] The cost uncertainty in the High Decarbonized Methane and Electrification with Fuel Backup cases is driven by uncertainty in the cost of synthetic natural gas, while the uncertainty in the cost of the High Electrification case is a result of uncertainty in the cost of electricity system improvements, building shell improvements, and building equipment.[3]

[1] Plan, page 2.

[2] Id.

[3] Id., page 2-3.

Overall, the Plan generally recommends pursuing the Electrification with Fuel Backup pathway, while being opportunistic with respect to funding or other support that could lead to a reduction in the cost of the High Electrification case, making that case more attractive.

Synapse evaluation

Summary

We have found serious errors in the assumptions of the E3 Study, which call into question the directional results that are reflected in the Plan. The largest single error is in the assumptions around building shell improvements: the E3 Study assumes that Maryland would pursue a massive and expensive practice of deep building retrofits that are not cost-effective in terms of energy savings, but only in the High Electrification and High Decarbonized Methane cases. This drives up the apparent cost (and cost uncertainty) of those cases relative to the Electrification with Fuel Backup case.

In addition, we found that the E3 Study understates the uncertainty in the availability of decarbonized methane gas and understates the performance of heat pumps.

We also found that the regulatory and ratemaking implications of the different cases are important considerations for the development of the Plan.

Finally, we found that the cost price of delivered gas will need to increase substantially to maintain the gas infrastructure for use in just a few peak hours. This will make it very unattractive for customers to remain on the gas system, increasing the risk of mass defections.

Overall, we conclude that the Plan should not embrace the Electrification with Fuel Backup approach, based on the E3 analysis presented to date. It is possible that revised analysis, correcting the assumptions we have identified would show a fuel backup approach as favorable. However, based on the information available today, we recommend the Plan be amended to build its approach from the High Electrification case, with allowances for retaining limited continued use of gas for certain customers when adequately supported by objective analysis.

Building shell improvements

The E3 Study assumes that Maryland buildings undergo expensive and extensive deep retrofits in the High Electrification case. Specifically, E3 assumed that homes would receive deep retrofits at a cost of approximately $37,000 per home[4] (for single family homes), with comparably large and deep shell improvements in multifamily and commercial buildings.[5] In total, the annualized cost of building shell

[4] E3 Study, page 98.

[5] See E3 Study, pages 100, 102, and 104, which show that the capital costs for building retrofits are the dominant annualized cost for all-electric and multi-fuel buildings.

improvements in 2045 would be roughly between $3.8 and $6.2 billion.[6] E3 assumes these retrofits would reduce space heating and cooling energy consumption by 29 percent (for residential) and 34 percent (for commercial).[7]

Deep retrofits are not required in order for existing buildings to use electric heat pumps. In the Maryland climate, heat pumps are capable of delivering enough heat to maintain comfort even in homes that are not retrofit, although the heat pumps would need to have a larger heating capacity. Some level of weatherization is desirable to improve comfort and to reduce the cost of electrification if it is cost-effective.

We evaluated what savings in energy costs would be gained by Maryland's building owners in return for these investments in the High Electrification case. In the case of an all-electric single-family home, the E3 Study shows an annual customer electricity cost of about $1,200 in 2035 in the High Electrification case.[8] Even if this entire electric bill were for space heating and cooling, the retrofit would have reduced the annual electric bill 29 percent, from less than $1,700 to $1,200, for annual savings of less than $500. A deep retrofit that costs $37,000 to achieve annual bill savings of $500 does not make economic sense.

In addition to evaluating the economics of the building shell improvements from a customer perspective, we analyzed the costs and benefits from the system level. We compared the state-wide annual retrofit cost of $3.8 to $6.2 billion to the total resource cost that it avoids. The primary resource costs that building shell improvements avoid are the costs of larger-capacity heating and cooling systems and electric generation (both energy and capacity), transmission, and distribution.

E3 assumes that the incremental levelized capital cost of HVAC equipment the High Electrification case is between $600 million and $1.5 billion per year.[9] If this incremental cost is proportional to the capacity of the heat pump systems, and if we assume space heating and cooling energy savings of 30 percent for this scenario,[10] forgoing deep retrofits would increase these levelized HVAC equipment costs by between $180 and $450 million. (Total HVAC system cost does not increase proportional to capacity, but for the purposes of this rough calculation it is reasonable to assume that *incremental* cost may be proportional to capacity.)

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[6] E3 Study, page 25. Values are estimated based on the presented total costs for the High Electrification and High Decarbonized Methane cases, and assume that the Building Shell Improvement costs are the same in those two cases.

[7] Id., page 40.

[8] Id., page 34. Value estimated based on the All-Electric bar in the High Electrification case.

[9] Id., page 25. Values estimated based on the HVAC portion of the High Electrification bars, using comparisons with the Electrification with Fuel Backup bars.

[10] Based on the 29 percent savings for residential and 34 percent savings for commercial buildings.

The E3 Study calculates that the additional efficiency in the High Electrification case saves about 1.4 TWh per year.[11] At an energy cost of $49 per MWh,[12] forgoing this efficiency would cost the state an additional $69 million per year.

Forgoing building shell improvements would mean a further increase in the winter peak, beyond the 15 GW by 2045 that E3 calculates.[13] Assuming an average of 30 percent lost efficiency, the peak would instead rise by 21.4 GW by 2045.[14] This would create costs for generation capacity and transmission and distribution upgrades. Using E3's assumed incremental costs for these services for the period 2024-2045, annual electric sector costs would rise by about $579 million per year for generation capacity, $257 million per year for distribution capacity, and $180 million per year for transmission capacity.[15]

In total, in exchange for deep retrofits costing $3.8 to $6.2 billion per year, the total savings would be about $1.3 to $1.5 billion per year.[16] Viewed at the system level, as at the customer level, the retrofits assumed in the E3 Study are not cost-effective. The net result of these assumptions is to make the High Electrification case appear more expensive, and more uncertain, than it actually is. Simply removing any building shell improvements from the High Electrification case would change its calculated cost from E3's "$7.7 to $14 billion per year" to $5.2 to $9.3 billion per year.[17]

It is surely true that some level of building shell efficiency is cost effective, in the High Electrification case. That level of cost-effective efficiency would reduce, rather than increase, the annual cost of this case. Some level of building shell efficiency would also, surely, be a cost-effective add-on to the Fuel Backup case.

Uncertainties

Table 1 shows the primary sources of cost uncertainty in each case. Our evaluation of the E3 Study found that the largest source of uncertainty in the cost of the High Electrification case is the cost of building shell improvements. The previous section showed how those uncertainties can be reduced while also reducing the cost of that approach. The High Electrification and Electrification with Fuel

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[11] Derived from comparing estimates of the "Efficiency-SH" and "Efficiency-AC" savings values in the two cases presented on pages 51 and 52 of the E3 Study.

[12] E3 Study, page 79

[13] Id., page 19

[14] 30 percent efficiency applied to a peak growth of 21.4 GW results in the 15 GW from the E3 Study. (15/0.7=21.4).

[15] E3 Study, p. 80, shows annual capacity costs of $90/kW-yr, transmission capacity costs of $28/kW-yr, and distribution capacity costs of $40/kW-yr for the period 2024-2045.

[16] Total savings equals $180 to $450 million + $69 million + $579 million + $257 million + $180 million = $1,265 million to $1,535 million.

[17] $7.7 billion - $3.8 billion + $1.3 billion = $5.2 billion. $14 billion - $6.2 billion + $1.5 billion = $9.3 billion.

Backup cases share the same uncertainty regarding building equipment.[18] The Fuel Backup case has a $1.8 billion difference between total costs of the High and Low cases, reflecting the uncertainty associated with that case. The High Electrification case has virtually the same uncertainty regarding HVAC and water heating costs as the Electrification with Fuel Backup case, and adds about $0.6-0.8 billion in uncertainty regarding cooking and laundry.[19] This leaves the primary difference in uncertainty between the two cases to be uncertainty in electric system costs, on one hand, and uncertainty in decarbonized methane costs, on the other.

Table 1. Primary sources of cost uncertainty by case

High Electrification	Electrification with Fuel Backup	High Decarbonized Methane
Building shell efficiency	Building equipment	Building shell efficiency
Building equipment	Decarbonized methane	Decarbonized methane
Electric system improvements		

We have not been provided E3's supporting data, and E3 provides no explanation regarding the range in scenario costs associated with uncertainty in the cost of electric system improvements. The Study presents only point values, and the values it presents for grid costs are conservative. As the Plan points out, Pepco has recently completed an electrification study[20] that shows that peak load in a high-electrification case would be comparable to historical growth rates. This means that higher peak loads should generally be able to be accommodated during the normal replacement cycle of grid assets, thus mitigating any extra costs due to early replacement or unexpected construction. The Pepco study also points out the critical role of load flexibility in mitigating grid costs. Newly electrified loads, particularly such as electric vehicles and water heaters, are potential sources for capacity and to mitigate peaks on the transmission and distribution systems at lower costs than the combustion-turbine and traditional construction costs that E3 assumes. The E3 Study does not address flexibility.

On the other hand, the E3 Study is highly optimistic when it comes to the availability and cost of hydrogen and synthetic natural gas (SNG). The E3 Study does not give proper weight to the importance of its assumption that there would be a multi-state or national push for this path, in order to support the scale of industry to produce these fuels and the resulting cost declines. For example, in order for E3's optimistic cost scenario for SNG to come to pass, the US would need to capture CO_2 from biofuel

[18] Page 25 of the E3 Study shows that the uncertainties in building equipment are comparable between these two cases, aside from uncertainty in the cost of cooking and laundry equipment.

[19] E3 Study, page 25. Fuel Backup: $2.4 billion - $0.6 billion = $1.8 billion. Additional costs for cooking and laundry are estimated from the High Electrification columns.

[20] https://edocket.dcpsc.org/apis/api/Filing/download?attachId=140553&guidFileName=1211ecc8-254d-4fc1-9143-10c8442e3fbc.pdf

production (which generally takes place far from Maryland), and either bring the CO_2 to the location of additional off-grid generators and electrolyzers making hydrogen (with new CO_2 pipelines), or transmit the additional electricity to the location of the CO_2 (with new transmission lines). This level of nation-wide coordination, industrial development, and multi-state infrastructure planning would require federal leadership. This means that if Maryland were to count on the Fuel Backup case to reduce costs, the state would be counting on federal leadership on the development of SNG. There is scant evidence that this is a federal priority.

In summary: While there is uncertainty in the cost of electric grid upgrades in the high electrification case, it is more likely that these costs are overstated. Meanwhile, the uncertainty regarding both the availability and cost of SNG required for the Fuel Backup case remains large and more likely to skew toward the higher end of the range without extensive federal leadership and support. Any case that relies on substantial amounts of SNG in order to meet the state's building decarbonization objectives has not only a cost risk, but also a real risk that the greenhouse gas emission reductions counted on are simply not available. Because of the long-time stock-turnover time period in building heating systems, it is not possible to change course and fully electrify homes late in the game if SNG supplies turn out to be expensive or unavailable.

Heat pump performance

Our review identified two issues with E3's assumptions regarding heat pump performance. First, E3 apparently assumed that the coefficients of performance for heat pumps will be static over time. The E3 Study provides the efficiency values that E3 assumed but does not include any information about assumed improvements in performance for newly installed systems. Given the intense interest and scale that nationwide building decarbonization would bring to heat pump technology, in all climate zones, we disagree with this assumption. The NREL Electrification Futures study, for example, assumed (in its central "moderate advancement" scenario) that the efficiency of residential heat pumps would increase by 25 percent between 2020 and 2030, on its way to a 45 percent increase by 2050.[21]

Second, E3 assumed that the coefficient of performance (COP) for commercial heat pumps will be lower (2.5 or 3.6 depending on the case) than that of residential heat pumps (3.2 or 4.0, respectively). NREL, on the other hand, assumes that commercial products have a higher COP. Given the opportunity to capture waste heat from within commercial buildings, which does not exist in residential buildings, we agree with NREL's assessment.

Regulatory and ratemaking considerations

The Plan identifies a key challenge with the Electrification with Fuel Backup case: under current ratemaking paradigms, customers in this scenario who have both a heat pump and gas furnace would be better served by using their heat pump exclusively through cold periods, and not using their gas furnace at all. In fact, they could choose a slightly larger heat pump and avoid connection to the gas system

[21] NREL, "Electrification Futures Study Technology Data," available at https://data.nrel.gov/submissions/78

entirely (with its associated customer charge).[22] The Plan states that regulators would need to develop a rate approach that encourages customers with dual fuel systems to maintain the combustion system and switch fuels during cold periods. While the Plan is silent on the options, this rate approach could include recovering costs of the gas system from electric ratepayers or taxpayers, in order to keep gas rates low enough to be attractive during the only times of year when customers would use the system.

In contrast, the High Electrification scenario requires no major reforms to utility-specific cost recovery and ratemaking. As customers see that it makes sense for them to switch to heat pumps and off the gas system, they would do so, and their buildings would be decarbonized as a result. We would stress, however, the importance of public policy and support to assist low-income customers and renters with this transition early in the process. Because these ratepayers have limited ability to change their heating systems, there is a risk they could be left paying high gas rates as those with more means leave the system. Carefully managing the reduction in gas system utilization and investments, as in the "structured transition" sensitivity in the E3 Study,[23] could be essential to mitigate risks to ratepayers and the utilities' owners.

Gas system costs

Assumptions for the Electrification with Fuel Backup case regarding maintaining the current gas system, including replacement of existing pipes, are not clear from the E3 Study. Regardless of these assumptions, however, the price of delivered gas will need to increase substantially to maintain the gas infrastructure for use in just a few peak hours. Dramatic increases in gas utility volumetric charges, customer charges, or both will likely be required in this scenario and will result in a growing number of customers defecting. In contrast, the High Electrification case does not need backup fuels, because heat pumps are capable of cost-effectively providing heating during peak hours.

Concluding remarks

Our brief evaluation of the Maryland Building Energy Transition Plan and its supporting analysis by E3 indicates that the Plan may be drawing unwarranted conclusions for the state based on E3's incomplete analysis and unfortunate assumptions. Based on our rough calculations based on the E3 Study (without any access to data not presented in the E3 Study itself), it appears that the Plan's statement that the Electrification with Fuel Backup case is both lowest cost and lowest risk is incorrect. It appears that the High Electrification case is in the same cost range as the Electrification with Fuel Backup case, and has less cost uncertainty. Even more important, the High Electrification case does not depend on new technologies and industries that are outside Maryland's control (namely SNG), and therefore does not risk leaving the state to find out in the 2030s that it is too late to meet its targets without costly early replacement of heating systems.

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[22] We would add that a customer could even choose to use a delivered fuel, such as propane, on the coldest days and both minimize their electric grid impact and avoid paying for the gas system.

[23] E3 Study, page 83.